BRILLIANT BUILDINGS

HARRIS ACADEMY SUTTON

Creating the first ever Passivhaus secondary school

The story behind one of the UK's most technically challenging education projects

1. INTRODUCTION

The trailblazing Harris Academy Sutton in south London takes sustainability to new heights. As the largest school – and the first secondary – in the UK to be built to the Passivhaus standard, the top-quality building sets the sector standard for exceptionally low energy use and superb user comfort.

The four-storey, six-form entry school accommodates 1,275 pupils and 95 staff. Constructed for the London Borough of Sutton by Willmott Dixon, the contractor was appointed following its successful delivery of the UK's largest non-residential Passivhaus scheme, the George Davies Centre for the University of Leicester.

The school forms part of Sutton's masterplan for the London Cancer Hub – which aims to be a world-leading campus for research, treatment, education and enterprise.

WHAT THE SCHOOL WANTED

JAMES FISHER
Principal, Harris Academy Sutton

Harris Academy Sutton has sustainability at its heart and within the very fabric of the building. We want to take that message to our students who are the next generation of the borough's inhabitants and they can grow and develop that for generations to come.

One of the first things you learn about as a teacher is how to enhance a learning environment to get the best out of your students. There is a real sense of space within the building thanks to the light wells which provide a significant amount of natural light, reducing the reliance on artificial lighting. This lends itself to a fantastic environment for students to learn and for adults to work in.

On any project on this scale you may find issues along the way. What we have been most impressed with is the speed of response from Willmott Dixon and the London Borough of Sutton, working together to get the school off the ground. The main benefit is the flexibility Willmott Dixon has shown; being able to move quickly on small design changes and slight structural points. Sometimes what looked good on paper was not quite right when walking round the project in development, but the team was quick to respond and more than helpful – they have been fantastic.

Seeing the light: Careful orientation and sizing of windows, together with selective shading, optimises solar gain in winter and prevents overheating in summer.

"WE ANTICIPATE THAT THE LIGHT, HEATING PROCESS AND AIR CIRCULATION AROUND THE BUILDING WILL ENHANCE THE LEARNING ENVIRONMENT, CONCENTRATION LEVELS AND THE WAY THAT STUDENTS AND TEACHERS INTERACT – MAKING IT BETTER FOR EVERYONE INVOLVED."

JAMES FISHER
PRINCIPAL, HARRIS ACADEMY SUTTON

Climate for learning: In the winter, fresh warm air heats rooms and spaces. They never get stuffy and there are no uncomfortable draughts or cold spots. In the summer the building stays fresh and cool. As a result, pupils and staff feel alert and comfortable all year round.

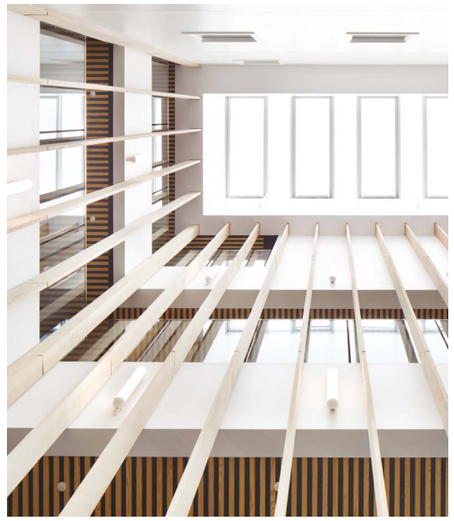
Passivhaus effect: The "fabric first" approach centres on measures such as extra thick insulation in walls, floors and roof; triple glazing on windows and doors; and an exceptionally airtight building envelope – approximately 14 times more airtight than building regulations require.

The right materials: "This school is different from other schools because there is a large focus on light and shared spaces," says principal James Fisher. "In terms of materials, there is a lot of wood which subliminally sends a message to our students about the sustainability aspect, while also enhancing the learning environment."

Saving the planet and saving money: The council wanted a school with minimal operational carbon, certainty of energy savings and an excellent indoor environment. It opted for a Passivhaus building because of its ability to meet these objectives in a more focused way than a BREEAM-rated scheme. This typically consumes 80% less energy than a standard new building, giving tremendous savings on operating costs and carbon emissions.

Key outcomes

- The UK's first Passivhaus secondary school
- The country's largest Passivhaus school
- Very low operating costs
- 80% less energy use than a conventional building
- Ideal internal temperature all year round
- Superb air quality for better learning, health and wellbeing
- Exceptional airtightness – around 14 times lower than building regulations
- 0.3 air changes per hour, which is half of the Passivhaus requirement
- 40% project spend with local businesses



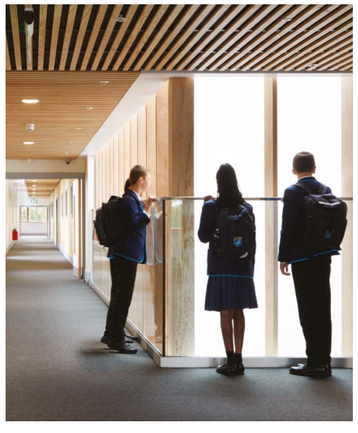
Left: One of the many flexible learning spaces, optimised by natural light.
Below left: Timber finishes continue throughout the interiors, including the sports hall.
Right: Light wells draw natural light deep into the building.
Far right: The composite concrete and timber structure is clad in wood panels.

2. WHY PASSIVHAUS?

Developed in Germany in the early 1990s, Passivhaus is an international standard for designing and constructing buildings that deliver super-high energy efficiency and impressive occupier comfort. Crucially, to achieve certification, everything must be built exactly as designed and to top-quality standards, ensuring that performance in use mirrors the design model and targets.

The London Borough of Sutton has had a forward-thinking approach to sustainability for decades and its ambition was to build a school with minimal operational carbon consumption, certainty of energy savings and an excellent indoor environment. The council opted for Passivhaus because of its ability to meet these objectives in a more focused way than the BREEAM environmental certification scheme.

For the school, this translates into energy use that is typically 80% lower than a standard new building, giving tremendous savings on operating costs and carbon emissions. Internally, better air quality, ideal temperature and natural light provide an optimum building to study and work in. Throughout the year, mechanical ventilation with heat recovery (MVHR) provides fresh air, with the quantity locally adjusted in response to carbon dioxide sensors in all rooms. In the winter, fresh, warm air heats rooms and spaces. They never get stuffy, which tends to cause sleepiness, and there are no uncomfortable draughts or cold spots. In the summer, the building stays fresh and cool. As a result, pupils and staff feel alert and comfortable all year round, which positively impacts learning ability and wellbeing.



THE PASSIVHAUS DIFFERENCE

Passivhaus has been a relatively unknown standard in the UK, but with sustainability never more critical to people and the planet, it is now moving from niche to norm. When Willmott Dixon delivered the Passivhaus standard with the George Davies Centre at the University of Leicester in 2015, it was the largest non-residential building in the UK to achieve the coveted standard at the time. The Harris Academy Sutton project is another huge step forward for Passivhaus in the UK.

Visually, buildings are no different to others of a very high quality. Where they diverge is in how the building performs – namely, with very low energy costs and carbon emissions, excellent air quality and a constant comfortable temperature. At the heart of the standard are a number of key principles.

Fabric first

The Passivhaus "fabric first" approach to design and construction is about carefully optimising the fabric of the building itself so that energy efficiency is achieved passively.

It centres on measures such as extra thick insulation in walls, floors and roof; triple glazing on windows and doors; and an exceptionally airtight building envelope – approximately 14 times the requirements of building regulations. Through exceptional insulation and airtightness, heat leakage through the windows, walls, floor and roof is prevented.

Other fabric elements include careful orientation and sizing of windows, together with selective shading, to optimise solar gains in winter and prevent overheating in summer.

Excellent air quality and thermal comfort

Another mainstay of Passivhaus is a highly efficient MVHR system, which controls and optimises internal air quality and temperature. The system automatically brings in and filters fresh air from the outside, removes stale air from inside and supplies cool or warm clean air at an even, comfortable temperature to all areas of the building.

All "free" heat, such as from daylight, people and equipment, is recovered and used to pre-heat incoming cooler fresh air (in winter mode). This means that the heating systems should only be required on the coldest of days, keeping energy consumption extremely low. Although radiators are fitted in some of the rooms, they are incredibly small – around 40cm x 45cm for a classroom of about 30 pupils. As there are no cold draughts coming in, they don't need to be conventionally placed under the window and are typically out of the way behind doors.

The required boiler size equates to a domestic unit in a standard four-bedroom house. Given that the building is around 70 to 90 times bigger, this is exceptionally small, meeting all of the school's needs with minimal energy consumption.

Quality assurance

The same construction materials and components are used as for conventional buildings. However, in order to meet the stringent Passivhaus requirements, components need to be top-quality (with full test data) and installation standards have to be exemplary.

"FOR ALL OF US, THIS WAS VERY MUCH A CO-OPERATIVE, PARTNERING PROCESS. AS THE PROJECT EVOLVED, EVERYONE DEMONSTRATED THESE VALUES IN A VERY POSITIVE WAY."

ADAM WHITELEY,
SENIOR PROJECT MANAGER,
LONDON BOROUGH OF SUTTON

As part of certification, everything undergoes a rigorous and continual quality verification process on site. This is to ensure that all elements of the construction are completed exactly as designed so that there is no energy performance gap – the difference between efficiency levels on paper and what is actually achieved in use.

Passivhaus buildings have a reputation for operating precisely as predicted at the design stage, and do not experience an energy performance gap. Research shows that in other types of buildings in the UK, the gap is two to five times more than design targets, so in this respect Passivhaus really stands out.

Beyond BREEAM

Passivhaus is tightly linked with building performance outcomes and is known for delivering on its promise of low operating costs, certainty of energy savings and a really great environment for occupants.

The widely used BREEAM certification scheme, on the other hand, has benefits in terms of addressing sustainability issues over a wide range of themes, but is less focused on outcomes than specification and project processes. Quality of installation on site is not checked under the scheme and building performance is not necessarily assessed in use. It is important to note however that Passivhaus doesn't preclude incorporating BREEAM elements or other sustainable features into a project.

For the school, additional sustainability aspects include use of carbon-neutral or carbon-positive cross-laminated timber internally for the storeys above first-floor level. There is also the flexibility for classrooms to be made bigger or smaller in line with changing needs, as many of the classrooms are defined by non-structural partitions.

Externally, the building was mainly clad with untreated timber, plus copper and some aluminium, making it environmentally friendly, low-maintenance, durable and recyclable. Measures were also incorporated to ensure that surface water is fully absorbed on site in order to prevent strain on the local drainage system.

3. DELIVERING THE NEW SCHOOL

Achieving Passivhaus certification is no mean feat. Design and construction are complex, and expertise and commitment are vital.

Collaboration

One of the cornerstones of successfully delivering a project of this kind is higher than usual levels of collaboration between everyone – from customer and architect to contractor and supply chain partners. From a very early stage, Willmott Dixon worked with architect Architype as a single team with a common goal. This "one team" ethos enabled construction expertise to inform design and vice versa, and meant that challenges could be solved effectively to make sure of the best and most cost-efficient delivery.

Close collaborative working continued throughout the entire build period. "For all of us, this was very much a co-operative, partnering process," says Adam Whiteley, senior project manager at the London Borough of Sutton. "As the project evolved, everyone demonstrated these values in a very positive way."

Design

Designing a Passivhaus building is a rigorous process. Detailed design quality tends to be far more demanding than for most buildings, with all work checked by an independent assessor.

Areas that need very close attention include building orientation and windows, which need to be precisely sized to optimise solar gain, natural light and views. Depending on orientation, window shading also needs to be carefully designed so that overheating is prevented, without blocking daylight. Most rooms in the school have manually opening windows, with a simple indicator light to show whether opening is beneficial or costly in terms of energy.

The relationship between the building's surface area and its volume needs to be analysed so that the layout minimises heat losses. And all heat generated from building use needs to be quantified and taken into account in the design – ranging from numbers of occupiers and school equipment to food preparation in the kitchen.

Construction

Passivhaus buildings have more high-performance elements and the specification for mechanical and electrical components requires higher-quality products. In addition, contractors need to be extremely diligent to ensure the skilled workmanship and installation that the standard requires.

With quality critical to achieving certification, Willmott Dixon engaged with the supply chain at a very early stage to communicate its significance, and continually reinforced the importance of getting things absolutely right. "A key part of this was a Passivhaus-specific induction for the entire supply chain," says Graham Thompson at Willmott Dixon. "Every person was made aware of the concept, why getting everything right was so important and why stringent quality control was essential."

To support this, an open, "no blame" culture was established, with everyone encouraged to speak up if they thought something was being done incorrectly. These messages were strengthened by toolbox talks and posters throughout the project.

Very high levels of insulation are integral to Passivhaus. Where insulation boards abut there must be no gap; additionally the tolerance (air gap) behind and between them can be no bigger than 3mm. The school's ground floor, set on concrete slabs, and cross-laminated timber (CLT) roof both required perfectly abutted insulation boards, and met the extremely tight tolerances through the use of multiple layers with staggered joints. On the timber-framed second and third storeys, insulation was pumped into the wall void to completely fill it.

Achieving airtightness is a huge challenge on a Passivhaus building and it cannot be left until the end of a project. Every single interface needs to be completed efficiently and to high quality standards. Every inch of the airtightness membrane needs to be checked, and tests must to be carried out continually.

Rigorous control of any type of drilling or penetration through the building envelope is essential. On the project, penetration schedules were set, with every item carefully inspected to make sure it was correctly sealed and signed off before being covered over. As part of the process, two Willmott Dixon airtightness champions were appointed. They made sure that penetrations were fully sealed, submitting photos of everything to the Passivhaus accreditation body for compliance.

On a Passivhaus building, the requirement is for very low air change rates, with no more than 0.6 air changes per hour. For conventional buildings, the air change requirement under building regulations is around 10.0m^3/h.m^2, and for a BREEAM building it's 4.0. Willmott Dixon achieved 0.30 air changes per hour on the school (equivalent to 0.7m^3/h.m^2), which for a building of over 10,000m^2 is remarkable.

"The airtightness champions were instrumental in achieving the low air changes," says Christian Dimbleby of Architype. "They spent considerable hours over the course of the project checking work at every stage around the building – this really shows the commitment they had."

A sound investment

Given what's involved in terms of design, labour and materials, Passivhaus costs are slightly higher than for a conventional building. On average, there is an additional 5-10% capital cost for Passivhaus – equivalent to, or less than, building to the level of BREEAM Outstanding. However, this figure is expected to decrease as building regulations tighten and the volume of Passivhaus building in the UK increases. And when running costs are factored in, it is significantly cheaper in the long run.

A template for future schools

For Sutton council, the £40m school is a major asset in every respect. It is being perceived as a gateway for the London Cancer Hub, which is set to deliver economic regeneration through education, employment and training.

For pupils and staff, the superb air quality and optimum temperature provide a healthy, productive environment, supporting better learning and wellbeing. The school also integrates pupils into the campus's wider remit of scientific research and treatment, encouraging careers within life sciences.

Local people are also benefiting (see right), with sports facilities, assembly halls and other spaces available for community use.

Completed in July 2019, with the first intake of pupils having arrived in September, this remarkable school sets new standards for sustainability and quality – it is an inspiring beacon for future secondary schools to follow.

"A KEY PART OF THIS WAS A PASSIVHAUS-SPECIFIC INDUCTION FOR THE ENTIRE SUPPLY CHAIN. EVERY PERSON WAS MADE AWARE OF THE CONCEPT, WHY GETTING EVERYTHING RIGHT WAS SO IMPORTANT AND WHY STRINGENT QUALITY CONTROL WAS ESSENTIAL."

GRAHAM THOMPSON (OPPOSITE), CONSTRUCTION MANAGER, WILLMOTT DIXON

Above left: Graham Thompson of Willmott Dixon. The contractor worked closely with architect Architype to ensure that all challenges were solved quickly and effectively.
Above: The interiors are designed to provide optimal conditions for students to learn in.

Investing in the community

£64,331
Total social value

142
Number of apprentice weeks on the project

20
Number of events (including assembly talks, careers events, mock interviews, mentoring, work experience, sports activities and nursery visits)

241
Number of hours spent by Willmott Dixon people working in the community

WILLMOTT DIXON

SINCE 1852

BRILLIANT BUILDINGS

Willmott Dixon is a privately-owned contracting and interior fit-out group. Founded in 1852, we are family-run and dedicated to leaving a positive legacy in our communities and environment. Being a large company means we can create a huge and lasting positive impact on our society. This is not only done through what we build and maintain; it's achieved through the fantastic efforts of our people who make a major contribution to enhancing their local communities.

www.willmottdixon.co.uk
@WillmottDixon

To find out more about Passivhaus, please contact one of our team:

North: Kevin Clarke, kevin.clarke@willmottdixon.co.uk
Midlands: Stephen Corbett, stephen.corbett@willmottdixon.co.uk
North London and East: Paul Kirkwood, paul.kirkwood@willmottdixon.co.uk
Wales and West: Nigel Gregory, nigel.gregory@willmottdixon.co.uk
London and South: Stephen Parker, stephen.parker@willmottdixon.co.uk
Central South: David Notley, david.notley@willmottdixon.co.uk

WITH THANKS TO THE LONDON BOROUGH OF SUTTON, HARRIS ACADEMY SUTTON, ARCHITYPE AND WARM FOR SHARING THEIR INSIGHTS FOR THIS PUBLICATION

PHOTOGRAPHY BY JACK HOBHOUSE AND PETER LANGDOWN