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New schools of thought

Cottrell & Vermeulen in Essex, Coffey Architects in Camden
PLUS Heron Tower: a 'time capsule' in the City of London

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Green generation

As a champion for a greener ethos in school design, Cottrell & Vermeulen Architecture has put its theory on sustainable refurbishment to the test at Westborough School, Westcliff-on-Sea. Photography by *Anthony Coleman*

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Main picture Photovoltaic and GRP canopy supported on larch columns, shelters an 'African garden' and rubber play surfaces
Left The main entrance has been redesigned with a new reception area

Cottrell & Vermeulen Architecture is at the forefront of British school design. From the Krishna-Avanti Primary School in Neasden, north London, to the Cardboard Building at Westborough Primary School in Westcliff-on-Sea, the firm has been instrumental in helping to improve the culture behind designing for education, with a particular focus on energy reduction.

Its latest work sees the firm returning to Westborough, a site it has been developing for nearly two >>

Site plan
- Focus of new works
1. Westborough Road
2. West Road
3. Gainsborough Drive
4. Macdonald Road

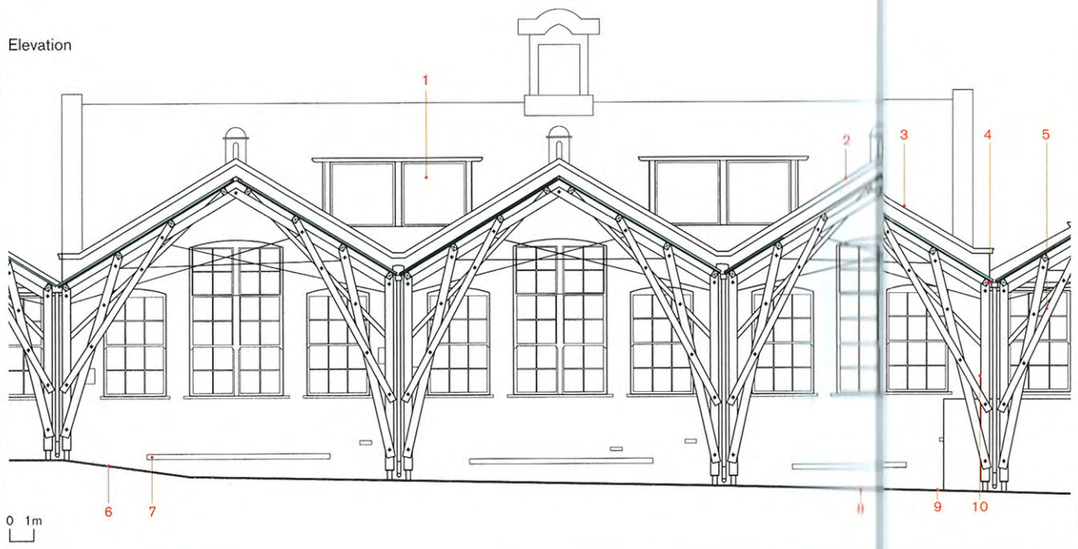
decades. The recently completed zero carbon refurbishment has been jointly funded by Southend-on-Sea Borough Council's Primary Capital Programme and Department for Education. The works, conducted under the architects' lean, mean, green approach (see page 38), provide a test bed for ways to refurbish older school buildings in a sustainable way. There was a 90 per cent reduction target for carbon emissions, with a range of active and passive strategies to save energy.

The focus of the project is the school's Edwardian redbrick main building. The buildings have been modernised to meet current academic requirements, with improved insulation and acoustic lining in the hall, and the main school entrance redesigned with a new reception and waiting area with improved access. New playground cabins can be used for both play and storage and a canopy along the back of the school provides a circulation route that supports photovoltaic panels. Monitors around the school display energy use and carbon emissions.

Richard Cottrell says there is an urgent need for a better understanding of how to affordably and efficiently refurbish schools. 'Studies show that new builds can emit over four times more CO_2 than refurbishments. New builds meeting current standards could take up to 50 years to catch up with refurbishments in terms of repaying their carbon debt through lower operational emissions.'

For performance data on Westborough Primary School, visit www.architectsjournal.co.uk/westborough

Elevation



1. Double glazed, timber-aluminium composite windows
2. Glass-laminated photo-voltaic panels
3. Profiled GRP
4. Aluminium gutters
5. European larch truss
6. In situ wet pour rubber crumb surface
7. Existing benches
8. Planters formed with paving slabs
9. Exposed aggregate concrete to African Garden
10. Circular European larch columns

Main picture
Canopy elevation from playground

Credits

Start on site November 2009
Contract duration 14 months
Gross internal floor area of refurbishment 948m²
Gross area of playground stores and canopy 292m²
Form of contract/ procurement Negotiated two-stage tender/Building contract JCT ICD 2005
Total cost £1.35m
Cost per m² £1,088.71
Client Southend-on-Sea Borough Council and governors of Westborough Primary School (also partially funded by Department for Education
Architect Cottrell & Vermeulen Architecture
Structural engineer Engineers Haskins Robinson Waters
M&E consultant OR Consulting
Sustainability consultant Buro Happold
Main contractor Balfour Beatty Construction
CDM co-ordinator BZ Consulting
Approved building inspector MLM Building Control
Estimated annual CO_2 emissions 18kg/m². phase 1 of refurbishment (previously 40.1kg/m2)

Approx. annual CO_2 emissions (kg/m²)	Contract duration (months)
18.0	14

Lean, mean and green Cottrell & Vermeulen Architecture's low-carbon strategy at Westborough School

LEAN INTERVENTIONS TO REDUCE ENERGY DEMAND

Insulation of existing walls Insulated Drylining board added to improve the thermal performance of existing external walls. *Insulation of roof and introduction of inner roof lining* Insulation bonded to the existing internal surface will improve both thermal and acoustic performance of the roof. *Installation of secondary glazing* A combination of double glazing and internal secondary glazing improves thermal performance. *Improvement of building air tightness* Control airflow through existing roof vents and ensure windows and doors are properly sealed. *Insulated distribution pipework* Hot water and heating pipework has been insulated to reduce losses and improve control.

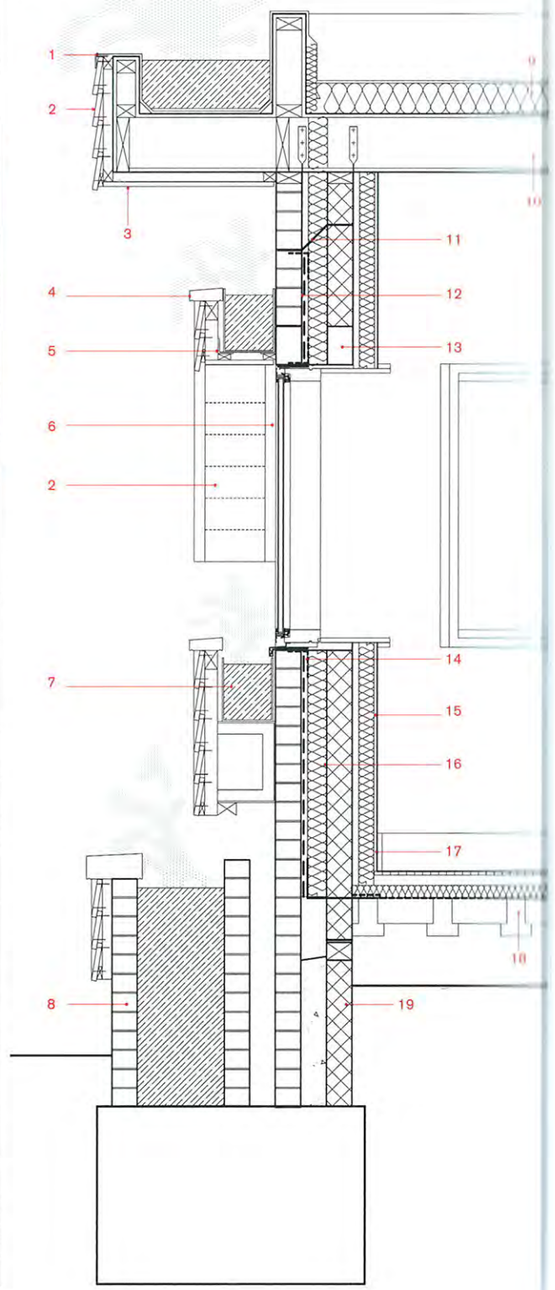
MEAN INTERVENTIONS TO SUPPLY DEMANDS EFFICIENTLY

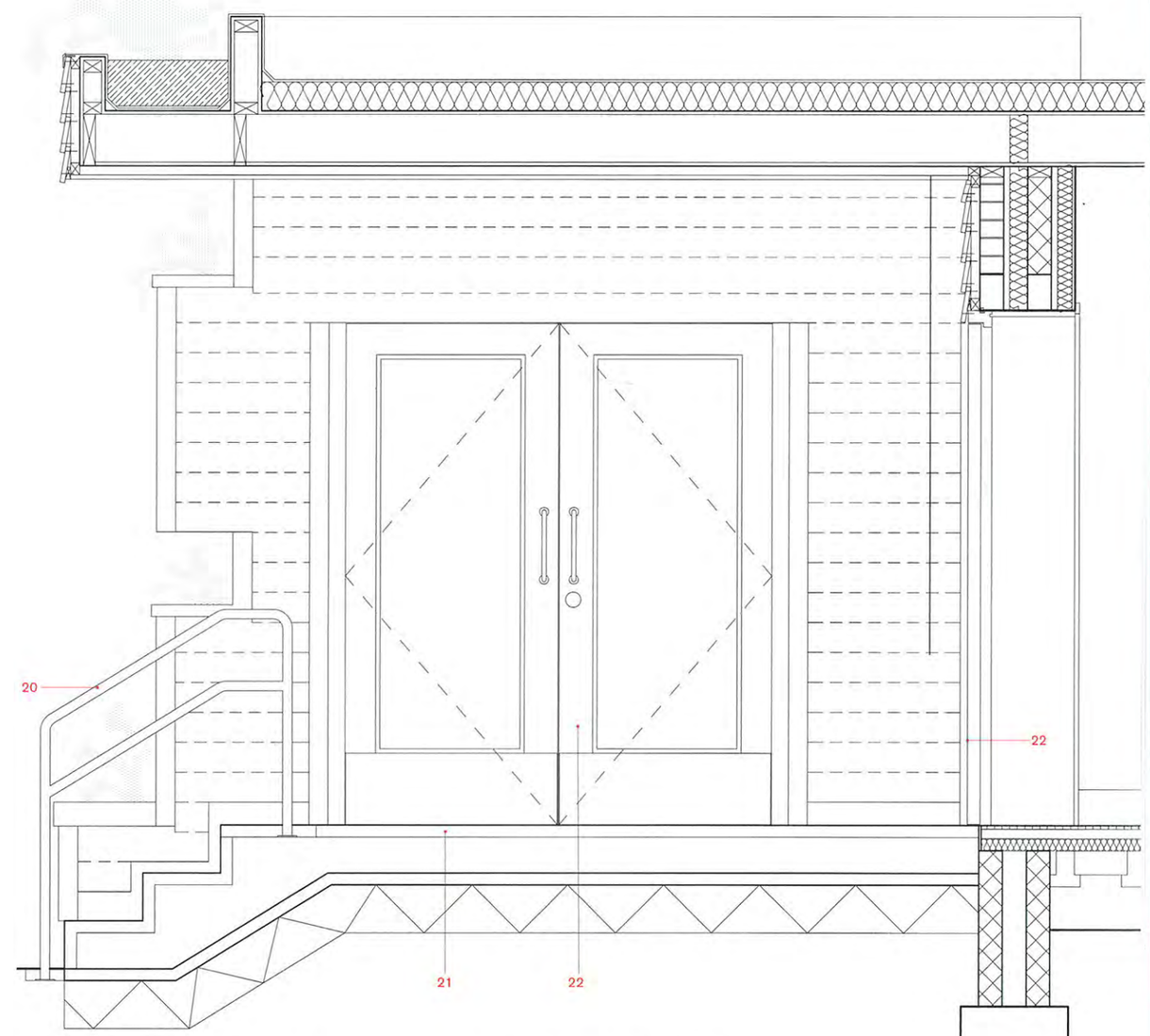
Modification of fluorescent lights to use T5 lamps Existing fluorescent light fittings modified to accept more efficient T5 lamps. Energy consumption reduced by 45 per cent. *Lighting control* PIR/Daylight sensors used to control classroom lighting. *Computer energy management* Improvements to energy management of existing IT infrastructure. *Optimised scheduling of heating plant operation* New boiler controllers allow optimised scheduling to reduce unnecessary running hours. *Hot water alternative generation* Providing 'regional' water heaters reduces hot water carbon emissions by up to 50 per cent. *Submetering and energy management* Submetering of energy consumption will allow a detailed image of how and where energy is consumed. *Heat Exchange* Heat exchange systems have been installed to maximise energy use within the ventilation and heating systems.

GREEN INTERVENTIONS TO USE RENEWABLES

Solar Photovoltaic Solar photovoltaics have been installed on the south facing pitch of the roof structure. Outputs from a typical, UK-based, solar photo voltaic array can achieve yearly electrical yields of approximately 100 kWh/m²/year. *Biomass boiler* As an alternative to gas boilers, a biomass boiler is a way of meeting the school's heating demands. The school currently uses 150kW. By installing a biomass boiler, it is estimated that 66 per cent of annual heating carbon emissions will be saved. *Rainwater harvesting* A rainwater harvesting tank has been installed for toilet flushing.

Entrance lobby detail





1. Bauder intensive green roof system to planted gutter; aluminium coping angle
2. European larch square-edge, lapped weatherboarding
3. 18mm marine ply
4. Larch coping
5. Galvanised steel angle to support box planter
6. Double glazed fixed timber aluminium composite window
7. Galvanised steel box planter
8. Engineering brick
9. Bauder roof system with 120mm insulation
10. 200 x 50mm timber joists at 400mm centres
11. Cavity tray
12. Cavity drain
13. Precast concrete lintel
14. DPC to head sill and joint of window reveal
15. 72.5mm composite insulated dry-linng board and skim on 25mm battens
16. 75mm rigid cavity insulation
17. Softwood skirting
18. Beam and block floor
19. 10mm blockwork
20. 40mm diameter tubular galvanised steel handrail
21. Exposed aggregate concrete ramp
22. Timber-framed glazed doors

0 1m

Primary schools

Property and construction consultant Rider Levett Bucknall explains how costs are allocated in building high-spec schools

Lance Taylor, chief executive, Rider Levett Bucknall

The challenge we face is how to reconcile the competing pressures of limited investment with reduced running costs and carbon emissions.

School budgets inherit running costs and become increasingly difficult to manage with increasing energy costs. This could hit the delivery of education by the redeployment of funding that would have been earmarked for other resources.

The current rationale behind improvement of the education building stock is to improve education outcomes by providing facilities that are inspiring to learn and work in, but can also be operated economically.

The recently issued Review of Education Capital concludes that 'substantial savings in both time and money are possible while also improving the quality of the finished product'. Estimated cost saving of 30 per cent could be achieved by a combination of measures including standardisation of design, application of lessons learnt and best practice and procurement through a single 'Intelligent Client'.

Complete 'standardisation of design' could lead to monotonous formulaic buildings that could be detrimental to learning. However, it is up to the industry to show that inspirational, low-carbon, low-energy design can be delivered through a collaborative approach, meeting cost and environmental targets and delivering the country's educational vision on budget.

Opposite Assembly hall, Westborough Primary School. Improved insulation, air-tightness and day-lighting, plus more efficient electrical and lighting systems, together with an installation of renewable energy systems, reduced carbon emissions at this remodelled Edwardian-era school by 70 per cent, compared with similar schools

Ian Sandland, partner, Rider Levett Bucknall

The Department for Education has set a target of 42 per cent reduction of greenhouse gas emissions from energy use in schools by 2020.

The main mechanism will be through capital funding programmes, and modelling shows that Building Schools for the Future and the Primary Capital Programme could be capable of achieving this target, if design efficiencies are realised. This will be by a combination of new build, refurbishment and retrofitting energy-efficient technologies to existing stock.

Refurbishment

Not surprisingly, in order to make reduced capital allocations go further, a greater proportion of school buildings will be remodelled or refurbished in preference to new build. However, this will depend on the ability of the proposed premises to be remodelled to provide facilities in line with the educational vision.

Westborough Primary School (see page 34) is an excellent example of how an existing Edwardian school building can be remodelled to respond to the needs of a modern learning environment, while reducing carbon emissions by 70 per cent, compared with similar schools.

The project utilises better insulation and improves air tightness and day-lighting. More efficient electrical and lighting systems and renewable energy systems have been installed, including solar thermal, photovoltaic canopies, and biomass boilers.

Cost benchmarking of refurbishment projects is notoriously difficult, as this will obviously depend on the extent of the works required. However, all factors should be considered when contemplating new build over refurbishment, particularly whole life costs, as a lower capital cost refurbishment may not produce the long-term efficiency or carbon savings that a new build project would be able to deliver.

New build

New primary schools currently in procurement are typically costing in excess of £2,000/m². For those aspiring to higher BREEAM status, this can increase to over £2,500/m². Much of this increased expenditure can be attributed to increased sustainability measures.

The government continues to put pressure on the construction industry to do more with less. The latest benchmark costs for primary schools propose an all-in cost of £1,730/m², with an equivalent construction cost of approximately £1,617/m².

Various examples of collaborative approaches by contractors and design teams consider, and offer, innovative ways of providing solutions that could be delivered for significantly less than the current benchmarks suggest, while maintaining excellent design standards that can achieve highly sustainable buildings.

These initiatives have not been limited to the cost of construction but also by interrogation of the space standards traditionally applied by reference to BB98 and 99. Emphasis is given to the schools education vision and aspirations, rather than assuming that the pupil population numbers and age range will determine the design size.

Some solutions suggest a net construction cost for a 2FE primary school new build of £1,750/m² and, for a conversion, a cost of £750/m².

Sustainable technologies

Energy benchmarking should be carried out to establish the best fit of the available technologies for a project, including predicting future energy consumption.

For a typical 2FE primary school, the following examples could apply:

- **Biomass** An 80-100kW biomass boiler could produce up to 75 per cent of the annual heating and hot water usage (or 55 per cent of the total annual energy) for a typical 2FE primary school. A budget cost for this type of installation would be around £35,000, excluding flues, building work and increased fuel storage area. Carbon emissions would reduce by approximately 40 per cent over a conventional scheme.
- **Ground source heat pumps** The cost of a 200kW closed-loop borehole installation would vary, depending on ground conditions, but a budget of £250,000 to £300,000 would be reasonable. This would produce approximately 90 per cent of the heating energy (65 per cent of the total annual energy) and produce reductions in CO_2 of approximately 30 per cent.
- **Air source heat pumps** A 200kW installation would cost in the region of £80,000 and would produce approximately 90 per cent of the heating energy required (65 per cent of the total annual energy) and produce reductions in CO_2 of approximately 25 per cent.
- **Wind turbines** Two ground-mounted, vertical-axis turbines would provide 15,000-20,000kW for a budget cost of £75,000. This would produce approximately 5 per cent of the total annual energy and reductions in CO_2 of about 10-15 per cent.

ANTHONY COLEMAN

Two form entry primary school
New build; BREEAM Very Good

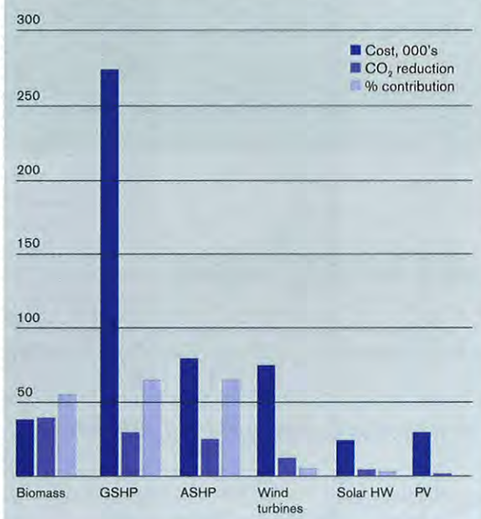
Capital	2,115m² @ £750/m²	£3,419,955
LCC	2,155m² @ £30m² x 25 years	£1,057,500
Energy use	2,155m² @ £3/m² x 25 years	£158,625
Total whole life cost	(per m²)	**£4,636,080**

Re-Model

Capital	2,115m² @ £750/m²	£3,419,955
LCC	2,155m² @ £30m² x 25 years	£1,586,250
Energy use	2,155m² @ £7/m² x 25 years	£370,125
Total whole life cost	(per m²)	**£3,542,625**

All figures exclude fees and VAT

Comparison of capital cost, CO_2 reduction and energy contribution in a typical 2FE primary school



- **Solar hot water** A 35m² array of panels would cost in the region of £25,000 and would provide 8,500kW/h. This would produce approximately 3 per cent of the total annual energy and reductions in CO_2 of approximately 2 per cent.
- **Photovoltaics** A 50m² array of panels would cost in the region of £30,000 and would provide 4,500kW/h. This would produce approximately 2 per cent of the total annual energy and reductions in CO_2 of approximately 2 per cent.

New build versus refurbishment

Although there is increasing pressure on construction budgets, in order to properly compare the whole life cost of remodelling and new build the planned maintenance and energy costs should be included in any analysis.

If we adopted the figures above to undertake a basic financial option appraisal of new build versus remodelling, the results could be as show in the tables (see right).

However, not many buildings are capable of being remodelled to a standard that fits the educational vision, with flexible and efficient use of space, or to achieve the whole life savings attained above.

Clearly, the more capital invested in energy saving for either new build or remodelling will reap long-term benefits, measured in both operation costs and carbon emissions.

A balance should be sought between increased capital cost and lower running and maintenance costs. One should also consider future energy costs, as prices are generally on an upward trend.

A short-term refurbishment may be the best option at today's costs, but long-term fuel cost increases should also be considered in any analysis.

RLB Rider Levett Bucknall