CIBSE JOURNAL

EDUCATION FACILITIES SPECIAL

BB101 CHANGES IN SCHOOL VENTILATION

CLASS OF YOUR OWN'S UGANDAN SCHOOL

CHEMISTRY LESSON

The Nottingham University Laboratory that aims to be carbon neutral within 25 years

The best condensing hot water solution for every application

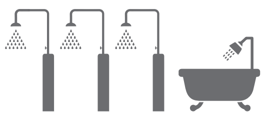
High-efficiency water heating without compromising comfort level

At A.O. Smith we have been convinced of the added value of condensing high-efficiency water heaters for many years. Therefore we offer a broad range of condensing heaters. To complete the range, we have recently introduced **Innovo**. The best hot water solution for every application!

BFC Twister Innovo

Due to the variety in output and capacity Innovo can be used in various domestic hot water applications, from a large home to a commercial site. Innovo is fitted with the latest technologies:

- Automatic gas/air premix burning system
- Low-maintenance powered anodes
- Easy control system



Efficiency up to 98% (gross) thanks to condensing system

After many years of R&D, we can confidently say that Innovo, BFC and Twister are very reliable water heaters.

Want to know more? www.aosmith.co.uk

A.O. Smith
Innovation has a name.

Supplement
www.cibsejournal.com
#Build2Perform

Editorial
Editor: Alex Smith
Tel: 01223 378034
Email: asmith@cibsejournal.com
Deputy editor: Liza Young
Tel: 01223 378048
Email: lyoung@cibsejournal.com
Technical editor: Tim Dwyer
Designer: James Baldwin

CIBSE Journal is written and produced by CPL (Cambridge Publishers Ltd) Tel: +44 (0)1223 378000. **www.cpl.co.uk**
1 Cambridge Technopark, Newmarket Road, Cambridge CB5 8PE.

Editorial copy deadline: First day of the month preceding the publication month

Advertisement sales
Sales manager: Jim Folley
Tel: 020 7324 2786
jim.folley@redactive.co.uk
Sales executive: Darren Hale
Tel: 020 7880 6206,
darren.hale@redactive.co.uk
Senior sales executive: Paul Wade
Tel: 020 7880 6212
paul.wade@redactive.co.uk
Advertising production: Jane Easterman
Tel: 020 7880 6248

Cover image

Change in the air

Designers will be under increasing pressure to get school ventilation rates in line with new standards due to be published later this year.

The new BB101 *Guidelines on ventilation, thermal comfort and indoor air quality in schools* not only sets more stringent air-quality targets and design criteria for summer overheating, but also explains how these vary depending on whether the building project is a new-build or refurbishment – and on whether the building is ventilated mechanically or naturally.

Breathing Buildings has created a handy infographic (page 10) showing how CO_2 limits and flow rates have evolved, and the new rules designers must follow.

Ensuring adequate ventilation – while minimising energy consumption – was a key design feature for the team behind the GlaxoSmithKline Carbon Neutral Laboratory for Sustainable Chemistry at the University of Nottingham, where air volume required for each fume cupboard had to be closely matched with the air and temperature requirements of laboratory users.

The building, which suffered a setback during construction when it was gutted by a huge blaze, is run on solar power and sustainable biofuel, and aims to be carbon neutral over its 25-year lifetime (see page 6).

In contrast to the net-zero carbon complexities of the chemistry centre, a team of young designers from a school in Sheffield followed a passive-design philosophy to create a community school in Uganda (page 12).

Working under the Design Construct Engineer learning programme – part of the Class of Your Own (Coyo) initiative – the 13- and 14-year-old pupils used Revit to model their hexagonal building with steel roof, which was lifted clear of the walls to allow air to enter the classrooms.

A crowdfunding campaign was launched last month to help raise the £150,000 required to build the school – so the pupils are well on their way to seeing their scheme realised.

LIZA YOUNG, DEPUTY EDITOR lyoung@cibsejournal.com

CONTENTS

Taking control of IAQ

Indoor air quality continues to be a major health concern, and has been shown to influence educational attainment in schools. Smart mechanical ventilation with heat and moisture recovery is the obvious answer, says Hoval's **Ian Dagley**

There is growing concern in the UK about the levels of air pollution in our cities and the possible implications for health. What many people don't realise is that the pollution inside our buildings can be as much as 100% worse than outside air. This is a serious issue for all indoor environments, including classrooms. For example, studies carried out by the University of Exeter have shown that CO_2 levels exceeding 1,500ppm can lead to a 5% reduction in Power of Attention measures.

In the past, poorly insulated buildings may have wasted a lot of energy but they did facilitate natural ventilation, so that indoor pollutants were less likely to accumulate. Nowadays we are building much 'tighter', better insulated buildings to live and work in and have reduced wasted energy significantly – but at the expense of natural ventilation.

Given that the average human inhales up to 20,000 litres of air per day, this is a serious concern. Each inhaled breath can contain as many as 75,000 dust particles and various airborne molecules, some of which will undoubtedly pose a threat to health. The more concentrated these airborne pollutants are, the greater the risk of allergies and other ailments.

In addition, poor ventilation will allow levels of carbon dioxide from exhaled air to rise to concentrations that can cause lack of attention and drowsiness. This is often a problem in poorly ventilated classrooms, where high occupancy allows CO_2 levels to rise to levels that impair concentration, cause headaches and induce fatigue. Similar effects will be experienced in workplaces with inadequate ventilation.

Recognition of this problem is leading to changes in Building Bulletin 101, 'Guidelines on ventilation, thermal comfort and indoor air quality in schools', which sets out regulations, standards and guidance on ventilation, thermal comfort and indoor air quality for school buildings. One of the key changes in BB101 is that ventilation rates should no longer be based on a litre/second/person measurement, but instead on ensuring CO_2 levels do not exceed daily averages of 1,000ppm.

Simply relying on open windows to improve ventilation introduces problems with noise, pollution and draughts.

Addressing the issues with smart ventilation

It has, therefore, become necessary to take active measures to restore and maintain good indoor air quality (IAQ) in classrooms, workplaces and homes. Moreover, this needs to be achieved without undoing the energy-savings benefits delivered by tighter buildings. This is not only essential for general health but also for our ability to function.

Ventilation measures should also exercise control over humidity levels so that the air doesn't become too dry – which makes people even more susceptible to respiratory problems.

The solution, therefore, is to specify a smart ventilation system that addresses all of these concerns. Hoval's HomeVent is one of the few MVHR systems to recover heat *and* moisture.

HomeVent units provide draught-free ventilation to maintain high indoor air quality at all times. With six models in the range, offering airflow rates from 150m³/h to 500m³/h, there is a HomeVent solution for a wide range of applications.

Excellent energy performance is assured by high efficiency heat exchangers, recovering heat from extract air and warming the incoming fresh air. Similarly, moisture from stale air is recovered and used to humidify incoming air to maintain comfortable humidity. All incoming fresh air is also filtered to remove pollutants, pollen and other potential allergens.

The compact design of HomeVent systems allows them to be located discreetly in the building and all processes are fully automated once the desired conditions have been set.

www.hoval.co.uk/products/homevent/

IAN DAGLEY is sales director with Hoval and has been with the company since 2005. During this time he has played a key role in broadening the company's offering to include low carbon heating, heat recovery and ventilation products, in addition to Hoval's traditional high efficiency boilers

Three major changes to school ventilation rules

BB101 sets higher standards for air quality and thermal comfort

Designers face three significant changes to the rules governing ventilation in schools, when new standards are published in late spring/early summer.

The revision of BB101 *Guidelines on ventilation, thermal comfort and indoor air quality in schools* is the first since 2006.

The new guidance sets more stringent air-quality targets, is tougher on summertime overheating, and requires pre-mixing of incoming air (see page 10).

Carbon dioxide (CO_2) levels are now only allowed to exceed daily average thresholds for 20 consecutive minutes, so ventilation systems need to work throughout the occupied period.

Thermal comfort criteria in schools are now more closely aligned with other building types. For example, summertime overheating needs to be assessed in terms of operative temperature, as with the approach used in CIBSE TM52. The guidance does not allow draughts in winter and the level of temperature elevation required for incoming fresh air is defined.

In winter, pre-mixing of incoming cold air with warm room air must be used as the default means of mitigating cold draughts, rather than simply using radiators. This is to reduce the heating bills in naturally ventilated buildings.

'This edition of BB101 heralds a new dawn for our schools. It addresses the issues of indoor air quality, thermal comfort and energy use more comprehensively, drawing on learnings from schools built over the last 10 years,' said Professor Shaun Fitzgerald, Breathing Buildings CEO.

Boiler makes space for a gym

Maiden Erlegh School in Reading has replaced its ageing heating system with 12 Vaillant EcoTEC 120kW output wall-hung gas boilers. The school management wanted a system that would reduce ongoing maintenance and running costs, had built-in flexible backup, and that could be operated remotely.

The school requested the separation of the three areas that had been fed from the main plantroom, and wanted individual plantrooms to serve the maths and science block, sixth-form building, and the main school.

The specification was in part determined by the position of the plantroom, which was 1,200mm below ground – so manual handling had to be minimised. The compact modular design met this requirement and freed up plantroom space for a new gym.

LIBESKIND LANDS IN DURHAM

Durham University has opened its £11.5m Ogden Centre for Fundamental Physics, designed by Studio Libeskind. The 2,478m² building includes 80 offices, which benefit from natural light and ventilation. Glazed doors and screens take additional light to the central atrium. Exposed concrete ceilings take advantage of the night-purge effect, and there are PVs and a ground source heat pump. Arup provided MEP and structural engineering, as well as specialist consulting services.

CREDIT / HUFTON + CROW

NO_x – combating the enemy within

A European Union (EU) directive will impose new NO_x emissions limits on new boilers from September 2018. Remeha's James Porter says schools should upgrade existing boilers to create better environments for their pupils

As attention on toxic air and its impact on children intensifies, nitrogen oxides – or NO_x – have been singled out for scrutiny. Road traffic is a major contributor to outdoor pollution, responsible for more than 50% of emissions, but buildings also emit NO_x. The City of London Corporation claims that 38% of NO_x emissions in the Square Mile are from gas heating of buildings.

From September 2018, new mandatory EU requirements for NO_x will come into force for space heaters, up to and including 400kW on new-build and refurbishment projects. Initially at least, all EU initiatives are expected to remain in place in the UK after Brexit. So, it is worth noting that the Ecodesign of Energy-related Products (ErP) Directive (iii) 2018 will impose maximum NO_x emissions of 56mg/kWh for gas and liquefied petroleum gas (LPG) boilers, and 120mg/kWh for oil-fired boilers. This aims to ensure only the most energy-efficient, low-NO_x heating products are manufactured, specified and installed.

Condensing boilers deliver the highest efficiencies of all boiler types, with the latest models achieving around 98% gross efficiencies. With emissions at or below 40mg/kWh, ultra-low NO_x boilers meet the EU standard EN15502 Pt 1 2015 Class 6 and are future-proofed for ErP NO_x emissions regulations.

Promoting low emission levels is not a new concept in heating. The London Plan recommends the use of low-NO_x boilers within borough council and City of London buildings, while Breeam addresses NO_x in the Pol 2 pollution category.

So what steps can schools take? First, specify only high-efficiency, low-NO_x equipment. Second, upgrade old or inefficient boilers to advanced condensing models. Third, optimise performance of the system through accurate sizing, good design and advanced controls.

Chemical equilibrium

The GlaxoSmithKline Carbon Neutral Laboratory for Sustainable Chemistry at the University of Nottingham aims to be carbon neutral over its 25-year lifetime. Rebuilt after a fire gutted the site a year into construction, Andrew Brister reveals the energy strategy behind the £15.8m building

Think of low-energy buildings – and space-age labs for generating the latest advances in chemistry may not spring to mind. Yet, the GlaxoSmithKline (GSK) Carbon Neutral Laboratory for Sustainable Chemistry boasts a Breeam Outstanding rating for its environmental credentials, putting it in the top 1-2% of buildings.

The centre is the latest development by the University of Nottingham on its Jubilee Campus. As the name suggests, the £15.8m facility aims to be carbon neutral over its 25-year lifetime. The energy required to run the laboratory is met by solar power and sustainable biofuel. Excess energy will produce enough carbon credits over 25 years to pay back the carbon used in construction, and is being used to heat a nearby office development. But in September 2014 – 52 weeks into an 84-

week build – the centre was gutted by a huge blaze. No blame was attached to the build process (an electrical fault in the temporary site supply was thought to be the culprit) and principal contractor Morgan Sindall has rebuilt it, largely using the same design.

From concept to reality

Part funded by a £12m gift from GSK, the building occupies 4,500m² over two floors, and includes lab space for 150 researchers, dedicated instrument rooms, a teaching laboratory, offices and space for outreach activities. The striking design, by architect Fairhursts Design Group – with its 'horns' to assist ventilation in the laboratories – includes a solar photovoltaic (PV) array on the southern aspect, a north-facing grass roof and a communal winter garden.

Aecom was the building services consultant on the project. 'We were employed by GSK to develop and validate the concept of a naturally ventilated, very low-energy chemistry laboratory,' says Matthew Butler, associate director, building engineering at Aecom. 'When GSK gifted the concept and supplied the funding, we had to evolve the design – as some of the requirements of the university are quite different – but still keep the zero carbon status.'

Central to this is delivering a building with a low embodied carbon content. The target is a 70% reduction, compared to a conventional new build. 'There is lots of wood,' says Butler. 'That presents a few »

15.8m

Cost of the new chemistry laboratory on the University of Nottingham's Jubilee Campus. The building aims to be carbon neutral over its 25-year lifetime

» challenges. For example, wood tends to vibrate more than other materials, sensitive equipment has been housed on the ground floor.' Wood can also absorb chemicals that may be splashed onto surfaces, so some areas have been treated, while parts of the labs have sacrificial panels that can be replaced.

The next challenge was to cut energy use. 'We have targeted areas, such as the ventilation system for the fume cupboards, and put heat recovery units on them,' says Butler. 'We've also included cooling only where necessary and done all the standard things, such as low-energy lighting.'

Renewables in the mix

The third part of the strategy is to generate energy from renewable sources. 'Solar power was always planned to be part of the mix and the building has a large roof area for the [PV] array,' says Butler. Panels can sit flat on the roof without a frame, giving an output of 230,000kWh per year.

The building also uses a biofuel combined heat and power (CHP) unit. 'Gas-fired CHP plant wouldn't have got us to carbon-neutral status,' says Butler. 'We looked at solid-fuel biomass, but – at the time – the technology was struggling in terms of handling the fuel and getting the heat and power out of it.'

Liquid biofuel was the best option, but the exact source of the fuel is a closely-guarded secret. 'It's an industrial by-product and that's all I'm allowed to say,' says a tightlipped Butler. 'The fuel isn't a food source because it needs to be sustainable.'

The CHP unit delivers 200kW of electrical power and 193kW of heat. It acts as the primary heat source, with a biofuel boiler as primary backup. A secondary, 'doomsday', gas-fired boiler is for use only if there are problems with biofuel delivery. Heat from the CHP is collected in a thermal store big enough for 3-4 hours' operation. Space heating is by underfloor heating.

Fume cupboards key to ventilation strategy

There are five labs on the first floor – four are conventional and one is an experimental concept laboratory. 'One of the challenges has been the university's requirement for many more fume cupboards than was planned under the GSK concept; that adds to the energy consumption,' says Butler.

In the four main labs, Aecom has installed low face velocity, variable-volume fume cupboards with automatic fast closures; when users walk away, they set back on volume. 'These provide all the ventilation for the space, so we can minimise the air supply to exactly what we require, based on the fume cupboards,' says Butler.

The distinctive 'horns' give very high flue-gas discharge rates

"A secondary 'doomsday' gas-fired boiler backup is for use only if there are problems with biofuel delivery"

It is here that the building's distinctive 'horns' come into their own. 'These give us very high flue-gas discharge rates, so we are able to reduce the discharge velocity, saving a lot of fan energy,' says Butler. Multiple nozzles on the discharge also allow a greater turn down on the fans. 'We can open nozzles to suit the desired air-flow rates.'

To save energy, there is a dedicated air handling unit (AHU) for each laboratory. This way, the air volume required for each fume cupboard can be closely matched with the air and temperature requirements for users in the space. No cooling is provided. A plate heat exchanger is used to exchange heat from the fume cupboard extract with incoming air, giving big savings on energy.

In the centre of the building is the concept laboratory, which is naturally ventilated. 'The building forms a ridge and we are using the wind pressure on the ridge to drive ventilation through plate heat exchangers to give natural ventilation and heat recovery for a very low-energy lab,' says Butler. 'We believe it's a first; you get naturally ventilated labs, but not with heat recovery to try to achieve a high air-change rate without heat loss.'

On the ground floor are two labs housing

The source of the liquid biofuel is a closely guarded secret. 'It's an industrial by-product and that's all I'm allowed to say,' states a tight-lipped Matthew Butler

specialist equipment that is temperature critical, so cooling has been installed in these areas. 'A dedicated AHU for each space allows us to maximise the free cooling from outside air before the central chiller needs to kick in,' says Butler. Also on the ground floor are offices and teaching spaces. Here, ventilation is via a variable air volume system without cooling, again using a heat-recovery heat exchanger unit on the ridge. 'This achieves very low energy ventilation to the offices,' adds Butler.

Changing user behaviour

A key part of the energy strategy involves cultural change from scientists. 'Academics don't work in the same way that the GSK concept envisaged, so we've had to look at things such as backing the ventilation system right down so we can just run one fume cupboard in a lab,' says Butler. Aecom holds regular meetings with the university to look at energy data and the impact of out-of-hours working. Chemical storage cabinets have also been accommodated. 'Scientists tend to leave chemicals in fume cupboards overnight, which means they use a lot of energy. The storage cabinets are run with a minimal ventilation rate to take out any vapours, saving a huge amount of energy in terms of fan running costs.'

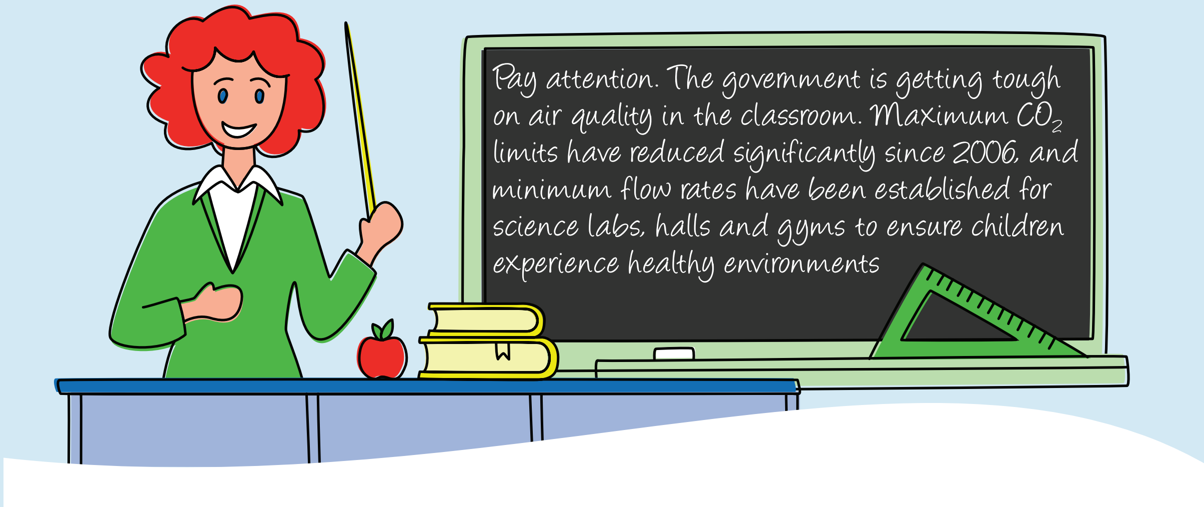
The fire that gutted the original building did not lead to major design changes. 'A couple more fire partitions were put in, but that was only because the fire regulations had changed in the interim,' says Butler. 'The fire had a galvanising effect and the project benefited from a greater spirit of collaboration after it.'

The result has certainly pleased the client. 'It's a project that defines a new way of approaching science and the environment that

sits around it – we're teaching our scientists to work in a way that's more sensitive to their carbon footprint,' says Professor Peter Licence, director of the centre. 'This building has to inspire people to want to do things differently.' **CJ**

Raising standards

Rules on school ventilation are changing under *BB101 Guidelines on ventilation, thermal comfort and indoor air quality*. **Breathing Buildings'** infographic shows how CO_2 limits are evolving



BB101
(2006)

Minimum flow rates

Classrooms should be capable of **8 l/s/p** for the design occupancy when occupied

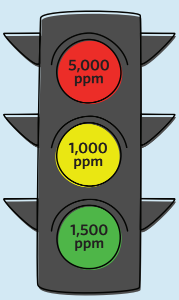
Classrooms need a minimum of **3 l/s/p**, for the design occupancy when occupied

Classrooms need a minimum daily average of **5 l/s/p**

Halls and gyms need to be capable of a minimum of **8 l/s/p** for the design occupancy when occupied

Science labs should be capable of **5 ACH**

Maximum CO_2 limits



During daytime occupation, maximum CO_2 must not exceed **5,000ppm**

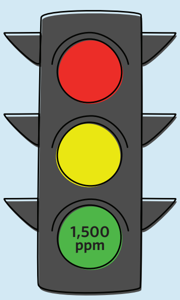
At any time, occupants should be able to lower CO_2 to **1,000ppm**

Average CO_2 during occupied day must be less than **1,500ppm**

PSBP FOS*
(2014)

Maximum CO_2 limits

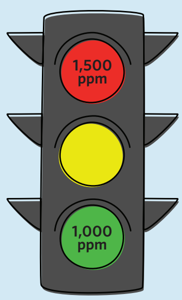
For natural ventilation



CO_2 can't be greater than **2,000ppm** for 20 minutes or more during occupied day.

Average CO_2 during occupied day must be less than **1,500ppm**

For mechanical ventilation



CO_2 can't be greater than **1,500ppm** for 20 minutes or more during occupied day.

Average CO_2 during occupied day must be less than **1,000ppm**

*Priority School Building Programme Facilities Output Specification

New

BB101
(due summer 2017)

Minimum flow rates

Special educational needs schools

8 l/s/p

Classrooms should be capable of **8 l/s/p** or **2 ACH** for the design occupancy when occupied, whichever is greater

8 l/s/p

Halls and gyms to be capable of a minimum of **2.5 ACH** or **8 l/s/p**, whichever is greater

Art and DT classrooms

2.5

Art and design rooms need a minimum of **2.5 l/s/m²**

Science laboratories

4

For science labs with an area >**70m²**, the minimum is **4 l/s/m²**

Maximum CO_2 limits

For natural ventilation

2,000 ppm

1,500 ppm

CO_2 can't be greater than **2,000ppm** for 20 consecutive minutes or more during occupied day

Average CO_2 during occupied day must be less than **1,500ppm**

For mechanical ventilation

1,500 ppm

1,000 ppm

CO_2 can't be greater than **1,500ppm** for 20 consecutive minutes or more during occupied day

Average CO_2 during occupied day must be less than **1,000ppm**

In science labs, an alarm goes off when CO_2 reaches **2,800ppm**

A class apart

Students at King Ecgbert School in Sheffield have won a challenge to design a community school in Uganda, by focusing on the needs of the local children. Andy Pearson explains how the industry-backed Class of Your Own initiative ignited a passion for building design and engineering among 13- and 14-year-olds

A 20-year civil war has wreaked havoc on the village farming communities of Uganda. Thousands of people lost their lives, millions lost their homes and almost all of the schools in rural areas were destroyed. Today, Ugandan children are left with no real hope of the education they so badly need and want. But things are set to change in Parabongo village, in the north of the country.

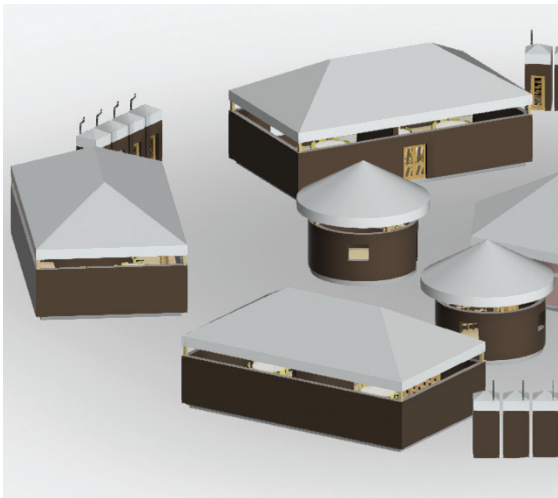
An impressive new school for more than 1,000 students has been planned. Its simple, elegant design consists of a series of classrooms arranged in concentric circles around a central assembly space, to help create a community of students; its scale and choice of materials have been chosen to reflect the local vernacular. The design even includes space for planting, to allow the school to grow food.

More impressive still is that the scheme was designed by a team of 13- and 14-year-old pupils from King Ecgbert School in Sheffield, under the Design Engineer Construct (DEC) learning programme – part of the Class of Your Own (Coyo) initiative. Coyo was founded by Alison Watson in 2009, to introduce studies on technical and professional elements of the built environment onto the school curriculum (See 'A class of your own', Education Facilities Special, *CIBSE Journal*, May 2014). The initiative has been gaining momentum ever since. Each year, as part of the DEC curriculum, Coyo sets students a challenge; in 2015 it was to design a new school for Parabongo.

Watson says the idea for the challenge stemmed from the work Alison Hall, of charity Seeds for Development (**www.seedsfordevelopment.org**), had been doing in Parabongo to help 'empower the local community to improve their lives to become socially and economically resilient'. The challenge brief was for a team of up to 10 students to design an accessible and sustainable school to

Raising money for Parabongo

It is hoped a cycle sportive organised by DEC and Topcon will raise £25,000 towards the Parabongo project. The event takes place on Sunday 25th June 2017 in Mid Wales www.dectopconsportive.com



accommodate 1,000 children aged between three and 18 years. It called on students to think about their selection of materials, to make the best use of those that are both readily available and easily adapted by a local workforce. It also suggested that architecture, civil and structural engineering, building services engineering, facilities management, quantity surveying, project management, interior design and landscape architecture should all be represented in developing the design solution.

'It was logical that we launched this very special competition – the whole point of the Design Engineer Construct learning programme is to enable young people to lead on their own projects,' says Watson.

The teams were given a detailed plan of the site, which had been prepared by Liverpool John Moores University with the support of Topcon Positioning Systems. Students were also encouraged to email questions about Ugandan life and schooling to Ronald, a 13-year-old pupil in Kampala.

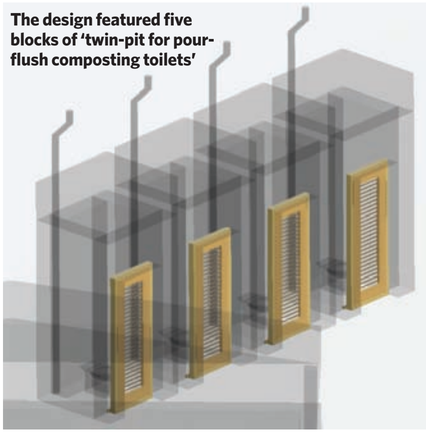
The work that led to King Ecgbert's winning entry started in July 2015, when Year 9 DEC students investigated the vernacular building styles of rural Uganda, the availability of materials, and climate data. 'Students could pick the discipline in which they wanted to work, so those more interested in cultural aspects of design could focus on how the buildings should feel,' says Helen Vardy, the school's leader of learning, Key Stage 4 and 5 design and technology.

The research enabled the students to develop a concept design for the new village school and then to build a physical, 3D model of it in cardboard. At its heart, King Ecgbert School's scheme is a large hexagonal school assembly building, which also functions as a large classroom and a space for students to eat lunch. Set out in a circle – around this hexagonal hub – are four smaller, circular buildings, their form developed to reflect traditional rural Ugandan homes. These are classrooms for younger children.

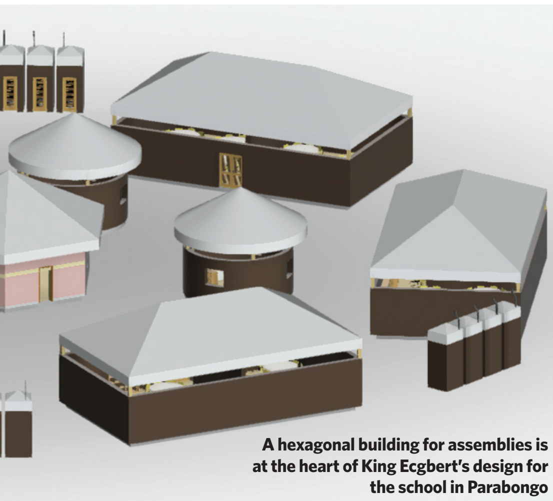
Children in Parabongo, Uganda

Surrounding the nursery classrooms is a second circle comprising six larger, rectangular buildings, each capable of housing two classes of 40 students. The designers hope this will give everyone 'a chance to learn and talk to their teachers without being overshadowed by the sheer number of students in their class'.

"As part of the entry, the team modelled the design using Revit to create drawings, renders and walkthroughs"



The design featured five blocks of 'twin-pit for pour-flush composting toilets'



A hexagonal building for assemblies is at the heart of King Ecgbert's design for the school in Parabongo

On the outer perimeter of the school, spaced between the rectangular classroom blocks, are five blocks of four composting toilets. The students' presentation explains that the concept is based on 'twin-pit for pour-flush toilets', as opposed to 'ventilated improved pit (VIP) toilets', because they are beneficial to the soil and 'will be able to be used at all times, unlike the VIP toilets, which cannot be used when full or being emptied'. The students estimate a cost of £75 per toilet – £1,500 in total.

The scheme also includes a large kitchen block – set to one side of the site – and gardens for planting cassava, a crop grown locally for food.

The buildings are constructed from traditional materials, including unfired clay/straw brick walls, which will be made on site by the community, and straw roofs.

In February 2015, four Year 10 DEC students, working at lunchtimes and after school, set about reviewing the research and refining the concept. The team was: Jessica Chamberlain, architect and building services engineer; Jessica Mellor, project manager, civil engineer and facilities manager; Alex Wheatley, landscape architect and interior designer; and Katie Wilkinson, architectural technologist, structural engineer and quantity surveyor. They worked under the name *Timu Matumaini* – Swahili for Team Hope – which was chosen 'to show what school and an education means to anyone who is given it'.

Vardy says the team worked well together: 'They all seemed to fall into their roles naturally and were good at challenging one another.' As part of the entry, the team produced a report, made a video (**bit.ly/1R6W91v**), and modelled the design using Revit to create drawings, renders and walkthroughs. The judges were impressed, describing the scheme as 'an outstanding design' and saying that the team 'showed they had clearly thought through every aspect of the brief'.

Things really started to take off after King Ecgbert's entry won the competition. The winning team visited Arup's offices in London, where they met James Okumu, head teacher in waiting of Vision Hope School, who had been flown in from Uganda courtesy of Arup. 'It was incredible meeting the principal and hearing what difference a school will make to the community,' says Vardy, who added that »

» Okumu was enthusiastic about the scheme. 'He loved the design because he said "it gave the school a real sense of community because it is based around a circle".'

Okumu also proposed some improvements, including teacher accommodation. 'We'd not even considered that,' says Vardy. 'The suggestion helped highlight some of the cultural differences between what we'd assumed they needed and what they actually needed.'

The principal raised concerns that the blocks of toilets were too close to the classrooms and explained that the villagers were very concerned about fire in buildings – so the design team replaced the traditional grass roofs with a corrugated steel alternative. Arup then worked with them to incorporate these refinements into their design.

The steel roofs had the advantage of being low cost and they could be used to collect rainwater. 'They do have quite a bit of rain [in Uganda] and it does get incredibly hot,' says Vardy. The roofs were lifted clear of the walls to allow air to enter the classrooms through low-level window openings, and to rise up and out from beneath the eaves.


The site of the new school

The team describe this solution as a 'solar roof extraction system', which they say makes 'the perfect atmosphere for learning minds'. And because the school doesn't have access to electricity, the students suggested the roofs could also be used to support solar panels.

Quantities of materials needed were calculated by the team, working with BAM, and a cost to build the scheme was estimated at £150,000, including getting experts out to Uganda to help local people construct the project. The final element of the design was a visit to Arup's Sheffield office – the school's DEC sponsor – to finalise the team's digital model.

Participating in the project has been a valuable experience: 'The students learned how powerful buildings can be and what a difference they can make – it's beyond architecture,' says Vardy. 'It has also been hugely beneficial for the students to take on real-life roles and to work on a real brief; it has given them an insight into working as a team'.

For Coyo's Watson, the task now is to realise King Ecgbert's design; 'We're trying hard to raise money to get the school built,' she says. A crowdfunding initiative was launched in March with the help of CIBSE Yorkshire, to raise the capital needed. Depending on how well the funding goes, the pupils may even get the opportunity to fly to Uganda to see their scheme realised. **CJ**

- **For more information about the DEC module visit www.designengineerconstruct.com**
- **To donate to the project bit.ly/CJApr17coyo**

Using windows for classroom ventilation An educated solution

With the latest iteration of BB101 nearing the end of its detailed public consultation process, SE Controls' **Dr Chris Iddon** explores its impact on comfort levels, ventilation and perhaps most importantly, classroom indoor air quality (IAQ)

Hybrid and mixed mode systems are now being used more widely in new build school projects as the individual benefits of fan-assisted and natural ventilation are combined to provide solutions that are practical, economic, adaptable and controllable.

Windows and dampers still remain an important part of ventilation solutions, as they can provide higher airflow rates than fan-assisted systems, which are generally designed to meet IAQ specifications. The greater flow rates required for summer cooling can be provided by windows during the day and as part of a night purge strategy. In addition, windows also provide the capacity for purge ventilation, which is a requirement of Building Regulations ADF.

Ensuring openable windows comply with Building Regulations.

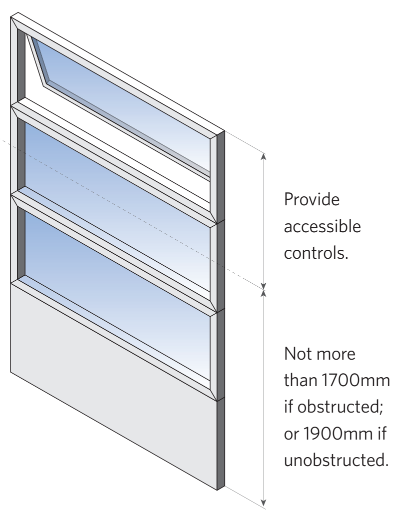
To prevent clash and fall issues, design risk assessments usually result in restrictions to the amount that low-level windows can be opened. As high-level windows can be opened wider, these are often used to provide the effective open area necessary to deliver increased flow rates.

High-level windows also promote cooling of the exposed thermal mass during night purging, but designers should be aware of the requirements of Building Regulations Part K (Part N in Wales). This stipulates that controls to open windows that are more than 1900mm above floor level (AFL) or 1700mm AFL, if obstructed, should be accessible, as shown in figure 1.

Consequently, ordinary window handles on such-high-level vents do not meet building control requirements and alternative opening control methods should be considered. This applies not only to new build, but also any refurbishment projects incorporating the replacement of high-level openable windows.

At SE Controls, we provide a range of solutions for the operation of high-level windows; using push button operated electrical actuators, either stand-alone or linked to automatic indoor air quality monitors, such as our NVLogiQ system, or via a manual winding mechanism. We can also provide assistance to help designers specify the most appropriate solution.

Figure 1: Building Regulations - safe opening and closing of windows



Monitoring and logging CO_2 for demand control of ventilation.

The upcoming revision of BB101 recommends that carbon dioxide sensors should be used where possible to save energy through the monitoring and demand control of ventilation systems. NVLogiQ, which was developed in conjunction with Loughborough University's School of Civil and Building Engineering, provides a solution that will meet and exceed these requirements by both monitoring IAQ and adjusting window opening using actuators:

- Allows reduced ventilation rates when required, e.g. with low occupancy
- Allows the building to be used out of hours
- Enables increased ventilation in summertime
- Maintains acceptable levels of indoor air quality
- Control of local TRV to minimise heating energy consumption and avoid system conflicts
- Logs internal temperature and CO_2 concentrations
- Allows web enabled access for real-time remote data monitoring
- Compatibility with systems that provide tempered ventilation for IAQ during inclement weather
- Local manual control over the ventilation rate, allowing users to open/close vents dependent upon occupant comfort and internal circumstances.

Although there are numerous methods of improving air quality in schools and maintaining adequate ventilation levels, just opening a window is one of the easiest, most accessible and cost effective.

- **www.secontrols.com**

School corridor ventilation.

Ventilation to communal areas is often overlooked and although occupation in such areas is often transient, these areas can be prone to overheating and accumulate stale air if the ventilation needs are not properly considered. The consultation version of BB101 states that the best way of providing the required ventilation to corridors is by opening windows or vents and where the windows or vents are under local or manual control, the discomfort criteria concerning incoming plume temperatures do not apply.

DR CHRIS IDDON cEng MCIBSE, is natural ventilation design manager with SE Controls

EVOLUTION IS COMING

SPRING 2017

evolutioniscoming.co.uk

remeha