Local Government Task Force
CONSTRUCTING EXCELLENCE

demonstration project

Teaching Blocks and Courtyards

Whitecross High School and Specialist Sports College – a school for a changing climate

Contractor:	Stepnell Ltd
Client:	Herefordshire Council
Case Study Ref:	300
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Region:	West Midlands
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Themes:	Sustainability, lean construction, value, stakeholder engagement

Whitecross High School in Herefordshire is an excellent example of how an integrated design and construction process, involving early consideration and engagement of the supply chain and end users, can provide a quality learning environment which reflects the challenges of sustainability delivered on time and budget with ongoing whole life cost savings.

Background

The school was built under a PFI project, to be managed for 25 years by the contractor. This was Stepnell's first PFI contract and it acted as consortium leader, sole equity provider and design and build contractor. With the PFI approach there was a real financial driver for whole life costs to be considered at an early stage. This enabled the Stepnell team to carry out an in-depth assessment exercise to determine which environmental technologies and solutions would add value to the project and provide a reasonable pay-back period.

As such, the development of the design brief was carried out with environmental sustainability as a core consideration, mirroring the clients requirements. Prior to the brief being developed, a number of 'state of the industry' reports on water use, low energy buildings and embodied energy in construction materials were specially commissioned. Space flexibility and green travel were also important considerations.

School construction defined within the DfES Building Bulletins, requires up to 8 litres per person per second air change in teaching spaces as well as strict acceptable temperature boundaries; typically 20°C +/- 2°. Given concerns about future climate change, Stepnell considered that a 'heavy mass' and mechanically ventilated option would provide the best solution. This was an innovative method as mechanical ventilation is highly unusual in the education sector, especially as it tends to produce higher energy costs, clearly contrary to one of the key project drivers. The design was based on the heavy mass (i.e. concrete floors, roof and blockwork internal walls) acting as a heat sink during summer days, absorbing heat from occupants. The structure is then purged with cool air during the night time, expelling surface heat energy from the structure. During the winter, the highly insulated structure retains heat with sophisticated heat recovery systems included in the mechanical air flow to ensure minimum heat energy use. The heavy mass solution, used in conjunction with mechanical ventilation, is demonstrating reductions in energy use targeted.

The project benefited substantially from early supply chain involvement. The ICT, FF&E, M&E and steel frame package contractors were involved from early stages and were able to input into discussions on design and buildability (although a change to M&E contractor was required at the start of the construction phase). This early involvement led to a really close working dialogue with the opportunity to quickly turn round value engineering options.

Targets

In order to measure and monitor performance the project team set a number of key performance indicators (KPIs) for both the delivery of the project and for the school in use.

During the construction phase, Constructing Excellence Key Performance Indicators were collected throughout to measure the performance of the project and identify areas for improvement.

For the building in use, as mentioned above, one key measure was that of energy use. Total target energy use was 94 kWM2 per annum. Metering was installed throughout to ensure that performance could be monitored across the various teaching blocks by use of a sophisticated BMS system.

Indications, after the first year of operation, have largely borne out the assumptions about energy use made at design stage. However, there have been some management issues over the use of technologies within the school by occupants and facilities managers. These arose due to a lack of awareness of the methods by which the building functions (especially where these people have experience of the ways in which schools traditionally operate) and so further training needs were identified.

Measurement against key criteria, such as air change, temperature and lighting, is carried out for all PFI schools to ensure that minimum criteria are met. To date, all such specifications have been met resulting in no performance reductions.

Although not required under the contract, Stepnell carried out client satisfaction surveys both in autumn 2006, soon after occupation, and again in spring 2007 after the school had been open for two terms. The team were anxious to draw as much learning as possible from the end users opinions on how the building was performing, both to influence the ongoing operation of the facility and to transfer learning both onto any future Stepnell schemes and into the rest of the industry. The results of these surveys were shared with the Head Teacher and proved a very useful means by which to draw out opinions on the school.

As well as mapping energy use, the Building Management System (BMS) was designed to measure both air flow pressures and temperatures in each teaching space. This data is extremely useful in enabling complicated building services installations to be balanced, thus providing the optimum learning environment. One drawback, however, is that the use of such sophisticated solutions requires considerably more training than traditional methods.

Use of sustainable energy

Throughout design and construction the quality of the teaching environment and low energy consumption were given the highest priorities, resulting in a design utilising:

- High thermal mass to restrict fluctuations in classroom temperatures and negating the need for air-conditioning
- Mechanical ventilation (with heat recovery) to all teaching spaces to ensure excellent fresh air quality and temperature and enabling night time cooling during summer
- Efficient lighting with daylight and motion sensors, maximising natural daylight using north/borrowed light and controlling solar gain through orientation and brise soleil
- Highly insulated buildings requiring minimal heating with an energy target in the best 10% of school buildings
- Low energy equipment and fittings
- A sustainable urban drainage system (SUDS) including sedum green roof, which encourages biodiversity, reducing run off and replacing part of the green field land utilised for the project
- A highly sophisticated BMS system, enabling individual automatic classroom control of lighting, heating and ventilation
- An energy meter installed in the entrance to demonstrate energy use of the school to pupils and to raise their awareness of sustainability
- Cedar cladding from sustainable sources and non-vinyl flooring.

Cross Section of Teaching Blocks

As part of the up-front options appraisal exercise carried out in 2003, at initial design stage, each of the following were considered for inclusion in the school:

- Geothermal heating
- Solar thermal heating
- Photovoltaic cells
- Wind turbines
- Biomass boilers

In order to assess the viability of each of these solutions payback periods were calculated, comparing energy savings against the capital costs of installing such technologies, with benefit not being found in adopting any of these options. Subsequent to these decisions being made, with rises in energy costs and reductions in the capital costs of some of the technologies, the project team appreciate that, were the same options appraisals to take place now, it is possible that different conclusions would be reached.

The fact that schools have relatively low utilisation rates, with teaching for eight hours maximum on only 190 days per year, further impacted on the calculations for the use of environmental technologies. In addition, schools are generally closed during the summer – the period which provides the greatest benefit in terms of solar thermal heating.

However, Stepnell were anxious to demonstrate a commitment to sustainability and use the opportunity to learn from working with renewable energy and so opted to install a wind turbine despite the earlier options appraisal. Different sizes and performance specifications of turbine were considered with the decision being made to install a 15kw model. The appraisal indicated that this would provide a 15 year payback if, as was anticipated, a 50% grant could be obtained. Planning permission was received after a lengthy process of consultation with the planning authority and the sub-surface infrastructure for the turbine was fitted as part of the main build programme. Unfortunately, the model chosen for installation was removed from sale for redesign by the manufacturer and the redesigned model is now awaiting certification and confirmation of funding. It is anticipated that, once operational, the turbine will provide around 6.5% of the school's energy requirements.

Lean construction

Stepnell had worked with the Construction Lean Improvement Programme (CLIP) prior to beginning the Whitecross project and were keen to transfer the learning from this previous work. There were two key areas in which there was felt to be benefit in adopting lean principles:

Airtight building envelope – working with CLIP, Whitecross ensured that construction of the air barrier was carefully managed at every stage, resulting in the main teaching blocks achieving an airtightness of 3.8cm/m2/hr against a target design parameter of 10cm/m2/hr.

Zero defects for furniture and equipment – lean construction techniques were used in the formulation of Room Data Sheets in which all interfaces between building structure, services and fixed furniture and equipment were managed, with the result that there were no incidences of rework in this area.

Stakeholder engagement

In evolving initial concepts, architects Haverstock Associates used a team of their young architects to work with groups of students to identify what they liked and didn't like about school environments, resulting in the chosen concept receiving substantial buy-in from the school. The Head Teacher was enthusiastically involved in design evolution, channelling the views of her Heads of Department through to design meetings.

In order to keep students involved in the project process, a number of site visits were organised for both staff, students and governors to see how their new school was developing. There was a specific request from the Head to address an issue of 'low female employment aspirations' in the area and Stepnell arranged for a group female employees from its consortium (construction, FM, architecture, lawyers) to talk to students about career opportunities.

Stepnell were keen to engage with the local community and, in order to facilitate this, set up a project website during the bid phase to seek community views. These views were extensively used during design and local residents were kept informed of progress at all times during construction, both through letter drops and on-line updates of the website. An extensive viewing gallery for visitors to site was provided and the site team also carried out works free of charge for a local charity.

Early Consultation with Students

Informal Dining Spaces also showing mechanical ventilation

A school leaver was recruited as a trainee quantity surveyor on a formal development programme during the construction phase at Whitecross. He has to-date successfully completed the first two years of training and is progressing well.

The project entered the Considerate Constructors Scheme and achieved an audit score of 40 out of 40. The assessor commented,

> *"a thoroughly well organised site with an exceptionally high adherence in company culture to the CCS Code of Practice and teamwork."*

Following completion of the project a conference was organised at the school to transfer the learning from the project into industry. This day proved very successful with a number of high-level delegates from other organisations, both client and supply side, attending to pick up lessons from Whitecross.

Lessons learned

- The mechanical ventilation system provided certainty of compliance with regards to air quality and temperature in teaching environments
- Early involvement of the supply chain enables a better end product
- Early consideration of environmental sustainability has produced significant whole-life cost savings.

> *"The Authority are immensely proud of the finished School, which was developed in a good partnership spirit and encompasses all of the Authority's requirements for a modern, green and sustainable educational environment. The fact that the School was also finished on time, with early occupation of certain areas, and to cost is also a great testament to the entire team, both Stepnell and Authority, that were involved in its delivery."*
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> ***Herefordshire Council***

CONSTRUCTING EXCELLENCE
in the built environment

Constructing Excellence
Warwick House,
25 Buckingham Palace Road,
London SW1W 0PP

T 0845 605 5556 **E** helpdesk@constructingexcellence.org.uk
W www.constructingexcellence.org.uk

STEPNELL

Richard Wakeford, Stepnell Ltd,
Lawford Road, Rugby, Warwickshire, CV21 2UU
T 01788 574511 **E** richard.wakeford@stepnell.co.uk