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The DfEE has significantly revised its school design bulletin. At the launch, design teams used it to explore low-energy design options

Educational environments

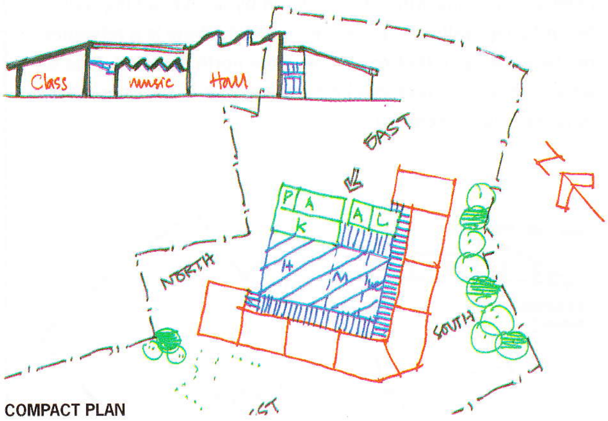
BY SEBASTIAN MACMILLAN, NICK BAKER AND MICHAEL BUCKLEY

The desire to create a stimulating, light, sunny, spacious and airy interior is a longstanding goal of school design. Victorian schools were notable for tall windows and high ceilings. In the 1980s several schools in Hampshire and elsewhere attempted to use solar gains for heating, with varying degrees of success.

Exploiting direct solar gain requires not only south-facing glazing but also that room surfaces, especially floors which receive direct insolation, are of sufficiently high thermal admittance to absorb the solar gains and avoid overheating. These last requirements are not always compatible with soft finishes needed for acoustic reasons. In addition, excessive areas of glazing – even when they are south-facing – can lead to local cold radiant effects and glare.

Glazed streets or atria can provide valuable circulation space if unheated; but heating them to full comfort temperature as teaching space can turn them into an energy penalty. With attached sun-spaces, occupants must take action – such as opening the dividing windows or doors – to benefit from the solar-heated air when it is available, and the opposite when gains cease so as to avoid reverse flow. Sun-spaces, like glazed streets, reduce the availability of both natural ventilation and daylight to the rooms to which they are attached.

In the 1990s higher levels of insulation and double glazing have become the norm. Fabric heat losses have reduced, so ventilation losses have become relatively more significant. Concern about indoor air quality has focused attention on adequate ventilation rates to dilute internal pollutants. There is also greater awareness of the cost to the school – and of the effect on the global atmosphere – of using electricity. The provision of ample and well-distributed daylight then is vital, not just for the well-being of pupils but also on global environmental grounds.



COMPACT PLAN

'The provision of ample and well-distributed daylight then is vital, not just for the well-being of pupils but also on global environmental grounds'

Challenging plans

The DfEE has substantially revised its former Design Note 17 as a new Building Bulletin – BB 87[1]. This covers acoustics, lighting, heating and thermal performance, ventilation, and hot and cold water supplies. It also includes a calculation method for assessing the energy rating of different design options. BRECSU, the agency responsible for managing the DETR's Energy Efficiency Best Practice Programme for buildings, has recently published good practice guides on school design[2] and refurbishment[3].

When the three were launched at a series of seminars, delegates (mostly architects) formed teams to prepare outline plans for junior schools following one of four broad approaches: compact plan, courtyard plan, finger plan or linear plan. An example of each is described below.

As well as a site plan and a brief, the teams had available to them the LT Method for assessing strategically the lighting and thermal performance of their designs, and the energy-rating method from BB87 for more detailed evaluations of, for example, varying insulation levels and ventilation rates.

Exploring options

The compact plan wraps a corridor around the centrally planned hall and adjoining music room. In turn classrooms wrap around these, facing south-east and south-west. Ancillary accommodation is to the north. The section shows how extensive rooflighting is proposed to both the hall and music room to allow daylight deep into the plan. The corridor is also toplit. Classrooms have a monopitch roof with a southerly overhang to reduce glare and summer overheating. The northern sides of the classrooms have north-facing high-level glazing to increase the evenness of daylight and facilitate cross-ventilation.

The LT predictions of primary energy consumption and carbon dioxide emissions are summarised in Table 1 (excluding ancillary energy uses such as domestic hot water and small power, or kitchens). The LT results show this compact plan can be very energy-efficient, particularly because of the extensive use of rooflighting. The LT analysis assumes the artificial lighting is off whenever there is sufficient daylight to reach the 300 lux threshold. Owing to their daytime occupancy, primary schools have considerable potential for exploiting daylight.

Table 2 explores variations on the compact plan. The second case shows the effect on primary energy consumption of removing the rooflights and introducing mechanical ventilation. The third case also assumes lights are on all the time. These demonstrate how dramatically energy consumption can escalate with apparently minor changes in design strategy or building use.

Three other plans are illustrated in the boxes, representing a courtyard plan, finger plan and linear plan. Table 3 summarises the annual

TABLE 1: COMPACT PLAN SCHOOL

	Annual primary energy use $kWh/m^2/y$	*Annual CO_2 emissions $kg/m^2/y$*
Lighting	13.5	3.0
Heating	77.5	14.7
Vent & cool	2.2	0.5

TABLE 2: COMPACT PLAN VARIATIONS

Variation	*$kWh/m^2/y$*
Original compact plan	93
No rooflights, mechanical ventilation	142
As above plus lights always on	183

primary energy consumption and carbon dioxide emissions for all four designs. Predicted energy consumption varies only slightly because the plans and sections of these small, single-storey buildings have been successfully manipulated to provide opportunities for daylight, sunshine and natural ventilation. Generally in well-insulated school buildings, heat loss is dominated by ventilation, and so does not show great sensitivity to the surface areas of the building envelopes.

The very low lighting figure for the finger plan is due to the 60 per cent glazing ratio on the southerly façades. Although the energy performance may appear to be good, such a highly glazed design may experience more discomfort problems from glare and overheating. Simple overhangs on south façades will help but shading on west façades – where the incident afternoon sun is at a lower angle – is more problematic. Generally, adopting well-distributed but modest glazing areas is a better strategy than having large glazing areas, even if they are south-facing.

Designs need to include realistic assessments of how occupants will operate services and controls. These school plans do show that an environmental approach to school planning need not exclude any of the four generic design options. All four were predicted to fall within BB87's Band A – the most energy-efficient. □

Sebastian Macmillan is an architect and partner in Cambridge-based research consultancy Eclipse. Nick Baker is a physicist and senior lecturer/joint director of The Martin Centre for Architectural and Urban Studies at the University of Cambridge. Michael Buckley is an architect at the BRE and is responsible for the BRECSU/ETSU Passive Solar Design marketing programme which is funded by the DTI

References

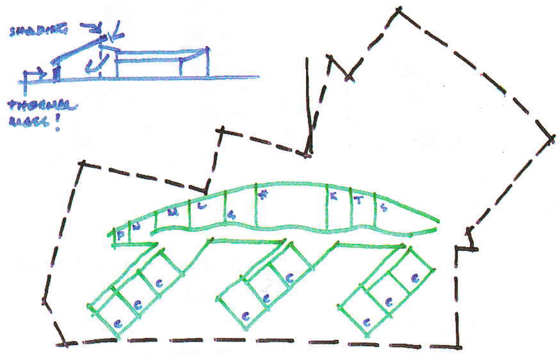
[1] Guidelines for Environmental Design in Schools, *Building Bulletin 87, published by the Department for Education and Employment, The Stationery Office, 1997, £13.95.*

[2] Energy Efficient Design of New Buildings and Extensions – for Schools and Colleges, *Good Practice Guide 173, available from BRECSU, single copies free, tel 01923 664248.*

[3] Energy Efficient Refurbishment of Schools, *Good Practice Guide 233, also available free from BRECSU*

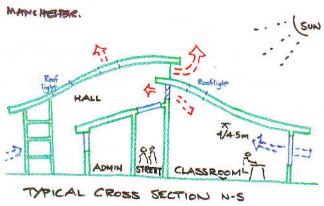
BOX 2: FINGER PLAN

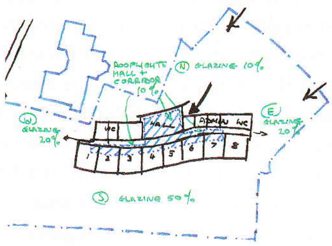
All classrooms are oriented south-east, receiving morning sunshine in winter, but with less risk of summer overheating than west or south-west-facing classrooms. With a 60 per sent glazing ratio proposed, overheating risk would need to be checked. The section through the shallow ancillary block shows that rooms will receive some sunshine through high-level south-facing windows, shielded by an oversailing roof. North-facing walls are 30 per cent glazed. There is a reference on the drawing to thermal mass on the north façade, but as the wall is unlikely to receive direct insolation it is not clear what purpose it is expected to serve.



BOX 3: LINEAR PLAN

All classrooms face due south with other accommodation to the north. Classrooms benefit from northlights above the spine corridor, which also provide cross-ventilation. The hall can have windows on the north, as well as small areas facing east and west, and it can receive sunlight through high-level south-facing glazing.





BOX 1: COURTYARD PLAN

The location and orientation of classrooms is similar to the compact plan, except that they surround a courtyard which is enclosed on the north side by the hall and nursery class. Again the classrooms have a monopitch roof with southerly overhangs, and high-level north-facing windows. Borrowed light is proposed from the library area. The hall is both side-lit and roof-lit.

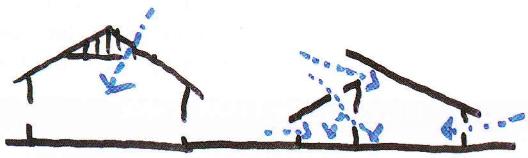


TABLE 3: LT PREDICTIONS

Plan type	*Annual primary energy use kWh/m²/y*			*Annual CO_2 emission kg/m²/y*	*% floor area passively treated*
	Light	*Heat*	*Total*		
Compact	13	78	93	18.2	94
Courtyard	12	75	87	16.9	100
Finger	9	74	83	15.9	100
Linear	19	73	92	18.2	100