PROBE strategies under test include solar control and facade detailing ☑

School designers are increasingly having to cope with the demands of multi-mode use ☑

Local authority budgets need to rise to meet the increased environmental expectations in DfEE design guidance ☑

PHOTOGRAPH: RODERIC BUNN

Birchensale School 1

In the first of a new series of intervention studies, the PROBE Team sit down with the architects and engineers of a new school to refine the design using lessons from the PROBE post-occupancy studies.

BY ADRIAN LEAMAN, RODERIC BUNN & PAUL RUYSSEVELT

If one had to choose a building type which contained the most constraints on budget, fees and degree of design freedom, then local authority schools would probably be quite high on the list. They have to be extremely robust, flexible and very simple to operate. Forget trained facilities managers – teachers and caretakers are the ones punching the buttons.

The extension to Birchensale Middle School in Redditch is one of six school buildings being procured by Worcester County Council. While all have different architectural teams, they follow a similar briefing and procurement process.

ECD Architects invited the PROBE Team to attend design team meetings to make observations on progress, and to suggest ways in which PROBE data could aid them in their decisions.

In this context the researchers act purely as passive commentators and information providers. It is not the PROBE Team's responsibility to either formally advise or make value judgements, but to identify potential pressure points, relate instances of problems and solutions from other buildings, and monitor the usefulness of that information to the design team.

Design details

The PROBE involvement took place over two design team meetings. ECD Architects and services consultant Whitby Bird have already established a base brief for the project, which is to double accommodation for 8-12 year olds from 300 to 600 within a budget of £1.5 million. Just over 80% of the budget will cover a new extension, while the building services - both new and refurbished - would account for 12%. This allowed for 1784 m^2 of new build and 539 m^2 of improvement to the existing fabric to give a new total building area of 4336 m^2.

The existing building is a 1970 vintage SCOLA system-built construction in two blocks – a single-storey ancillary unit with hall, offices and boiler house, and a two-storey teaching block with classrooms and specialist teaching areas (figure 1) . The blocks are connected with a single-storey link, which also provide the reception and main entrance.

Originally there were four blocks of four classrooms within two-storey blocks linked by a single-storey block of specialist teaching areas. Theses have since been re-arranged to accomodate additional specialist teaching areas some having to double as form rooms.

The client initially wanted to increase the number of classrooms to six per year. The brief has recently been amended to five and a half classrooms per year, ie the school is to be accomodated with classrooms for a five class entry school, but with specialist accommodation for a six form entry school.

The building will also house a music room and two practice rooms, one `learning resources'

Each PROBE intervention study will be reported in three articles over the next 18 months. The series will use a numbering system separate from the standard PROBE building studies so readers can keep track.

room, toilet facilities for 600 children, an assembly hall/dining room, a gym, and a staff suite (with work area, social area, seating, kitchen and social area, and staff toilets). The administration facilities will include offices, medical rooms, a reception office, staff training room, secure store and stock cupboard, and premises management facilities.

Key design objectives

After consultation with school staff, ECD identified the design and planning of the four year-groups as the key to their design strategy. This sets the criteria for the structural planning, the room sizes, circulation spaces and, in spaces like the laboratories, the choice of furniture.

To achieve this, ECD had three options:

☐ the addition of a new classroom block (the easiest to achieve, but not the best functionally)
☐ two new wings either side of the existing teaching block
☐ to extend the building along one elevation

The design team recognized that wrapping the existing building with two new wings would be both aesthetically pleasing and would serve to mitigate the poor performance of the existing fabric. However, it also created problems with natural ventilation and daylight. As the pros and cons were juggled, it became more obvious that the strategy should be driven primarily by the pedagogic objectives and rather less so by the physical, environmental and engineering criteria. Hence the only option was to extend the existing building along the south elevation.

Figure 1 shows the ground floor plan of the existing building (with areas to be refurbished highlighted) and the new build along the south elevation. Birchensale is a tad unusual in catering for children in the 8-12 age range. This means the facilities must be designed to span two stages of educational development, from general teaching to semi-specialist education.

Circulation is another major issue. Figure 1 shows that the original building was designed with a racetrack type corridor – fortunately generous in width – and classrooms with a reasonable ratio of external elevation to plan depth.

The architects have to deal with three issues: first they must ensure the circulation works in relation to the new year-groups (and budget limitations mean that only the existing circulation routes can be extended). Second, the services engineers have to provide environmental solutions for new land-locked spaces and natural ventilation for new perimeter zones. Third, some areas are to be planned to accommodate future use by the public. These issues can make a big dent in the cost plan.

Servicing issues

Birchensale Middle School presents a paradox: schools are generally simple structures with minimal servicing – largely for reasons of cost and precedent. But as a consequence the environmental challenges are immense.

Consulting engineer Whitby Bird & Partners had two targets to meet: a daylight factor of 4% in the classrooms and a temperature limit of 28°C with a permissible exceedence of 10 days in the summer term. These are preferred criteria laid down by the Department for Education and Employment (DfEE) in *Building Bulletin 87*.

Whitby Bird has undertaken daylight modelling to establish daylight factors and thermal modelling to analyse the potential for overheating. A Tas simulation was run for the thermal analysis, and the daylight modelling was carried out using Lightscape. The following is a short summary of the issues and results.

For the thermal analysis Whitby Bird modelled the entire building inclusive of the planned extension, simulating the building over the year to identify the incidence of overheating in classrooms. Two types of window system were modelled, along with different glazed areas, different degrees of solar shading, and various rooflight scenarios. U-values for the extension were taken as 0·23 for the walls and 0·24 for the roof.

As readers will appreciate, for a classroom space to appear daylit the minimum average daylight factor should be above 2.5%. Anything below 2% is likely to require electric lighting during daytime. The architects were keen to expose the timber roof trusses as a cost-effective means of improving the aesthetics while doing away with the need for a suspended ceiling. Unfortunately, the required daylight factor could only be achieved with the reflectivity qualities of a plasterboard ceiling.

Whitby Bird & Partners discovered that the new classrooms are exposed to a lot of sunlight, and so the solar gain is high. Subsequent modelling showed that a 40% glazing ratio was the maximum that could be used before the classrooms began to overheat. Indeed, all the rooms were found to overheat unless August was omitted from the simulations.

The most effective glazing system was a three-part, 1·4 m high window with the top and bottom 0·5 m sections openable, plus shading to 45° on the lower window sections. With this, the balance between solar gain and daylight penetration resulted in a 3·4% daylight factor on the working plane – acceptable under *Building Bulletin 87*. The landlocked laboratories and the art room in the existing block are rather less exposed, but even here openable rooflights were deemed necessay to improve ventilation and daylighting. Whitby Bird also concluded than an openable rooflight running along the back of the new classrooms would also be beneficial.

PROBE input: the brief

The brief was already well advanced by the time the PROBE team became involved, and therefore it was too late to include our input. Nevertheless it is helpful to write a brief so that the project targets are understandable to all. This should also cover cradle to grave monitoring, ease of maintenance and usability, comfort, health and aesthetics.

The brief should certainly not be couched in jargon, but sometimes it is difficult to appreciate when a term used innocently can carry more than was intended by its author. An example here is the use of the term laboratory.

Laboratories imply fume cupboards, specialist gases and environmental risk - all sorts of baggage which might lead the client to expect more from the space than can be provided, or worse, for teachers to suffer more complexity than they can manage. In the PROBE team's view, it would be safer to use the expression 'science room', fol-

What are intervention studies?

The intervention studies are a new element in the PROBE research programme. The research team is applying the experience gained from the extensive PROBE database to help engineers, architects and clients to improve the procurement, design and management of buildings.

The PROBE project will be carrying out four separate intervention studies: project briefing, detailed design, initial occupancy and long term building operation. Due to the nature of the construction process, the articles will not necessarily appear in order.

At Birchensale School, the PROBE Team is helping the designers identify key problems which can be partially or wholly resolved by applying the feedback from PROBE post-occupancy studies. The relationship is purely advisory, whereby the researchers offer evidence of both good and bad practice to inform the design team's decisions.

The objective is not to judge the performance of the design team, but to discover whether the PROBE advice was useful, practical and ultimately beneficial. Guidance is being given on a whole range of issues, but primarily on energy efficiency, building usability and manageability, and occupant satisfaction.

lowed by a definition.

Usability and manageability should be key briefing points. School budgets tend to allocate over 80% of resources to staff, leading – among other things – to invidious trade-offs between maintenance, redecoration, energy and the staff themselves. Simple, low cost buildings are often easier to run and maintain.

The PROBE team questioned the need for the building energy management system to be controlled from Worcester County Council, and not delegated to the school itself. The balance between remote expertise and local inability to dictate events is not always well managed.

Control and comfort issues

In a naturally ventilated building, the design of the window elements and the quality of their engineering are crucial. Here, the PROBE team questioned why the interior blinds were being specified as a separate fit-out item and not integral with the window system.

The design team expressed a preference for mid-pane blinds, which do seem to offer the best returns in a three-element window. However, this was perceived to be a high capital-cost item which the school may not be able to afford.

Further discussion between the client and the design team could re-order the priorities if the client was made aware of the risks.

Blinds not installed initially are often installed in haste when the occupants rebel. This often leads to the choice of cheap (and easily broken) blinds, or worse, the wrong type of blind which foul window handles or other types of opening mechanism. Blinds can also prevent easy access to hopper windows, even when the blinds are retracted, and can also rattle in air paths thereby disturbing both pupil and teacher.

Mid-pane blinds can resolve such problems, with one important proviso. Leaving aside the issue of perceived higher unit cost (and the perception of extra design effort for no extra fee), this option introduces the need to cross, move or otherwise disrupt conventional boundaries of professional responsibility.

One way out of that is to design the façade elements as a package that can be dismantled contractually, with clauses to protect the integrity of the design solution. That way the client is more likely to get freestanding and coherent packages which fit and perform well together.

At the first meeting careful consideration was given to the question of roofing over an open courtyard to provide a protected buffer space. Experience has shown that such internal atriums are often poorly used if unheated, and an additional energy burden if heated.

Enclosing the space would also severely compromise the ventilation of the surrounding rooms. Public spaces like penthouse courtyards can also end up being 'colonised', which both restricts free access and remedial actions to solve the aforementioned problems. The design team has heeded this message and have retained an open courtyard.

While the SCOLA-inspired circulation routes

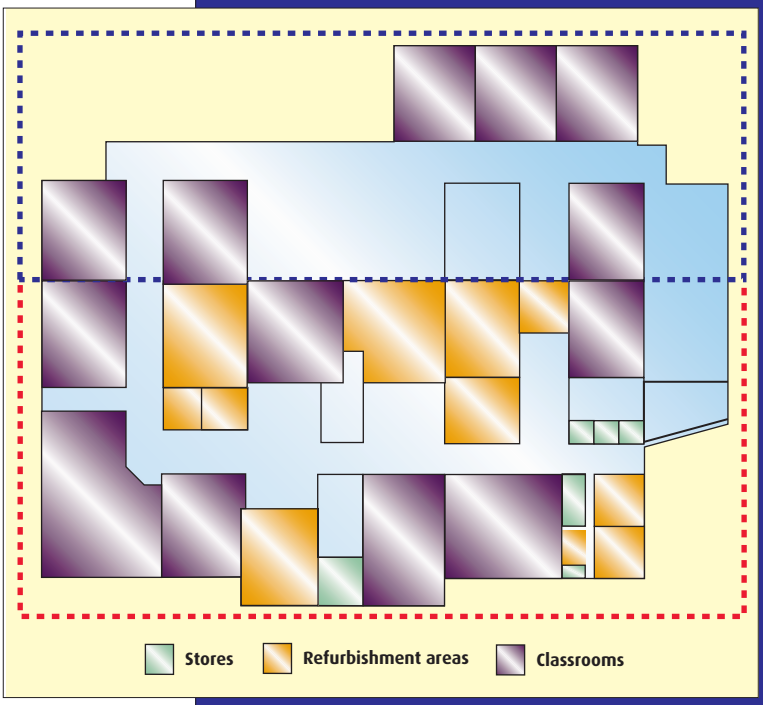


Figure 1: The basic plan of Birchensale Middle School. The area within the blue dotted line covers the extension, while the red dotted line delineates the existing school and the zones earmarked for refurbishment.

The client's view

The extension to Birchensale Middle School is largely a response to demographic changes in the Worcester region, *writes Ian Paul.* The local authority is rationalising its school buildings, closing some and enlarging six others.

Birchensale Middle School is typical of the school estate: system built, of lightweight construction and prone to wide swings in internal comfort conditions. In common with all local authorities, Worcester is required by central Government to improve the environmental performance of its teaching facilities. The government is also expecting a demonstrable link between each local authority's environmental policy *vis a vis* cuts in carbon emissions and improved management of the school estate.

Concerned at meeting these higher environmental targets, Worcester used the BSRIA Code of Environmental Performance as an aid to selecting architects and engineers with the right ethos. ECD Architects was appointed on the basis of their experience in natural cross ventilation, while Whitby Bird & partners were regraded as having particular strengths in simulation modelling.

space to fill

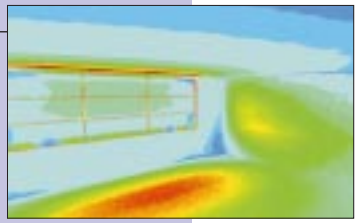
Ian Paul CENG? etc is xxxx xxxxx at Worcester Country Council.

key design constraints

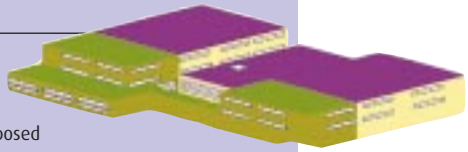
1. Birchensale Middle School. The SCOLA structure and planning philosophy was well thought-out, with efficient use of space and circulation. However, the thermal limitations of the external envelope, with a high proportion of single-glazed windows to wall area, mean that the school (like most examples of the genre) suffers high solar gain, glare and draughts, and swings in environmental temperature.

2. Lights on, blinds down – and wonky: a variation on a well-worn theme particular to school buildings. This is evidence that good façade detailing – inclusive of window design, solar shading, blinds and window opening mechanisms – must be very carefully integrated to optimise daylighting and ventilation control strategies.

3. Daylight modelling resulted in a three element window, with 45° partial external shading, providing a daylight factor of 3·4% in the classrooms. Thermal modelling revealed that the DfEE criteria of less than 10 days over 28°C could be achieved for a limited number of the scenarios examined.



4. The model of Birchensale Middle School, colour coded to show the existing building (purple) and proposed extension (green). Rooflights will be used to illuminate landlocked internal rooms which have limited access to daylight. With the low roof of the extension, security may be an issue. Building Use Studies has carried out (unpublished) studies on arson and vandalism in schools. Information can be requested via www.usablebuildings.co.uk



Birchensale Middle School
Client: Worcester County Council
Ian Paul, Graham Parker (consultant)
Architect: ECD Architects
Brendan O'Neill, Suzie Baker
Services Consulting Engineer: Whitby Bird & Partners
Tony Greatorex, Duncan Price

PROBE Team advisors
Adrian Leaman, Paul Ruyssevelt

PROBE articles directly relevant to this study
PROBE 5: Cable & Wireless Training College, *Building Services Journal*, 6/96
[1]PROBE 11: John Cabot City Technology College, *Building Services Journal*, 10/97

For downloadable PDF files of these and earlier PROBE reports, visit the PROBE website at www.usablebuildings.co.uk./Probe/ProbeIndex.html.

in the original building have worked well, there are questions over their effectiveness as ventilation routes. For example, it is the convention for corridor doors to be propped open to improve natural ventilation paths, with adjustable transfer grilles above the classroom doors. This immediately raises a number of design issues, such as the ventilation/acoustic trade off, and the means by which ventilation flaps operate.

Schools historically have one less adjusting pole than the number of classrooms, Hand winders can also end up over-wound or trapped by furniture[1]. Electrical motors ultimately fail. So while the flap damper itself can be very simple, the solution needs to be manageable, intuitive, foolproof, robust and easy to use.

The same is true of the well-motivated desire by the architect Brendan O'Neill to provide special zoned wall switches with sun, cloud and night symbols to encourage appropriate switching. The PROBE team concluded that this will have to be tightly written in the specification to survive any cost-cutting exercise.

Future proofing

While prevailing guidance is dogmatic on structures like classroom clusters, group sizes, and teachers needs, these are being challenged by the demands of 'multi-model' switching. Schools are also expected to be more intensively used and to cater for increased hours of operation.

The architect has anticipated such demands in the design of some of the classrooms, removing walls to create a more appropriate structural grid. Mobile furniture is also being considered in place of fixed benches for the laboratories.

Designers clearly need official guidance that recognises both the change in building use, and the growing evidence that a mix of serving strategies – mechanical and natural – can achieve energy efficiencies lower than those possible through natural ventilation alone.

The responsibility for ensuring Birchensale Middle School is suitable for long-life loose-fit lies more with the authors and publishers of *Building Bulletin 87* than it does with the design team. Schools will inevitably become more intensively used, possibly year-round, and this will strain natural ventilation strategies.

No targets have yet been established for thermal and electrical energy use and the Probe Team would like to see the application of the `energy tree' assessment technique of *CIBSE TM22*. The results would then assist cradle-to-grave benchmarking.

In the PROBE Team's recent experience many naturally ventilated buildings have suffered problems of overheating despite having been the subject of modelling exercises. It would recommend that the design team reviews the modelling in this case to ensure that the assumptions are sound and the results are robust.

Overall, the design of Birchensale Middle School looks compact and simple, meeting the client's needs. Time will tell if these have been specific enough in the crucial areas, like year groups. It will also be interesting to see how the window/ventilation/blinds issue is resolved.