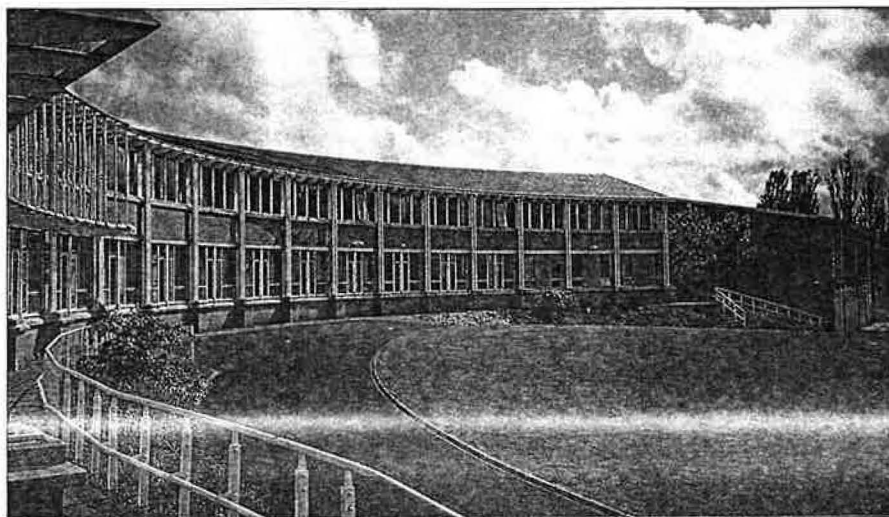


# PROBE

## 11: John Cabot City Technology College

Mark Standeven, Robert Cohen, Bill Bordass and Adrian Leaman revisit the first building in our new series of post-occupancy articles: John Cabot City Technology College. To understand the building's detailed design, readers must refer to the original article "A lesson in school building" (*Building Services Journal*, May 1994).



PHOTOGRAPH: TONY WELLER

**T**he John Cabot City Technology College (CTC) in Kingswood, Bristol was the last of 15 City Technology Colleges established between 1986 and 1993 as centrally funded – but independently managed – technology-based secondary schools<sup>1</sup>.

The go-ahead for John Cabot was given in 1990, Cable & Wireless acting as managing sponsor in partnership with the Wolfson Foundation. Construction was delayed until June 1992 due to a government spending freeze.

At the depth of recession a very keen tender was accepted from the main contractor. The designer believes the college received excellent value for money, but that the keen price made it difficult for the contractor to obtain high quality from all the subcontracts.

The consequence of having a fixed opening date (the start of term), meant that the last stages of construction and commissioning were extremely fraught. At the end of the build period, for example, some floor coverings were laid over concrete screeds which had insufficient time to dry out, forcing remedial work to be carried out.

The college opened in August 1993, 14 months after going on site. It has been filling up by an annual intake of 150. By 1996-97 there were 600 pupils, and 1997-98 will see it reach its design capacity of 750. In August 1998, the college's 1993 intake will graduate to

the lower sixth, and by August 1999 John Cabot CTC will reach its full complement.

The CTC's maximum capacity is 900 pupils, but there is a planned extension because 85% of pupils are now expected to stay on into the sixth form, not 50% as originally anticipated.

The college currently operates a 40-week, four-term year and is open from 08.00 h to 22.00 h each weekday during term-time. The 'pupil day' is from 08.30 h to 16.40 h.

### Building design

The college has a treated floor area of 8800 m<sup>2</sup>, arranged about a central street running east-west<sup>2</sup>. This footprint includes an existing 150 m<sup>2</sup> building used as a sixth form centre, although it was not part of the designers' brief.

The main assembly hall and adjacent dining room is at the eastern end, with the sports hall to the west and the main teaching spaces in three, two-storey wings to the south.

The staff room, administration offices, library and other teaching spaces are in a two-storey crescent to the north of the street. The main entrance is via a double-height atrium at the north eastern end of the street.

As in most schools, the college is predominantly naturally ventilated, supplemented by mechanical extract fans in laboratories, workshops and toilets. West and south west-facing facades are fitted with manually-controlled

motorised external roller blinds for the control of daylight, glare and solar gain.

Space heating is from three gas-fired boilers. Two dedicated gas boilers and calorifiers serve the kitchens and the changing rooms, with local electric storage heaters for the toilets and washrooms. All main hvac plant is linked to a 200-point building energy management system (bems) providing central control and monitoring. All internal lighting is manually switched and external lighting is controlled via a time-clock and photosensor.

Due to the high use of IT equipment, 24 kW of cooling is provided by two packaged heat pumps serving the computer network room and a larger telecommunications room. A seminar room also has its own split 15 kW cooling unit to meet the needs of the college sponsors, who use it as a meeting facility. These dx units have their own packaged controls under timed on/off switching from the bems.

### Ventilation performance

The teaching spaces in the three wings are predominantly cross-ventilated. The ground floor has cill height, outward-opening casement windows and small fanlight windows at the perimeter in a worthwhile attempt to provide both high and low level openings.

Unfortunately, the handles for the high-level windows are 2.45 m off the ground and

have to be twisted by hand (they cannot be operated by pole and hook). Opening and closing the windows typically requires clambering onto a desk – consequently, they are rarely used.

At the rear of the rooms, a means for cross-ventilation is provided by ceiling-height extract grilles venting to ridge louvres via vertical builders' work ducts. These incorporate low-speed extract fans operated by wall-mounted key switches.

High-level ridge louvres extend for the full length of each wing, and are split into separately openable sections for each 3.6 m structural grid. The louvres are opened and closed using manual screw winders, with handles at waist level.

As the depth of each classroom varies, some louver sections serve individual classrooms while others serve the spine corridor. During the first winter the louvres, even when closed, failed to prevent down-draughts into the corridors, which became unacceptably cold.

In spring 1994, the college covered and sealed the louvres using white perspex and silicon sealant. This alleviates the winter under-heating, but severely restricts summer-time ventilation of the corridor spaces which are consequently prone to high temperatures.

The louvres in the lightwells at the rear of the classrooms are fully operational, but they are out of view and it is impossible to see whether they are open or closed, the only clue being direction indicators on the hand winders. There have reportedly been several occasions when louvres inadvertently left open overnight have prevented the room temperature from reaching comfort levels in time for the start of the school day.

It also seems that the airflows within the light wells can exhibit "one-pipe circulation", whereby the incoming air drops down one side of the light well and rises up the other, causing unexplained draughts.

Teaching spaces on the first floor of the crescent use opening low-level casement win-

RIGHT: The main workshop at the John Cabot CTC.



dows and high level clerestories to achieve both cross and stack ventilation. The top-hung clerestories have the same manual hand winders as used elsewhere.

Manually openable low and high-level windows in the fully-glazed sections of the main street's southern facade provide effective stack ventilation to the street and main entrance foyer, supplemented by motorised opening louvres under bems temperature control in the upstands of the skylights.

The main hall uses the same opening ridge louvres as the first floor wings, together with a small number of low level opening windows and three high-level mechanical extract fans expelling air via grilles in the eaves.

In response to complaints from adjacent dwellings about noise break-out from the main hall, the college has sealed the ridge louvres and now adheres to stringent operational rules which prevent the opening of low level windows during occupation of the main hall – the hall can become stuffy when fully occupied, and uncomfortably hot during warm weather.

Problems have also been reported with noise from the dx condenser units, mounted on the flat roof above the main street, which comes through adjacent open clerestory windows, mainly into the library.

## Heating system performance

The main heating plant has a 250 kW condensing boiler and two 400 kW high efficiency boilers under sequence control from bems outstation.

The boilers serve a primary header which in turn serves a lthw heating main to five variable temperature circuits (one each for the three wings, the crescent and the music room) and fan coil heaters in the drama studio, sports hall and dining room. The return from a separate primary variable temperature heating circuit serving the underfloor heating zones in the main hall, the entrance foyer and the dining hall uses the condensing boiler's secondary heat exchanger to ensure maximum efficiency in condensing mode. Any flow temperature shortfall is made up from a three port valve connection to the primary header.

During the past year the sequence panel has been out of service. The college was reluctant to pay the quoted £1500 replacement cost and the boilers have been manually switched during this period. The college has only recently obtained replacement parts for a fraction of the quoted price. It expects to have the sequencer back in use for this heating season.

## Daylighting and shading

Ground and first floor teaching rooms in the wings have cill-to-ceiling glazing. All west-facing glazing is protected by external roller blinds, which are motorised, with teachers taking the decision to operate them via wall-mounted key switches in each room.

A central override retracts the teaching wing blinds at 17.00 h, and disables them until the following morning. On the first floor wings the central spine corridor is daylight via gentle-sloping ridge glazing above the upstand housing the ventilation louvres. This roof glazing serves lightwells at the rear of classroom where they extend into the corridor space.

Spot measurements by the PROBE team in one east-facing first floor classroom on an overcast June day gave daylight levels of between 100 and 250 lux at desktop height. Daylighting from the light well at the rear of the classroom provides useful uniformity, with adjacent light levels only slightly lower than at the perimeter. Both the main hall and the sports hall are well daylight. The main hall achieves this mainly via rooflights in the vaulted ceiling.

## CO<sub>2</sub> emissions and electricity consumption

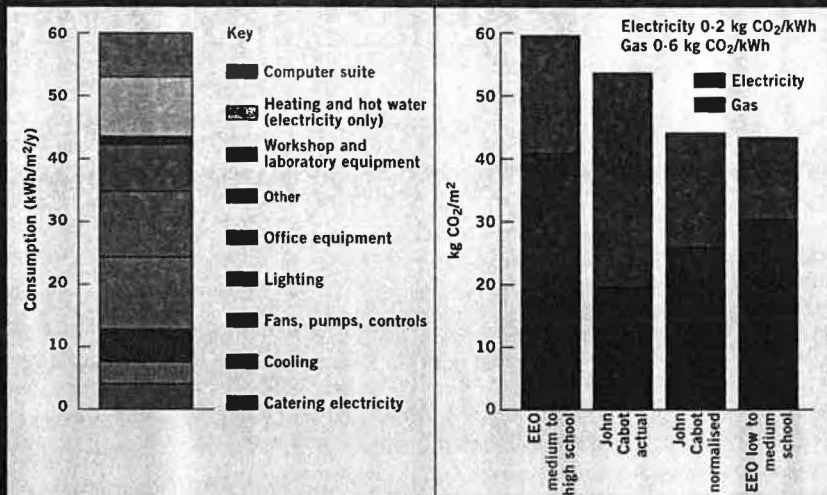


FIGURE 1: Breakdown of carbon dioxide emissions and annual electricity consumption at John Cabot CTC.



The sports hall has half-height glazing for its full length to the north and very high-level clerestories to the south. Glare protection is by vertical sails hanging from the ceiling. There is excellent daylight uniformity.

The library at the eastern end of the crescent has a series of narrow external roller blinds perpendicular to the windows to protect against low level glare from the setting sun, and controlled by a separate unit to the blinds for the wings. Due to the curvature of the crescent, at certain summer sun angles some of the blinds can be parallel to the solar rays and provide no protection.

Only a few areas are sufficiently enclosed to require electric lighting on bright days, in particular parts of the ground floor corridors in the wings, plus adjacent areas (especially where the view to the windows is obscured by furniture or lockers).

### Lighting and controls

Main classroom lighting to 300-350 lux is provided by pairs of 1200 mm 36 W T8 fluorescent lamps in category 2 luminaires (14.5 W/m<sup>2</sup>). Laboratory and workshop areas use twin 58 W T8 lamps (500 lux, 23 W/m<sup>2</sup>) with prismatic diffusers. Teaching space lighting is manually switched in rows parallel to the facade, offering the potential for responding to higher levels of daylight adjacent to the glazing and the rear lightwells in rooms where they exist.

Observations during the PROBE survey suggest that this facility is not exploited. Lights were often all off when daylight was adequate everywhere, but if any part of the space had insufficient daylight, all the lighting was on.

Interestingly, the design team had considered automatic lighting controls, but concluded that they would detract from the concept of local control and were not a priority.

Corridor lighting is via 23 W PL4 lamps in recessed fittings (5 W/m<sup>2</sup>), wired in relatively small groups which allows only those required to be switched on. In the internal street they are supplemented by a number of high-level metal halide downlights.

### Central plant controls

The college has a comprehensive and complex Staefa bems system which was intended to provide monitoring and control of all the main hvac plant. This bems is also linked to a range of sub-meters (main gas, kitchen gas, heating boiler gas, main electricity, kitchen electricity, kitchen water) and two heat meters for the primary chw circuit and the vthw underfloor heating circuit.

The provision of this potentially valuable sub-metering stemmed from the client's requirement to be able to recharge outside organisations for the energy used when hiring out the school facilities for short periods.

However, there are a number of serious flaws in the system. First, there are clear faults in the validity of on-screen information. For example, during the PROBE visits to the building a number of heating circulating pumps were observed running even though the boiler plant was isolated and the bems status indica-

tors showed them to be off. The sub-meters are also incorrectly read by the bems. Other errors creep into the transfer of data to a public display panel in the main street.

Second, there are very limited facilities for altering control set-points and the graphical display only allows alarm set-points to be adjusted. Changes to plant time schedules are possible, but only via a separate very user-unfriendly interface, which requires knowledge of control module address codes. Any adjustments to compensation curves must be made by reprogramming the separate sequencer panel in the plantroom. This cannot be done by onsite staff.

The John Cabot maintenance staff have little confidence in the bems, despite training in its operation and undoubted computer literacy, and hence generally leave it to its own devices. By contrast, the motorised external blinds have their own central controllers for override control at the end of the day, and in case of high wind speeds. These function well and are a good example of how easy-to-operate automatic controls can be used successfully to support local manual operation.

### Energy and water consumption

Energy consumption data has been compiled from available energy bills. Electricity use for the year June 1996-May 1997 is based on bills, while gas consumption has had to be averaged over the three-year period (June 1994-May 1997) due to irregular meter readings and faulty bems information.

Electricity consumption between April 1996 and March 1997 was 509 MWh, split 404 MWh (79%) at the day rate and 105 MWh at the night rate for a total cost of £31 690 (6.2 p/kWh). This consumption was little changed over the previous year (April 1995-March 1996) which was 501 MWh at a cost of £31 845, suggesting that the increasing number of pupils made no significant difference.

According to monthly electricity meter readings from the suppliers' bills, there is a marked seasonal variation in consumption from a minimum of 800 kWh/24 h day in August to a peak of 1800 kWh/24 h day in January and February, which reflects both the increased use of electric lighting in winter months and also the use of electric heating in some areas of the college.

## Occupancy survey results

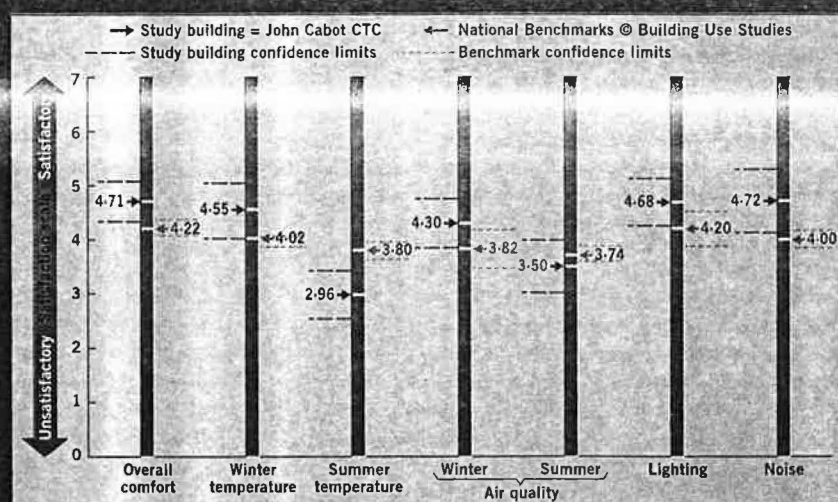


FIGURE 2: Overall satisfaction with John Cabot CTC's comfort conditions compared to BUS benchmarks.

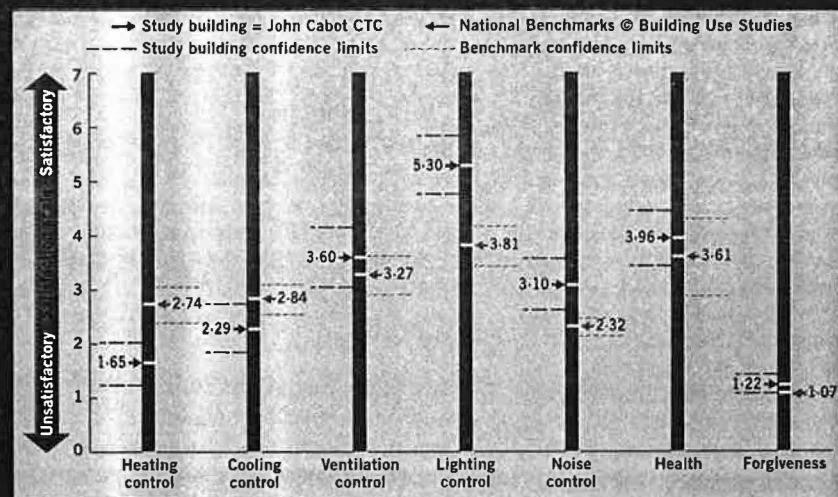


FIGURE 3: Occupant satisfaction with the building's health, management and control strategies.

Over a year, night-time use accounts for over 20% of consumption, and also shows the strong seasonal variation from a low of 200 kWh per night in summer to a high of over 400 kWh per night in winter. This variation is largely attributed to the night storage heating of the sixth form study centre.

The relatively high night-time baseload is due to the standing losses from local electric hws, the computer base units (left on for 24 h), the network servers, dedicated air conditioning and the external security lighting.

The supply capacity is set at 350 kVA at a current annual cost of £4600 (15% of the total bill). To date, the maximum monthly demand has peaked at 200 kVA (December 1996) and has typically been less than 150 kVA, suggesting ample opportunity for cost savings.

Gas consumption for the three-year period was 2618 MWh, during which there were 5452 degree days. This equates to an average annual consumption of 869 MWh.

With separate heating and hws plant and sub-metering of space heating boiler gas use as well as kitchen gas usage, it should have been possible to obtain a reliable breakdown of gas end-use. Unfortunately, the sub-me-

ters have not been monitored and the main gas meter had only been read twice (May 1994 and November 1995) in the three years prior to the PROBE survey, all other monthly readings having been estimated by the supplier.

During the period of the PROBE survey, when the space heating boilers were isolated, the college took manual readings of the main gas meter and kitchen sub-meter which, over a three-week period, indicated an average total daily consumption of under 100 kWh. Extrapolated for a year it is estimated that non-space heating gas use equates to about 30 000 kWh (or under 4% of total gas use).

Based on the treated floor area of 8800 m<sup>2</sup>, actual gas and electricity consumption equate to 98 kWh/m<sup>2</sup> and 57 kWh/m<sup>2</sup> respectively, while weather-corrected gas consumption is estimated to be 130 kWh/m<sup>2</sup> (figure 1).

This compares with the *EEO Yellow Book*<sup>2</sup> low-to-medium consumption for a secondary school (without swimming pool) of 151 kWh/m<sup>2</sup> and 22 kWh/m<sup>2</sup> respectively, and the medium-to-high consumption of 204 kWh/m<sup>2</sup> and 31 kWh/m<sup>2</sup> respectively. Related CO<sub>2</sub> emissions at 54 kg/m<sup>2</sup> are well above the EEO low-to-medium value of 43 kg/m<sup>2</sup>, and comparable

to the medium-to-high value of 59 kg/n. Note that the EEO figures date from the late 1980s, and don't allow for the IT and associated equipment loads found at John Cabot.

## End-use breakdown

Electric storage heating is the only form of heating in the sixth form study centre. The storage heaters are not easily controlled and respond poorly to weather variations. Total consumption is estimated at some 23 000 kWh or 150 kWh/m<sup>2</sup> of study centre floor area.

Total electricity consumption for the local water heaters is estimated at 7 kWh/m<sup>2</sup>. These are supplied from individual fused spurs and operate continuously, but time switches could be installed to reduce unnecessary standing losses outside normal occupancy hours. Continuous running may be responsible for 10% of their total consumption.

Electricity consumption for catering has been estimated at 4.4 kWh/m<sup>2</sup> from analysis of the kitchen appliances and their usage. Although most cooking equipment is gas-powered, there are several appliances with significant electrical consumption including two bain mairies, dishwasher hot water boost and chilled or frozen food storage.

The cooling consumption of 3 kWh/m<sup>2</sup> is from two split dx air conditioning heat pump units which serve the seminar room 12 h/day and the network room continuously. During the survey, the seminar room cooling was operating to a set-point of 18°C irrespective of occupancy. Significant savings could be made by matching its operation to demand. Although the network room cooling operates continuously, the equipment load appears to be modest, particularly at night.

Some 70 pumps and fans boast capacities from 180-3000 W, the majority controlled by the bems. Several heating circulation pumps and extract fans were operating during the PROBE visits, even during the summer vacation. A review of the bems configuration and time schedules should enable the consumption of these components to be more tightly controlled. At present, electricity consumption for fans, pumps and controls is nearly 5 kWh/m<sup>2</sup>.

The lighting consumption of 11.6 kWh/m<sup>2</sup> includes all internal lighting and is based on an assessment that classroom lighting is used for six hours per day on average during term time. Not uncommonly, the manual lighting control is not used as much as the good daylighting warrants.

The relatively high figure of 11.5 kWh/m<sup>2</sup> covers 200 networked Macs, 30 pcs and sundry printers and photocopiers. Computer screens are switched off at night, but many base units are left switched on for 24 h/day. A saving of 4.5 kWh/m<sup>2</sup> might be made by switching the base units off at night.

By subtracting the electrical consumption for hws, cooling, IT equipment and network servers totalling 27 kWh/m<sup>2</sup> (untypical for school use) from the total figure of 57 kWh/m<sup>2</sup>, the benchmark electricity use for John Cabot is 30 kWh/m<sup>2</sup> – similar to the medium-to-high EEO benchmark<sup>3</sup> of 31 kWh/m<sup>2</sup>.

## DESIGNERS' FEEDBACK

To have one of our buildings described as "exceptional by any standards" is very gratifying, write Linton Ross and Ken Carmichael<sup>1</sup>.

The John Cabot CTC is highly successful, and we would like to think that the building plays a significant part in this. Less encouraging is the news that, environmentally, the building is not performing as well as it might or as it was intended to.

We aimed to produce a building which, in addition to working well functionally, was structurally and environmentally explicit and also energy efficient. We are therefore disappointed that the energy targets which were set at the design stage are not yet being realised. However, we believe that the building is capable of better performance levels than the survey has revealed.

It appears not untypical in having problems of control, both mechanical and manual, which are significant in preventing it from achieving its design potential.

We generally seek a balance between an overall automated control system, in this case the building energy management system (bems), and local manual fine-tuning of ventilation and lighting. The study implies that, in both instances, the college could apparently do better in its use of these controls.

However, as designers who are necessarily obsessed with our buildings, we perhaps tend to over-

estimate the actual level of interest and commitment from the end-users, most of whom have other priorities in the college such as teaching and learning the curriculum.

There are clear lessons here for designers, users and equipment suppliers. The controls must be designed appropriately, set up correctly and maintained and adjusted with the benefit of available monitoring information to maximise efficiency and comfort levels.

BEMS are too often under-used due to poor commissioning and/or lack of operator confidence. To be effective, the system's interface must be easily understood and simple to adapt under changing situations. The owner or operator needs support after the building is handed over to ensure that all systems are being used efficiently.

Building users must also be made aware of the ability that they have to influence their immediate environment. Comfort, quality of space and appropriateness for its educational purposes are more likely to be considered sympathetically by end-users, as opposed to the environmental and financial benefits that are associated with energy efficiency as currently marketed.

<sup>1</sup>Linton Ross BArch RIBA is an architect with Feilden Clegg Architects and Ken Carmichael CEng MIEE is a services engineer with consulting engineer Buro Happold.



### Water consumption

Total water consumption for the academic year 1995-1996 (450 pupils) was 2370 m<sup>3</sup> or 5.3 m<sup>3</sup>/pupil, at a water supply cost of £1689. Sewerage charges calculated from 95% of the supply volume contributed a further £2370 to costs. The figure of 5.3 m<sup>3</sup>/pupil compares favourably with a low target level of 4 m<sup>3</sup>/pupil and high of 12 m<sup>3</sup>/pupil<sup>4</sup>.

Although water meter readings are only available for quarterly periods, there is a clear use cycle, with a peak in the first quarter and annual increases as the number of pupils rises.

### Facilities management

Day-to-day building maintenance is carried out by two building services staff who also have responsibilities for classroom preparation and some caretaking duties. Maintenance of all main plant is contracted out.

The college is finding that plant maintenance is expensive and recently turned down an offer to contract out all maintenance because the sums involved were out of the question. The college has been able to draw on its own technical expertise, for example when making repairs to the external blinds which occasionally need replacement guide bushes turned from nylon blanks. The college has replaced external sensors and identified the repair to the sequence control panel.

Unfortunately, the college does not currently exercise energy or water management, despite the almost unique provision for automating the separate monitoring of several end-uses. As a consequence, most plant is on for generous hours of operation and there is considerable scope for savings.

Tariff negotiations are contracted to a third party and, in the case of electricity, a different supply contract has been negotiated for each financial year since occupation.

### Occupancy issues

The standard PROBE questionnaire was completed by 47 staff (an 85% response) while a more concise questionnaire covering overall satisfaction and comfort variables only was completed by 121 Year 10 pupils (98% response). Most of these pupils had been at the college since its opening.

The staff scores for overall comfort, noise, lighting, winter temperature and winter air quality were all significantly better than benchmark norms from the BUS dataset<sup>1</sup>. For overall comfort, the score lay in the top 25% percentile of the benchmark dataset. However, scores for summer temperature were significantly worse than benchmarks, while summer air quality showed no significant difference (figures 2 and 3).

Perceived productivity is good with a gain of 6% attributable to the building (within the top 10% of the BUS dataset). On matters of control (figure 3), staff reported little perceived control over heating, cooling and lighting. There is also little perceived control over noise, although this is still better than benchmarks.

The speed with which people thought that h&v systems met their needs is no different from BUS benchmarks, but for lighting and

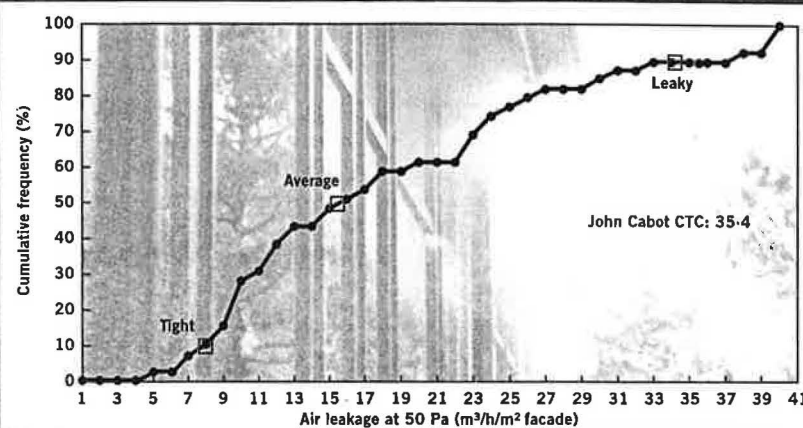


FIGURE 4: The air leakage rate of John Cabot CTC plotted on the BRE/BSRIA database

## The BREFAN test

benchmarks for  
**better  
buildings**

The BRE carried out pressure testing of Wing B at the John Cabot CTC using the multifan BREFAN pressurisation facility designed to quantify the envelope air leakage of large non-domestic buildings, writes Brian Webb.

The leakiness of the envelope is quantified by sealing an appropriate number of these fan units to an outside doorway and measuring the airflow rate required to maintain a pressure difference across the building envelope.

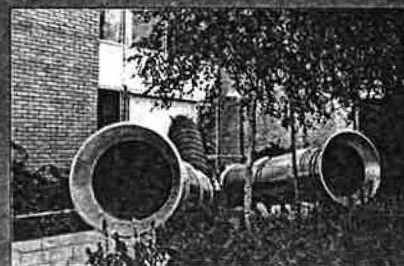
Containing both typical classrooms and workshops, Wing B was considered representative of the whole complex.

The wing comprises 24 ridge ventilation sections. The majority of the dampers have been blanked off and, prior to the test, it was assumed that this blanking provided an effective seal irrespective of the position of the dampers behind the blanking panels. The damper opening mechanisms are still active, and those still with handles are operated randomly by passing occupants.

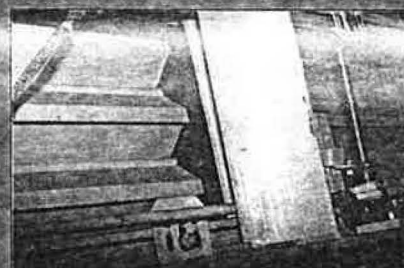
The pressure tests revealed significant air leakage around the blanking panels, suggesting that the position of the dampers is still important. For this reason, the test results reflect the actual situation rather than the best achievable case (when all dampers were guaranteed closed).

With the non-blanked off ridge vents closed the air leakiness was measured at 23.9 m<sup>3</sup>/h/m<sup>2</sup> of envelope at 25 Pa. With the non-blanked off vents open, the corresponding leakiness was 27.6 m<sup>3</sup>/h/m<sup>2</sup> and with the vents open (but all the extracts sealed) the leakiness was 25.2 m<sup>3</sup>/h/m<sup>2</sup>.

The infiltration rate for the non-blanked off ridge vents in the closed position, corrected to a flow equivalent of 50 Pa, comes out at 35.4 m<sup>3</sup>/h/m<sup>2</sup>. This has been plotted on the recently compiled building infiltration database (figure 4). At 25 Pa test pressure, a tight building would have a leakiness of less than 5 m<sup>3</sup>/h/m<sup>2</sup> and a



The BREFAN unit was also operated in reverse to de-pressurise the building and enable smoke tubes to identify the paths of air leakage.



The roof-level ventilation dampers were found to be very leaky along the top and bottom blades.

leaky one more than 20 m<sup>3</sup>/h/m<sup>2</sup>. From this it can be concluded that Wing B of John Cabot is leaky, and there is no reason to think that other parts of the building would be markedly different.

By reversing fan flow, smoke pencils showed the main leakage path to be through the high-level ventilation dampers, particularly between the louvres and their housing, and around the blanking panels covering the dampers.

Minimal leakage occurred around the windows and window frame/window reveal joints, which is commendable for a five-year old structure, although a small number of window opening mechanisms were identified as damaged and preventing the closure of the frame. These were sealed with tape during the test. The junctions between different structural elements such as walls and floors and roofs were also found to have minimal leakage.

Brian Webb runs the pressurisation test rig at the Building Research Establishment.

noise it is better. 40% of staff said the external blinds were unsatisfactory.

The extent to which staff tolerate deficiencies (calculated from the ratio of overall comfort to the average of the six main overall variables) is the second highest degree of "forgiveness" within the BUS dataset.

Staff and pupils were also asked to nominate their best or least-liked room in the college. 25% of staff like the conference room best because it is air conditioned, cool and quiet. Conversely, the canteen and dining area is considered small, cramped and noisy, and the medical room/changing rooms are disliked due to poor ventilation.

Staff comments focus on the good aesthetics and overall image of the building, but criticise the lack of space in the corridors, street and dining area. Several comments confirm the existence of summer overheating, and suggest the need for improved ventilation in changing areas and specific teaching areas.

## Pupil survey results

Like the staff, pupils are very uncomfortable in summer and reasonably comfortable in winter, but on overall comfort pupils are less satisfied than staff. On other variables – lighting, noise, design and needs – pupils tend to agree with staff about overall conditions, but seem to rate them slightly less favourably than staff. This tendency is at variance with most previous BUS surveys in which transient occupants, such as students and visitors, are relatively more satisfied with buildings than those permanently working in them.

Pupils share staff concerns over the size of the building, crowding in the canteen and corridors and summertime discomfort. They also mention locked toilets and windows, heating on in hot weather, lights on unnecessarily and noise from tutor groups, but good facilities for the disabled. Pupils like the canteen least and library/reception entrance the best.

Overall, John Cabot CTC is without doubt highly successful. It is very popular with children and parents as evidenced by the demand for places and the higher-than-expected staying on rate. The buildings and their facilities are exceptional by any standards, and enviable compared to most UK secondary schools.

## References

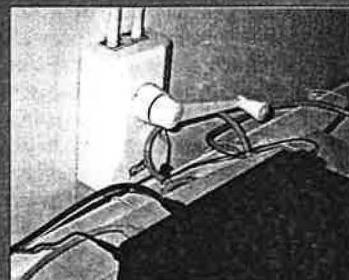
- <sup>1</sup>Building Bulletin 72, *Educational design initiatives in city technology colleges*, DES, 1991.
- <sup>2</sup>Brister A, "A lesson in school building", *Building Services Journal*, 5/94.
- <sup>3</sup>EEO Yellow Book, *Introduction to energy efficiency in schools*, March 1994.
- <sup>4</sup>*Managing school facilities guide 1: saving water*, HMSO, 1993.

The authors would like to thank Peter Newlands (finance director), Simon Gaulton (assistant building services engineer), the staff and pupils at John Cabot CTC and the original designers for their help during the PROBE investigation.

PROBE 2 is a research project conducted by *Building Services Journal* and managed by HGA Consulting Engineers. The research is co-funded under the Partners in Technology collaborative research programme run by the Department of the Environment, Transport and the Regions.

## Key design lessons

**Ridge dampers** The summertime ventilation in the first floor corridors has been sacrificed due to the poor winter performance of the ridge-mounted ventilation louvres, which have been blanked off. This demonstrates the potential problems encountered when using mechanical services dampers as opposed to opening window technology for the control of natural ventilation.



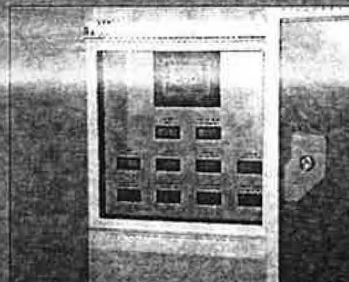
Space planning defeats technology: obstructed louvre controls in the music room.

**BEMS** Shortcomings in commissioning and handover have produced a lost opportunity for good control and monitoring of the building services. At John Cabot CTC, the controls have never worked properly, probably due to shortcomings in the specification, commissioning hand-over acceptance and lack of 'sea trials'. The users have no confidence in the systems, and the poor usability of the bems interface is also a strong deterrent to its effective use.



Student lockers in the circulation corridors, added after handover, are causing increasing congestion.

**Energy monitoring** Based on PROBE experience, customers are lucky if their monthly invoices for gas supplied have been supported by more than one or two actual meter readings. At John Cabot CTC, the gas meters have only been read twice in three years, a policy which can only serve to handicap attempts to successfully benchmark energy consumption. The problem seems rooted in under-performing controls (see description above), lack of guidance and good practice codes and subsequent loss of interest by the occupant.



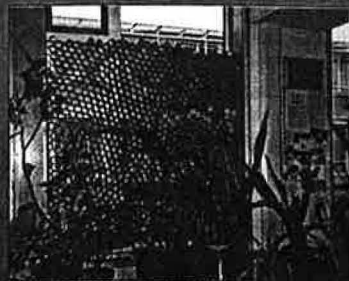
ABOVE: The bems summary display panel, intended to provide pupils with an insight into the building's performance, is not operating reliably.

**Space** The brief did not allow space for lockers as it was assumed that pupils would carry all they needed. Lockers have now been placed along the walls of the main street as a lesser evil than cutting into teaching space, but the additional congestion in the main street is noticeable, a problem which may worsen with more students.



LEFT: Close-up of the fixed external louvres located on the main hall.

**Fanlights** installed at high level are difficult to open and close, which consequently limits their intended function as ventilation openings. The opening clerestory windows in classrooms in the Crescent and the dampers in the first floor classrooms are out of sight and out of mind, and hence are sometimes inadvertently left open, causing rain ingress or excessive heat loss.



Do-it-yourself transparent insulation – stacked toilet rolls do the honours in the art studio. A patent beckons, surely.