Barclaycard headquarters

Barclaycard’s brief for its new headquarters building in Northampton seemed to ask the impossible. Conventional wisdom says that prestige offices cannot be squared with green engineering – prestige being associated with waste, and low energy with restraint.

The achievement of an ‘excellent’ BREEAM rating at the design stage seemed to square these two circles. It showed the developer was committed and that the design team had responded with a mix of conventional and distinctly unconventional low energy services: peak-lopping ammonia chillers, active chilled beams, exposed mass and mixed-mode mechanical and natural ventilation.

But have the building’s environmental credentials been borne out in practice? Are the occupants happy with the mixed-mode operation and the building’s broader range of environmental conditions? Moreover, did the developer’s courage in low energy architecture create status or austerity?

Full details of the building’s construction are given in the earlier Building Services Journal article, ‘Squaring Two Circles’. In brief, the development comprises a series of three staggered linear blocks on an east-west axis, connected by a 260 m internal street. The collection of three and four-storey offices are 15 m deep either side of the 9 m wide, glazed street.

Unusually for this kind of building the office facades are open to the street, except on the top floor where windows prevent the reverse flow of warm air. Ceiling heights are generous, ranging from 3.55 m to 4.3 m depending on the floor.

Most of the office space was designed with the speculative market in mind. A secure credit card department is on a lower ground floor, while the staff dining facility is on the ground floor of the east wing.

Representing a growing trend in information technology, there is no mainframe computer suite. Instead there are 12 data communication rooms distributed around the building. Only one has a dedicated cooling system. The remainder rely on central services.

The north elevation looks out over three linked lakes which, among other benefits, provide a source of (nominal) free cooling for the chilled beams.

Basics of the services design

Permanent natural ventilation is provided by a series of 45 mm diameter plastics tubes sized to give 5000 mm²/m of facade. These go through the lintels above the fanlight windows. The fan-
The high-level windows in the street are operated by pneumatically-driven rams and controlled by the Serck building energy management system according to temperature, wind and rain setpoints.

The mechanical displacement ventilation is designed to be triggered by mixed gas or space temperature sensors. Doubts about the efficacy of the sensor, combined with few complaints of poor indoor air quality, has made the maintenance team wonder if the gas sensors have ever switched on the ventilation. Barclaycard is considering changing to CO₂ sensors as they are more reliable, easier to recalibrate and cheaper over ten years.

The vertically zoned ducts were designed to equalise air supplied to each floor. This was the only balancing mechanism, and in practice more air was delivered to the ground floor than the top floor. This was resolved by reducing diffuser density at the ground level and increasing it on the top floor.

Top floors are inherently prone to overheating as the temperatures in the monopitch atrium roof can reach 40°C. With the vertical zoning, this can cause lower floors to be over-cooled when the top floor sensors trigger mechanical ventilation.

Some 3500 tubed trickle ventilators were fitted above the windows but, due to complaints from staff, about 1200 have been blocked. A further 1000 trickle vents have been fitted with deflectors to stop cold air dumping on occupants. The pressure test results suggest that even with one-third of the trickle vents permanently blocked, the leakage rate is still at least 50% higher than BSRIA recommends for a naturally ventilated building (see ‘BRE pressure test, p41’).

Operational experience: lighting

All offices have fluorescent luminaires with passive infrared occupancy-sensing detectors and two-stage dimming. Since occupation the dead band has been widened from 2.5 minutes to 12.5 minutes. This ensures the detectors pick up slight movements from occupants working on computers. Lighting levels are 350 lux.

Most complaints have been about the brightness of the lighting, even though the light level is 350 lux – 150 lux lower than the occupants' former offices. The building managers speculate that dissatisfaction with lighting seems to be less to do with the lamps and more due to the
Pressure of work and masses of white, laminated paper spread across the desks. As the old offices also had pull cords, loss of personal control rather than lighting level may be an issue.

The building managers have identified a split between those who had control in the previous building and those who did not.

Energy and water consumption
As the building is a prestigious head office, its energy and water consumption have been compared to the Type 4 building type in ECON 19, even though it is not fully air conditioned (see figure 1, right).

Gas is used for hws in the kitchens and space heating. A detailed analysis of gas bills shows that, in the 12 months from June 1998, total gas consumption was 113 kWh/m² (treated floor area). It is estimated that 96 kWh/m² is for space heating and 17 kWh/m² for catering (relatively high due to the large dining-room and over 2000 meals being served daily).

Normalised for standard weather conditions of 2462 degree days, the gas consumption for space heating is 111 kWh/m² and the total gas consumption 128 kWh/m². This is 12% above the Type 4 good practice benchmark of 114 kWh/m², but only 60% of the typical value of 210 kWh/m².

This achievement is largely due to the avoidance of tempered heat requirements of extensive high volume mechanical ventilation. Also, office internal heat gains are relatively high, and the condensing boilers can be turned off in summer.

A detailed analysis of electricity bills shows that, in the 12 months from November 1998, actual electricity consumption was 204 kWh/m² (treated floor area). This means that electricity consumption is 13% below the unadjusted Type 4 good practice benchmark of 234 kWh/m² and only 57% of the typical figure of 358 kWh/m².

Low fan power has helped. The designers set a target of 1 W/litre/s, and the installed fan power of 4 W/m² is well below the good practice level of 8 W/m². Natural exhaust via the atrium helps by negating the need for extract fans.

Although pump energy is reduced by variable speed drives, operating hours are high as the lake pumping circuits are on for much of the winter.

At 9 W/m², installed lighting loads are better than good practice, as is lighting efficacy. The estimated maximum running hours for electric lighting is just under the good practice level of 3500 h/y. Presence detection ensures that the use of lighting is restrained to the good practice level of 70%. This means that full load hours are 2400 h/y, making office lighting consume just 18 kWh/m²/y. The result is an electricity consumption of 73 kWh/m² – over twice the typical value of 36 kWh/m².

Overall performance
Electricity
In the 12 months from November 1998, actual electricity consumption was 204 kWh/m².

Gas
In the 12 months from June 1998, total gas consumption was 113 kWh/m².

Carbon emissions
The building emits 114 kg CO₂/m² – 9% below the good practice benchmark.
Results from the occupant satisfaction survey

Figure 3: Overall satisfaction with comfort conditions at the Barclaycard head office.

Figure 4: Overall satisfaction with health and perceived control over the environment.

The occupant survey: comfort
A survey for building occupants was carried out at the beginning of December 1999. Two hundred and eighty office staff were asked to fill in the standard PROBE questionnaire, of which 150 were first floor occupants and 130 from other parts of the building. The response rate was 91% for the first floor sample and 82% for the wider building population.

In terms of the occupant profile, the building has more women than usual and staff have fewer seats by windows. Staff are also accommodated predominantly in large workgroups in fairly regimented open-plan layouts. Both characteristics may make staff more critical of their conditions. Most staff had worked in the building for more than a year, and churn rates are low compared to other buildings. Higher churn tends to mean higher satisfaction, so the static population at Barclaycard will have tended to reduce the comfort scores.

Figure 3 (below left) shows the levels of occupant satisfaction with the building’s environment. The benchmarks shown are based on scores from a recent sample of 50 UK buildings studied by Building Use Studies, so they represent average rather than good UK conditions.

On comfort, Barclaycard scores consistently better than the benchmarks, with summer temperature and air quality, and lighting all being significantly better. Negative observations include lack of temperature stability (which some respondents said affected productivity), lower floors too cool while upper floors are too warm, and the seeming indifference of system settings to weather conditions.

In terms of air quality the building comes out as typical for winter conditions, although it is perceived to be more humid and stuffy and temperatures are felt to vary. For summer, the building is more comfortable and considered to be significantly cool – something rare in the UK.

Natural lighting is marked down by the occupants and, as in most buildings, there is too much electric lighting. The occupant perception of glare is typical for UK buildings.

The score for noise from other people is higher than that from colleagues, indicating problems with circulation and space planning.

Control and response
Scores for perceived control are all significantly lower than the benchmark figures, which themselves are well below the scale mid-point (figure 4, left). This is balanced by good scores for quickness of response, with that for cooling being significantly better than the benchmark.

The forgiveness score is a measure of the extent to which occupants tolerate some of the reported problems. Here, forgiveness is above the benchmark, so Barclaycard’s occupants may be giving the building the benefit of the doubt in some cases.

The building management responds to users’ requests for assistance through a telephone help desk. This administers reactive maintenance as well as room bookings and catering requirements for meetings. Faults and complaints are logged on a database and passed to in-house maintenance staff or a contractor.

The required response time is decided by the service desk operator in a range between emergency (1 h) and ten days. Issues are categorised by subject, for example heating, lighting, general maintenance, windows, etc. Building services and lighting issues are always given a 1 h response time.

The service desk is currently averaging 200 calls/day, of these about 48 concern HVAC or lighting. Interestingly, only 25% of those who
requested changes to systems rated the response time as fast, while 24% rated it as effective. Both these scores are significantly lower than the benchmarks.

Occupants express positive views on the building’s design and the way their needs are met, showing that staff are happy with the facilities. The health score, though, is low. This may be due to the time of year the survey was carried out, but the question asks whether people feel more or less healthy when they are in the building. As this is designed to solicit a relative answer, it should not be sensitive to the time of year. This needs further investigation.

Study of the survey samples shows that the building may be better on the upper floors, or at least on levels above the ground floor.

Overall building performance

There is nothing exceptional about the occupants’ views of the building. Most of the occupant survey scores are close to the averages or mid-points, and this can be explained by a cluster of negative factors which push the building’s overall score down. These include large, open-plan areas with lack of differentiation between workgroups, the lack of seats near windows, and the absence of personal control for the majority. Noise distraction is also a factor, along with intrusive circulation routes.

While occupants use words like impressive, pleasant, airy and bright to describe the building, criticisms include car parking, intrusion of doors, a lacklustre reception area and style over substance (ie too much emphasis on image and not enough on usability – a common flaw).

A lack of meeting rooms was mentioned by a significant number of respondents and there was a lot of negative comment about storage arrangements. It seems that there is not enough personal storage, especially for coats.

Note that the survey did not measure staff morale (a redundancy programme was underway at the time of the survey) nor the type of work that was being carried out.

On the energy front, it is pleasing that at least the PROBE Team has found a prestige head office which produces CO₂ emissions below the good practice level – an exceptional performance, showing that staff are happy with the facilities.

The BRE pressure test

The BRE carried out a fan pressurisation test of the Barclaycard head office. Four fans were used to pressurise the building’s massive envelope of 21 000 m². These were the BRE’s large fan pressurisation system, BREFAN, and the three medium-sized BREFANs. To date this is the largest building the BRE has tested using these fans.

Prior to the test the mechanical ventilation plant was shut down and the large number of supply and extract grilles sealed using polythene and duct tape. When first occupied, the building had 3500 permanently open trickle vents. Some of these have been sealed and others have been fitted with internal deflectors. Those left open were not sealed for the test as they are considered part of the base ventilation system and cannot be closed in normal operation.

The results of the test gave an average air leakage index for the building of 17.8 m³/h/m² at a pressure differential of 50 Pa. As plotted on the BRE/BSRIA database, the building is classified as just above the average benchmark value (figure 5, above).

Only a very brief air leakage audit was possible owing to the time taken to prepare the building for the test. As expected, a lot of air was passing through the permanent ventilators, especially those that were fully open. However, the screens on the inside face of the ventilators were dust-covered, which may have reduced their air flow rate.

A sample of the high-level, pneumatically-operated windows in the atrium showed them to be well sealed, with only slight leakage at some bottom corners. However, air leaked into the capped-off cavity through the window frame joints and was noticeable above the atrium windows. Leakage was also detected at the bottom of the sealed windows on level four. A selection of office windows was tested. These were found to be well sealed when closed, though some opening toplights leaked when the window was not shut tightly against the draughtproofing.

Air leakage was also detected through the window frame joints and was noticeable above the trickle ventilators at the junction with the columns.

Brian Webb is a senior scientist and heads the Airtightness Technical Consultancy service at the BRE. This pressure test was funded by the DETR as part of the BRE/BSRIA Building Services Journal initiative on improving building airtightness.

Figure 5: The air leakage data for the Barclaycard head office, plotted on the BRE/BSRIA database. The cumulative distribution represents a sample of three building types: those designed to be airtight, buildings designed without airtightness as a design criteria, and some older buildings.
**key design lessons**

1. **A low energy, prestige office**
   - At last the PROBE Team has found an ECON 19 Type 4 office with CO2 emissions 5% below the good practice level. The absence of a large computer suite is balanced by high energy use from the desktop pcs. Most significant, perhaps, the CO2 emissions for all building services is 25% better than good practice.

2. **Life cycle costing avoids false economies**
   - desktop pcs. Most significant, perhaps, the absence of a large computer suite is 9% below the good practice level. The ECON 19 Type 4 office with CO2 emissions at last the PROBE Team has found an A success for mixed-mode operation

3. **Manual versus automatic windows**
   - Barclaycard shows that neither option is a panacea. Automatic with manual override may be ideal but is expensive, although even top-hung windows must be closed at the end of the day. Manual opening should deal with any winter overheating, but typically staff in core areas are too hot while those at windows need heating to counter cold surfaces.

4. **Vertical versus horizontal zoning**
   - The degree of resolution when creating zones is a compromise between CO2 sensors, but these were downgraded to much cheaper mixed gas sensors. The former may cost three times as much, but they can be recalibrated on-site every five years, while the latter require replacement or recalibration off-site every two years.

5. **A success for mixed-mode operation**
   - The PROBE study appears to justify our initial estimate, but if we had known how the building was ultimately going to be used we would have probably been more conservative in our estimate. As m&e designers we do not (indeed, cannot) claim responsibility for achieving the goal. We were fortunate that we had a committed client prepared to accept different ideas, an architect with sympathy for engineering services and integrated design solutions, and ultimately a building operator keen to exploit the energy minimising potential of the building and systems.

**designer’s response to the feedback study**

The client’s brief was for an environmentally-friendly, naturally ventilated, intermittently occupied building. writes David Arnold of services design consultancy Troup Bywaters & Bodie.

As designers of the building services, we told the client’s project manager that we estimated the energy use of the mixed-mode design solution would only use 60% of a typical comparable building. As a measure of caution, he told the client the energy use would be 75%.

The PROBE study appears to justify our initial estimate, but if we had known how the building was ultimately going to be used we would have probably been more conservative in our estimate. As m&e designers we do not (indeed, cannot) claim responsibility for achieving the goal. We were fortunate that we had a committed client prepared to accept different ideas, an architect with sympathy for engineering services and integrated design solutions, and ultimately a building operator keen to exploit the energy minimising potential of the building and systems.

In response to the key design lessons:

**A low energy, prestige office**: Significant factors in the exceptional performance of the building, in terms of energy use, were the integration of thermal storage in the building and cooling pond, solar shading and low transport energy use for the air and water systems. With 75% of the ceiling slab exposed and closely coupled to the occupied space, this seems to provide about the right balance for overnight cooling.

**Life cycle costing avoids false economies**: CO2 sensors were specified originally but replaced by interior detectors as part of a cost saving exercise to maintain the budget. With hindsight it was a mistake.

**Manual versus automatic windows**: If the budget had been greater we would have used automatic windows with local controls. They were considered but rejected on cost grounds. Automatic window control would have increased control of overnight cooling but I am not certain whether it could have been justified on life cycle costs alone.

**Vertical versus horizontal zoning**: This is a lesson well learnt. All buildings of this type have a problem with overheating on the upper floors. We were aware of the problem and were of the opinion that the temperature difference would be within the design limits. Generally this was the case, but it led to complaints and we would use floor by floor control in future.

**A success for mixed-mode operation**: Mixed-mode has proved successful but it has been complemented by the proactive involvement and control of the facilities team. We need to develop more robust controls. The design strategy for chillers was that they would only be used for a few days per year in a typical summer. However, they also provide the client with an insurance against the effects of further climate change.

As designers we are in a privileged position to have the feedback from the PROBE study. It is complimentary about many of the design features but several lessons have been learnt. Hopefully, these will be used by designers in a less privileged position.