Charities Aid Foundation

THE PROBE PROJECT

Post-occupancy Review Of Buildings and their Engineering (PROBE) was a research project managed by *Building Services Journal* (*BSJ*).

Design and construction details of the Charities Aid Foundation headquarters were featured in the March 1996 issue of *BSJ*, while the PROBE study of 1997 was reported in the February 1998 edition.

BSRIA Members can access all *BSJ* building analyses and PROBE articles via BSRIA's on-line abstracting service, IBSEDEX. PDF versions of PROBE investigations, including that of the CAF headquarters, can also be downloaded from www.usablebuildings.co.uk.

Sorry if this comes as a shock, but new build is not the answer to the zero-carbon challenge. The sobering fact is that less than two percent of the nation's building stock is renewed every year, which means that 90 percent of the buildings we have now will still be around in 2016 – the government's first zero-carbon target.

New build will also become more of a privilege as lending for capital projects gets expensive and the cost of fuel climbs higher. Add to that increasing control over energy use in buildings through legislation, and it's clear that we need to do far more with what we've already got. Retrofit, then, is going to be the next big thing.

The passive solar buildings of the 1990s that we got so excited about, with their natural or mixed-mode ventilation, night cooling algorithms, intelligent controls, and smart solar shading, are coming round for their first major refit. The headquarters of the Charities Aid Foundation (CAF) is typical of this mid-1990s take on what constituted a low energy building, so what can we learn from its refurbishment?

Building design

Details of the building's construction was well documented in the March 1996 edition of *BSJ*. Suffice to say that the mainly open-plan 3700 m^2 (treated), three-storey building began life as a home for around 200 administrative staff. It's located on the former West Malling aerodrome in Kent and was developed as a pre-let by Rouse Kent (a joint venture between Rouse and Kent County Council).

The steel-framed, U-shaped building is brick-clad. Largely open-plan offices occupy the 13·5 m plan depth and are arranged around a south-east facing open-sided courtyard. Entry to the building is through a full-height glazed reception area, onto which the top two floors once opened out but which is now enclosed by new meeting rooms.

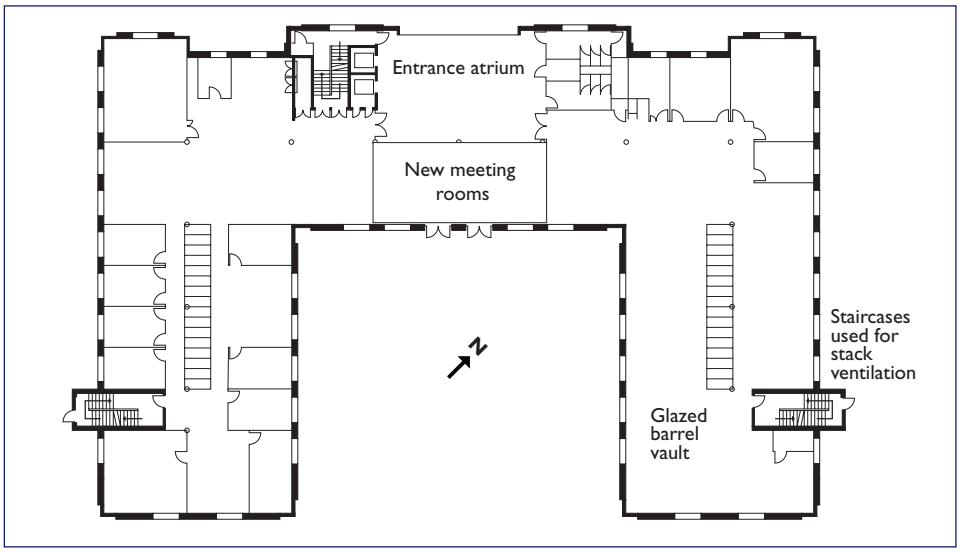
Ventilation was by openable windows and fanlights, with mechanical displacement ventilation via a pressurised floor plenum. In keeping with the times, mechanical refrigeration was avoided by the use of an an innovative indirect evaporative cooling system, whereby a fine water spray was used to cool the exhaust air. The extract air then passed through a plate heat-exchanger which cooled the incoming air.

The floor slabs were exposed to provide thermal mass and some beneficial radiant cooling, while the building's insulation values were in excess of that demanded by the *Building Regulations* of the time.

The glazing was of a high standard, comprising double-glazed Pilkington Suncool solar glass for the south-east and south west elevations, and low emissivity glass on the remaining elevations.

The CAF still occupies its building 12

Photograph: ©Roderic Bunn/BSRIA



Left, Figure 1: The top floor of the Charities Aid Foundation headquarters. The stairwells are used as thermal chimneys. Note the new meeting areas that close off the entrance atrium from the occupied space.

The headquarters of the Charities Aid Foundation was the subject of a PROBE investigation in 1998. Ten years on, **Roderic Bunn** reports on the building's first major refurbishment

years after it was constructed, so there's no change of use to take into account. True, the organisation has got larger, and the occupant density has increased to 360 on average, but by and large the tenant's requirements (and the maintenance resources) have stayed about the same.

The PROBE findings

In 1997 The CAF hq was subject to a PROBE investigation, two years after the building's completion (see box opposite: 'The PROBE project'). The PROBE team selected the building because it seemed an exemplar of its kind.

The 1997 study revealed some shortcomings that were in danger of becoming chronic problems. For a start, inadequate friction in the window mechanisms caused many windows to close under gravity or wind pressure shortly after they were opened. The building was also initially draughty, and there was evidence of uncontrolled infiltration especially around

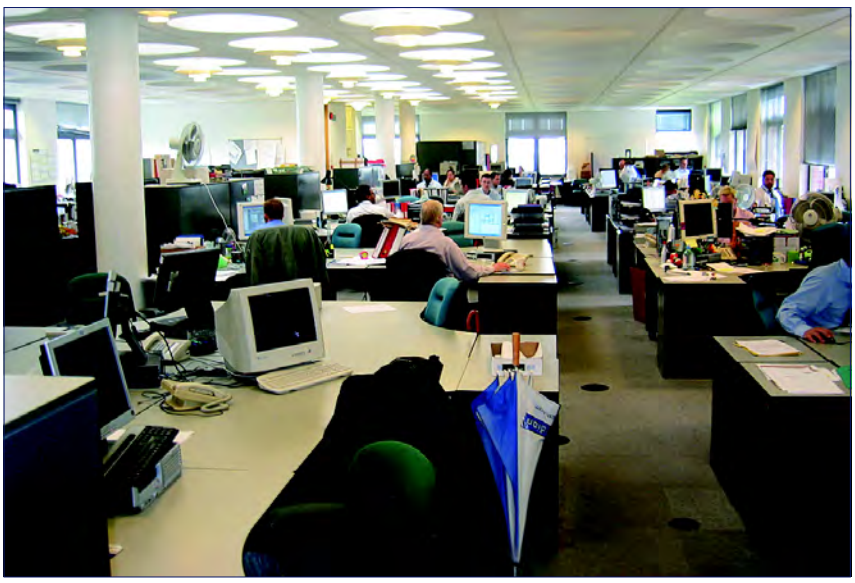
BSRIA PROJECT REVISIT

Project revisit articles look at notable buildings designed by BSRIA Members and investigate their performance over time.

The engineering services at the Charities Aid Foundation (CAF) were designed by building services consulting engineer atelier ten, with architecture by Nicholas Hare Architects.

A building worthy of a revisit is either a construction project notable for its contribution to design innovation and sustainability, or a project that demonstrates a step-change in delivering improvement through the supply chain.

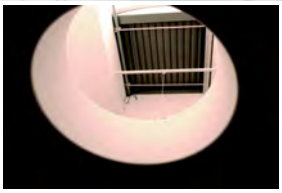
Above: Books were used to prop open fanlights that were never fitted with friction hinges.



Above: The offices in 2006. Count the desk fans in this and the adjacent photograph – always a clue that conditions aren't quite right.

Photographs: ©JPA

KEY **REFURB ITEMS**



The provision of automatic, thermostatically-controlled vents in the upstand of the rooflights help to alleviate solar overheating and also aid ventilation in the office space.

To solve overheating in the entrance atrium, four panels of planar glazing were replaced with glazed louvres. The location of the louvres were dictated by the planar glazing support structure; the louvres required their own framework.

The casement windows were high quality, but without stays tended to close on themselves (assuming the occupants were able to reach them). All these windows are now motorised, with the lower windows given new opening mechanisms.

Fire doors opening onto stairwells have been fitted with electro-magnets to provide additional stack ventilation on warm days. The outward-opening stairwell windows on the second floor are motorised to provide the point of extract.

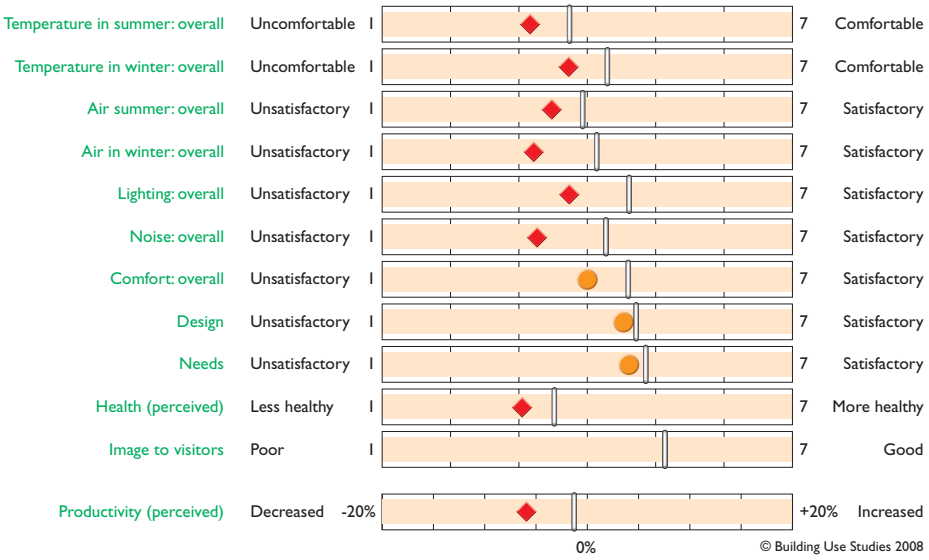


Figure 2: Building Use Studies carried out an occupant satisfaction survey of the headquarters for Charities Aid Foundation in late 1997 (image was not measured). Green triangles represent mean values significantly better or higher than both the benchmark and scale midpoint. Amber circles are mean values no different from benchmark. Red diamonds are mean values worse or lower than benchmark and scale midpoint. Be careful to read the directions of the scales and the scale labels. Benchmarks are represented by the white line through each variable.

the edges of planar windows.

The fully-glazed entrance atrium suffered glare and comfort problems. Ventilation to the space was cut on cost grounds, so openable windows or vents were not provided at either low or high level to allow heat to escape. Similarly, the barrel vault rooflights on the top floor had no means of venting the hot air that gathered there.

Despite their shortcomings as natural ventilation devices, the windows provided well-controlled levels of daylight. The compact fluorescent lighting was also regarded as effective and attractive.

Although energy management was not a high priority for the CAF in the early years of occupation, the building still performed at good practice levels for electricity consumption. A lack of gas bills (and many estimated ones) prevented detailed analysis of gas consumption.

The 1997 occupant survey showed the building to be similar to national benchmarks, but slightly on the cool to draughty side. It was also perceived to be more stuffy than benchmarks. Summertime temperatures overall were much hotter, less comfortable and more variable than benchmarks. The second floor was hotter owing to the planar glazing and rooflights.

Ten years on

A chance meeting between the then-chief executive of CAF and John Packer of environmental consulting engineer John Packer Associates (JPA) led to the consultant being asked to solve what had become an intolerably hot and poorly ventilated building. JPA carried out an environmental survey in summer 2006, the results of which showed that the initial shortcomings had led to severe summertime overheating and poor occupant comfort. Seemingly every desk had a electric fan.

JPA found that the fanlights were unusable. Although generously sized, the top-hung windows were too high for most people to operate them, and even if they could be reached, the windows had no stays to hold them open unless they were jammed open with books or cardboard. As they were not motorised, the fanlights couldn't be used for night cooling.

Similarly, the main windows also had insufficient support and required constant adjustment to stay open. The lack of ventilation openings in the west facade, and in the barrel vault rooflights, also trapped heat in the building.

Heat gains from occupancy have also gone up since 1997, with numbers now standing at nearly 400 (360 on average).

JPA found that poor commissioning of the indirect evaporative cooling system on the air plant led to counter-productive operation of the mechanical ventilation system. In fact, the adiabatic system had been de-commissioned by the maintenance engineers some years before due to unfounded concerns over *legionella*. This

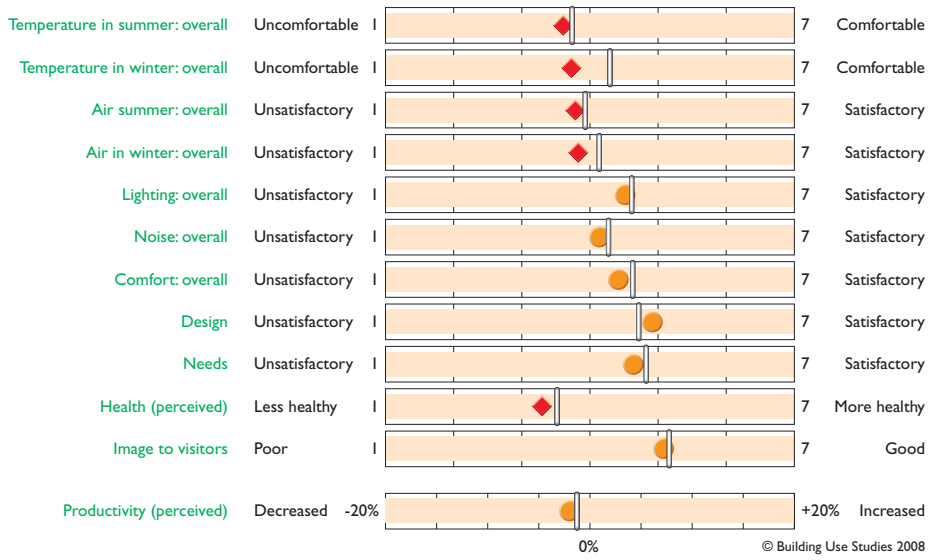


Figure 3: The results of the occupant satisfaction survey carried out on 25 September 2008. Compare the results with those from 1997 (*left*). Both sets of data use contemporary benchmarks. The CAF headquarters is home to 400 employees, with an average occupancy of 360. Exactly 260 staff were surveyed, and very few staff did not take part. Although the figures suggest that the building is still performing below average, the benchmarks are more stringent, which means that older buildings like the CAF hq will find it harder to perform relatively well.

raises the possibility that the heat recovery system is now heating up the supply air rather than cooling it.

As there is no mixing of the air-streams, JPA believe that the evaporative cooling could be re-commissioned with only minor adjustment to the filtration and disinfection systems to ensure safe operation.

Refurbishment options

Following a review of the options, the Charities Aid Foundation decided to overhaul the building's natural ventilation system and controls. "The critical thing was money. And being the organisation it is, the CAF wanted to keep its building green," said John Packer.

"The emphasis was on trying to get the building working well as it was designed," he added. "It would have been easy to say: 'let's just throw refrigeration at it, and get the displacement system down to 18°C', but our approach was that the building was basically OK. It just hadn't been finished.'

All casement windows have been fitted with new friction mechanisms to ensure that they remain open when needed, while the high-level windows have been equipped with automatic actuators, under the control of an improved Trend controls system. Each set of windows also has a local override switch for each window.

The windows are thermostatically controlled. If space temperature exceeds the setpoint temperature, the actuators open proportionally so that they are fully open at 4°C above setpoint.

The occupants have local override switches that enables them to open the fanlights proportionally with the length of time the switch is depressed.

"The operation of the fanlights is linked to the Trend bms to enable night cooling, and interlocked with the heating and air handling systems to ensure we don't waste energy," said JPA's Jack Hatfield.

JPA also created a thermal-chimney effect by fitting electromagnetic door holders to the stairwell doors at ground floor level and motorising the windows in the stairwell on the second floor. The doors are interlocked with the fire alarm so that the doors close on receiving an alarm signal. A similar approach has been employed for the stairwell adjacent to the reception. The fire doors on the top floor are kept closed to prevent hot air from the ground floor short-circuiting into the upper floors.

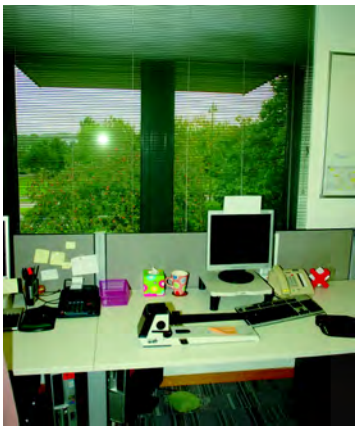
The two barrel vaults on the top floor have been fitted with thermostatically-controlled louvered passive ventilators. Before the refurbishment the solar gain and lack of ventilation in the rooflights caused temperatures to rise.

Colt passive ventilators have replaced the end-panes of both barrel vault rooflights. Combined with the openable fanlights, the ventilators give greater air movement across the floor plate.

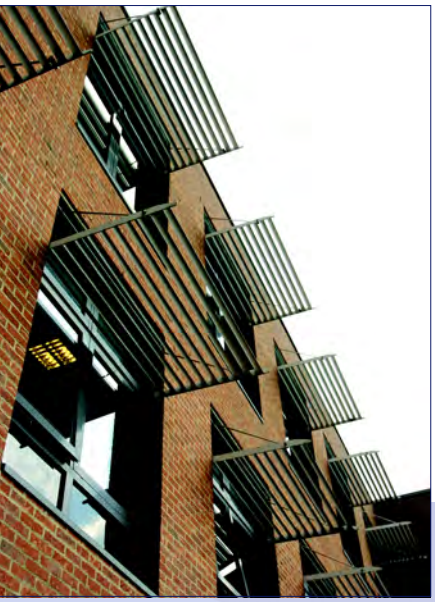
The planar glazing to the two-storey

©Roderic Bunn/BSRIA

Windows and blinds are difficult to match. Here, corner windows have mid-pane blinds that do not compromise the natural ventilation. However, the occupant has to keep the nearest blinds fully closed to prevent her eyes seeing lines on the screen. A roller blind may be better.



Here, the (original) venetian blind is mounted internally, which not only compromises air flow from the open fanlight, but may also direct air down behind the partition causing cold draughts around the legs. Mid-pane blinds may have been a more robust solution for all likely desk combinations.



Left: Each window on the eastern courtyard facade of the building is provided with horizontal brise-soleil between the main window and the fanlight. "We considered tilting or pivoting them so they don't face true south and deliver a bit more shading, but it wasn't cost-effective," said JPA's Jack Hatfield.

west-facing reception was unventilated, and there were high levels of solar gain in the afternoons. To allow hot air to escape, glazed, louvred casement ventilators have been installed at high level in the planar glazing of the two-storey entrance atrium. The main doors double as the air intake.

Some things could not be modified within the budget, and in any case the benefits were difficult to see until the building's basic shortcomings had been addressed. For example, the main air handling unit is a constant volume unit working at 4 ac/h, which is greater than the building's needs.

"It would've been nice to install control dampers, variable speed fans and to control the displacement system zone-by-zone" said John Packer, "but this will have to wait until a later phase." A simple short-term answer could be to turn off the fans during the day (letting the natural ventilation do the work) and only use the fans for night purging.

The de-commissioned evaporative cooling system could also be brought back into use with very little amendment. As it is, JPA feels the improved mixed-mode ventilation with night cooling should be enough to maintain comfort levels.

Occupant survey results

Figures 2 and 3 show the occupancy survey data for 1997 and 2008 respectively.

The results for 1997 were surprisingly poor, given the building's specification, but the seeds of discontent over summertime overheating were already beginning to show two years after completion.

Ten years on, and the summary statistics (Figure 3) would suggest that improvement is noticeble but slight. Staff still report summer and wintertime discomfort, although this may partly be a legacy perception.

A big change since 1997 is that the CAF hedquarters is much more densely occupied. Arguably it is much harder to improve perceptions of comfort in a very high density, open-plan office just by fixing the ventilation system. In any building, never mind one that is open-plan and clerical in nature, breaching a density threshold makes it much harder for occupants to be satisfied with their comfort conditions.

The anecdotal responses – comments made on survey forms by respondents – reveal noise from colleagues to be a major distraction, along with draughts, small toilets and lack of canteen facilities. The shortage of parking also frustrates staff, of whom the majority drive to the rural location.

Although it can't be proved, high occupant density has probably become the killer comfort variable at CAF. Low scores for noise and health hint at this conclusion. However, the author can report that CAF seems a lively and happy place. Many staff expressed the opinion that the environment was better following the refurbishment.

What all this tells us

Despite all the problems which have caused so much distress, the original design concept has proven to be fundamentally sound, so there's no question that the principles adopted by the original architects and engineers has proved largely correct. The real problem is that the building was probably never really finished, nor fine-tuned in the light of early experience.

The sharpest pebble in the shoe of the natural ventilation strategy was choice of window mechanism. Window stays may be tiny but they aren't trivial. At CAF, their inability to hold open the windows hobbled the natural ventilation system to the point where the building became almost unusable.

With the project team disbanded and cash always at a premium, the occupier struggled on with an under-performing building until it could take no more. And that's the point: project teams can't assume that buildings are finished at practical completion, and walk away thinking that high design intentions equal good in-use performance. It doesn't work that way.

Indeed, if CAF is anything to go by, even technologies like evaporative cooling, regarded as simple and robust by designers, can tax the abilities of maintenance staff to the extent that a risk of overheating is more bearable than having to maintain something perceived to be confusing and risky – even when it isn't. One has to see these things down the users' end of the telescope.

FACTS AND **FIGURES**

Developer Rouse Kent
Tenant Charities Aid Foundation
Original architect Nicholas Hare Architects
Original services consulting engineer atelier ten
Completion date December 1995
Occupancy
1998: 160
2008: 430 (360 average)
Normal weekday occupancy hours
06.30 - 17.00 h

Gas consumption (heating)
1997-1998: 151 kWh/m² per annum
2007-2008: 158 kWh/m² per annum

Incomplete metered data for electricity prevented an analysis of current electricity consumption

Refurbishment team
Services consulting engineer John Packer Associates
Ventilation contractor Natural Ventilation Solutions (SE Controls)
Passive ventilators Colt International
Window actuators and controls Window Master Controls
Building management system Trend