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CLASS ACT

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PRIDE OF PLACE

PUPILS LOVE IT BECAUSE IT LOOKS LIKE A SHOPPING CENTRE, AND THE TEACHERS GOT THE LOW-ENERGY BUILDING THEY WANTED.
DAVID ARMINAS **VISITS LEIGH TECHNOLOGY ACADEMY, DARTFORD**

A successful school design is one that doesn't look like a school. So say the students at Leigh Technology Academy in Kent, which opened in January. They came close to having just another cookie-cutter design, with the Education Department holding tight to a £25m budget. But the school's chief executive and teachers insisted on a sustainable structure that also fostered strong student belonging, to assist learning and morale.

BDP, the architect and services designer, learnt some significant lessons of its own on the way as it sought to innovate without breaking the bank. "At times it was like having a multi-headed client," says James Warne, BDP's head of environmental engineering.

The final result, delivered on budget and on time, is a low-energy building that relies on mechanically assisted ventilation of naturally cooled air using no chillers and virtually no mechanical heating.

The ventilation strategy is to reduce peak summer and winter temperatures using the thermal mass of the building. Further cooling is achieved by passing air through tubes buried in the earth.

Eden Project effect

From the north-facing street-front, the three-storey academy is nondescript. Once inside, however, visitors enter a spacious winter garden, reminiscent of Cornwall's Eden Project. The rear of the building forms a crescent shape which creates a large social area looking onto the playing fields.

Warne describes the project as "four buildings under one roof", as the academy operates a system of four colleges. There are, in fact, two additional sections at each end of the winter garden, containing functions such as admin staff. At the rear, curved cladding rises from the ground to the winter garden's ETFE roof.

Listening to the school's chief executive, Frank Green, and his fellow teachers helped BDP to shape the design. A trip to America convinced Green that large, open schools created a feeling of alienation among students. The idea of the four colleges with a large communal area developed during concept design work (RIBA stage C). Brunel, Da Vinci, Darwin and Chaucer colleges have their own principal and senior management to

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create small, close-knit communities.

"The first design was in September 2004 and by April 2005 we were on our third stage C concept report, rather than the usual one," Warne says. "We were creative in how we approached M&E. For example, we ran all power distribution services on the outside of the building. This freed up space that would have been plant-room and allowed us to justify the great internal spaces, such as the winter garden. As an industry, we shouldn't be designing large plant-rooms but large schools."

Teachers forced this innovation, Warne says. The building was constructed beside the old school, which was demolished after the move. "Because Leigh was an existing school and not totally new, we got input from the teachers who would occupy the new building. Also, Frank is an engineer, albeit metallurgy, but he could talk our engineering language."

Staff wanted the school to be as sustainable as possible given the budget restrictions. "Teachers were keen to have green technologies, such as boreholes and geothermal coupling, but the Department for Education and Skills was watching its £25m budget like a hawk. When something was flagged up as sustainable, the DfES wanted it removed, thinking it would be too costly, so we had to design in sustainability that took out mechanical expenses. By sitting down with staff at stage C, we could do value management then rather than value engineering at the tender stage. In the end, we just missed a BREEAM excellent rating."

Right: wind turrets supply fresh air and daylight. Below right: large windows over the winter gardens can be shielded in summer

View from a 'learning plaza' – an open balcony in the winter garden. Classes also take place on the garden floor

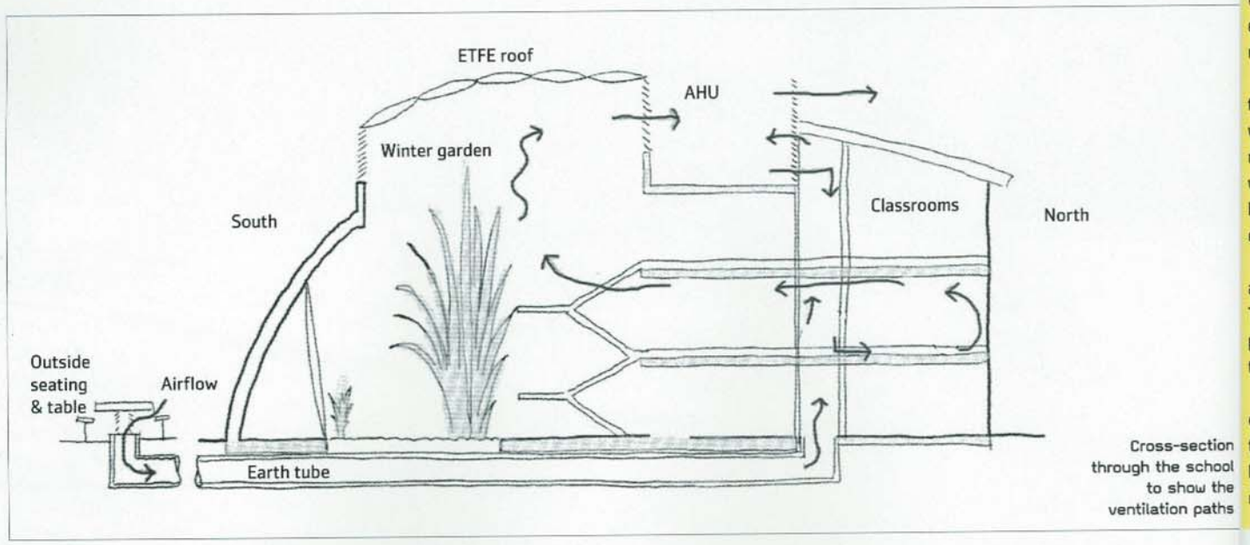
Air circulation

The building's thermal mass is used extensively to eliminate the need for mechanical cooling. Classrooms are located on the north side to gain good indirect natural light. This eliminates the need for blinds to reduce glare and cuts solar gain. On the south side of the structure, windows have shields to mitigate the summer sun's heating effect. But the shields allow in low-angle sunlight in winter, when the heat is needed.

Each college has its own ventilation system with an air-handling unit on the roof. The two end buildings – one for the art department and one for school administration and drama classes – have their own wind turret passive ventilation. "The heads wanted it separated this way," Warne explains. "If one college chose to operate on a different timetable from the others, it could adjust its building services accordingly."

Large fans on the roof drive the air circulation, sucking in cool air through the underground earth tubes to the top of the building and then back down through it, venting into the winter garden and classrooms. The greenhouse effect in the winter garden heats the air, which rises up to be vented in summer. Additional heat from students' IT equipment, located in "learning plazas" on the open balconies overlooking the garden, rises upwards and is also vented outside.

In winter, the vented air from the garden is pulled back in by the rooftop air-handling units. Heat recovered from the dirty air is transferred to the fresh air and ducted back into the classrooms.



Cross-section through the school to show the ventilation paths

"WHEN SOMETHING WAS FLAGGED UP AS SUSTAINABLE, THE DFES WANTED IT REMOVED, THINKING IT WOULD BE TOO COSTLY"

The view from the inside

Airflows are strong, steady and always fresh, and the lighting is great, says Frank Green, chief executive of Leigh Technology Academy, who chaired the project steering group that met BDP regularly for three years.

Some classrooms are too cold, however, with teachers having to put books over floor venting. In the winter garden, on the other hand, the air temperature needs to be cooler. But if the fans work faster, the air has less time to chill in the earth tubes. The energy management system needs tweaking over time, Green says.

His ambition was to have a building to match the school's teaching strategy – large classes with more social interaction in a collegiate environment, to foster a sense of belonging. "Otherwise, what's the point in having a new building?" He was inspired partly by his own unhappy experiences at Jesuit boarding schools.

Leigh students stay within their colleges and are taught in classes of 60 with three teachers. The open balconies, with IT equipment, allow pupils freedom of movement and the opportunity for social interaction.

Green's science background helped him in the design process. "I understand flow rates, infiltration and mechanical drawings, but am not my best at building layout. I would have preferred more 3D modelling during design discussions."

Earth tubes

Chillers were considered for summer cooling of fresh air but were considered too noisy and expensive. Instead, the fans draw in air at a temperature of 14-18°C from the earth tubes. "The 40m-long tubes are effectively concrete storm drains but are made watertight and buried about 1.5m below the school. It's like drawing clean fresh air through a cool cave," Warne explains.

"This was a concept we came up with right at the beginning of the project and it was tested over and over again. The DfES was adamant that it was not going to pay any more money for the system. But we proved it was cheaper than putting in chillers that may leak, be expensive to maintain and would likely need replacing in 15 years. With this system, you just brush out an earth tube once in a while."

The openings for the tubes are set unobtrusively beneath benches in the social area, away from the north side where the air is dirty from traffic. Students were told not to push litter through the slats of the benches as it clogged up the bug screens over the tubes. "Waste bins beside the seating easily solved that problem," Warne says.

Membrane ductwork

Within the classrooms, air circulates through a non-permeable removable membrane within floor voids, rather than the normal sheet-metal ductwork. The idea was developed through discussions with a vice-principal in charge of IT who wanted easy access to cabling.

"The material has been around for about 30 years and is similar in flexibility and weight to 'bouncy castle' material," says Clare Sheddick, a mechanical engineer who helped to design the system. The membrane is suspended from hooks in the floor voids and fans in the air-handling units inflate it into a rectangular shape. "Turning the fans off deflates the membrane, allowing access to cabling. It's also quickly and completely removable in sections simply by unzipping it," she says

In addition there is no protruding flange where the membranes are zipped together, unlike where sheet-metal ductwork is connected. This means that voids are smaller and building height has been saved, translating into 75mm savings for each of the three floors. Warne estimates that this cut the cost of cladding by more than £14,000.

Airtightness

Warne emphasises that the key to efficient passive ventilation is making the building fabric as airtight as possible. The Part L airtightness standard is set at only $10m^3/hr$ per m^2 of building fabric at 50 pascals. Warne thought this could be improved upon to save energy.

Thermal models suggested that going from $10m^3/hr$ to $7.5m^3$ produced a 10% energy saving, and from $7.5m^3$ to $5m^3$ saved another 5%.

Heat from 100-plus computers on the learning plazas is vented at the top of the winter garden

"We set an aspiration of 5m³/hr but contractors came back with a £1 million fee to improve the cladding," Warne says. He felt the issue was not the cladding but, rather, more attention to construction details.

A good relationship with the site manager of main contractor Galliford Try helped to improve airtightness through, for instance, better contact points where walls met roofs and proper sealing of drilled holes in the cladding. The fabric has been tested at 5.9m³/hr per m², a 40% saving on the Part L specification.

Having such an airtight structure has helped the acoustics, an important factor given that most classrooms are on the noisier north side of the building. Being airtight also helps maintain temperature stability. The only extra heating needed to maintain room temperature in winter is underfloor low-temperature hot water heating from a 500kW condensing boiler to keep the winter garden above a minimum. The system also runs during the night to maintain a stable temperature. In addition, a VRV system transfers heat from areas of high ICT to classrooms where heat is needed.

Wind turrets

The protracted stage C process included a move from simple roof windows to 14 passive-ventilation wind turrets for the two end buildings. Some rooms have no windows so here the turrets provide light as well as ventilation. These wooden lightwells rise 1.6m above roof level and are 0.8m diameter at the top, where they are sealed with toughened glass. The base openings in rooms and corridors are about 2m diameter. The turrets were bespoke and prefabricated.

"They were a one-off, designed by us using computational fluid dynamics," Warne says. "A couple of similar products are on the market, made from glass-reinforced plastic, but they don't have reflective inner plasterboard lining to aid natural lighting."

The turrets are made up of two circular sections, one inside the other. The central section is the lightwell and the cavity in between acts as the air passage into the space. Six dampers are located around each turret's perimeter.

"ONE OF THE STUDENTS SAID THE SCHOOL WAS GREAT – JUST LIKE BLUEWATER SHOPPING CENTRE. AT LEAST THEY CONNECT IT TO A PLACE THEY LIKE"

Wind blows against one side of the turret, creating a negative pressure on the opposite side. Air is blown through the dampers and down the cavity into the room below. It passes through the room and is sucked back up and out the opposite side of the turret thanks to the negative air pressure on that side.

The dampers work under a building energy management system time-clock, enabling wall-mounted control during lessons. Control of the dampers can be set for default according to the previous day's setting or adjusted manually.

Energy management system

Discussions with staff showed they were keen to merge a building energy management system with facilities management, security and access control, lifts and the monitoring of critical systems such as in computer rooms.

"It's not just about the building services alone any more," says Warne. "Typically, all these systems would be separate. Again, we were not allowed to spend any more money so we've had to innovate something far in excess of other schools. The system was developed in conjunction with Siemens, Dimension Data, TAC Satchwell and also Cisco because they sponsor the school."

School badges act as an ID swipe for classroom and out-of-hours entry. They are also a cashless vending card for use in the cafeteria. Students can download details of what they have eaten, including its nutritional value.

Lighting includes high-frequency low-energy fluorescent strip luminaires from Louis Poulsen. "We've increased the natural lighting so we get away with using fewer fluorescents," Warne says. "Other classrooms we've done have 12 but in Leigh we use eight, so it's a big cost-saving. Also, the fittings can accept different-sized fluorescents, so lighting levels can be adjusted up or down. The school needn't have different fittings and stock different spare parts."

CCTV has been installed in classrooms, allowing teachers to push a button to record incidents. "Quite often things happen and parents say, 'My child wouldn't do that.' The ability to record incidents offers security for teachers," Warne says.

He believes that the academy is an example to teenagers of the good careers available in architecture, surveying and building services, and BDP returned to make a careers video there. One of the pupils approached to ask what was going on. "We told him we designed the building and his reply was, 'Thanks, it's gorgeous.' Another said, 'It's great. It's just like Bluewater shopping centre.' At least they connect it to a place they like rather than an ordinary school." ■