CONCRETE QUARTERLY | SPRING 2012 | ISSUE NUMBER 239

OBJECT LESSON
Burwell Deakins' concrete design school provides a masterclass for Loughborough students

RISE OF SHINE
A housing scheme in Derby hits Code level six – with a little help from insulating concrete formwork

BREEAM COME TRUE
The Environment Agency's new Bristol headquarters sets the pace with an unprecedented 85% rating

A DESIGN FOR LIFE

With buildings contributing approximately 40% of all UK carbon dioxide emissions, their low-carbon construction and, to an even greater degree, their whole-life operation are of paramount importance.

Designers and their clients need to appreciate that while significant reductions in CO_2 are being achieved for cement and concrete production, the main CO_2 impact from a building is its day-to-day operation. This is where a real difference can and needs to be made.

It is a difference that can be achieved by using a whole-life building approach that fully embraces a low or zero-carbon philosophy and takes a long-term operational view. Here, concrete with its free and unrivalled high thermal performance, as well as a range of material benefits that minimise or even negate the need for additional finishes, can provide a holistic solution.

Furthermore, as the projects examined in this issue demonstrate, it is a solution that can provide answers to aesthetic aspiration and sustainable practicality as well as BREEAM rewards.

Guy Thompson
Head of architecture and sustainability
The Concrete Centre
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Concrete continues to lead the way on sustainability

The concrete industry has launched its latest Sustainability Performance Report, and has committed to an updated industry sustainable construction strategy.

The report on 2010 performance found that 88% of concrete production is responsibly sourced to meet the BRE framework standard BES 6001. This is higher than any other construction material sector. Other achievements include a 16% fall in CO_2 emissions for a standardised concrete mix compared to a 1990 baseline. The industry is now a net consumer of waste, using almost 47 times more waste, by-products and secondary materials from other industries than the waste it sends to landfill.

Not wanting to rest on its laurels, the concrete industry has updated the original 2008 Concrete Industry Sustainability Strategy with new objectives and performance targets to 2020 and beyond.

The updated strategy commits the industry to playing an active role in the delivery of a zero-carbon built environment, providing life-cycle assessment data, and developing a material and resource efficiency programme that informs best practice across the life-cycle of concrete. It also calls for the development of a low-carbon freight initiative to reduce the environmental impact of transportation and for a strategy to minimise water consumption.

Launching the report and strategy, Dyfrig James, chairman of the Mineral Products Association, said: "Our vision remains to lead the delivery of a sustainable built environment for current and future generations."

The report and strategy can be downloaded at www.sustainableconcrete.org.uk

IN THIS ISSUE

On the cover: East Park Design Centre, Loughborough University, designed by Burwell Deakins Architects

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The Concrete Centre

The Concrete Centre is part of the Mineral Products Association, the trade association for the aggregates, asphalt, cement, concrete, lime, mortar and silica sand industries.
www.mineralproducts.org

ARCHIVE

RETRO CONCRETE: SUMMER 1974

Architects react to the 1973 oil crisis … "Heat recovery and conservation are suddenly news," declared CQ, as it reviewed a pioneering Bristol office designed by Beardsworth Gallannaugh and Partners. An early heat recovery system used reclaimed heat from lighting, machinery and occupants, while the envelope of concrete blocks and facing bricks was designed to keep summer solar gain and winter heat loss to a minimum. As the editorial pointed out: "It is no use recovering heat from various sources, redeploying it throughout a building, and then letting it leak out through walls, windows and roofs."

Photo: Jim Lisamore, Architectural Visualisation

FABULOUS WEALTH AND RUTHLESS EFFICIENCY

Prime Development's five-star Bulgari Hotel and Residences, Knightsbridge, due to open in April, may host the most luxurious lifestyles, but the building is a paragon of efficient sustainability. Designed by Antonio Citterio and Patricia Viel, with Squire and Partners as delivery architect, the 85-room hotel uses post-tensioned concrete floor slabs with 25% less concrete and 65% less reinforcement than a traditional reinforced structure, while the use of cement replacement ground-granulated blast-furnace slag saved over 1,000 tonnes of CO_2 during manufacture.

Concrete Centre CPDs tackle new RIBA curriculum

The Concrete Centre is offering a number of training courses to help architects to meet their CPD requirements, following the introduction of a new curriculum by the RIBA at the end of 2011.

The curriculum now focuses on 10 core topics, all of which must be covered. At least half of all CPD activity should be structured. Architects must complete a minimum of 35 hours per year, keeping an online record with the RIBA.

The Concrete Centre is part of the RIBA CPD Providers Network, and runs a varied CPD programme throughout the year to keep architects and other construction professionals up to date. This includes half-day, full-day, in-house and evening training courses and seminars, offering structured CPD at general, detailed and advanced levels.

Five in-house seminars have achieved the maximum accreditation, for which architects will earn double points.

Informal CPD is also available from the website, via online guidance, podcasts and downloadable literature, as well as the CQ archive.

Attendance at any courses or in-house CPD sessions is logged by The Concrete Centre automatically, along with a record of documents downloaded. This provides an easily accessed online record on each architect's personalised webpage once registered.

Selection of CPD topics

CT1: Achieving visual concrete
SU1: The sustainability credentials of concrete
SU2: Utilisation of thermal mass
AR1: Code for Sustainable Homes – energy solutions
AR3: Architectural precast solutions

For more information, go to www.concretecentre.com/cpd

CONCRETE ELEGANCE LECTURE

Stanton Williams Architects' Central St Martins University of the Arts in King's Cross

IN THE CLASSROOM, ON THE BEACH

Concrete on both a grand and intimate scale were the subject of January's Concrete Elegance evening lecture at London's Building Centre, where the theme was "Exploring spatial quality and natural light". Paul Williams of Stanton Williams Architects presented the monumental open space of Central St Martins University of the Arts at King's Cross, while Mark Bell of Nord Architecture introduced the practice's small but perfectly formed Shingle House on the Kent coast at Dungeness.
The next Concrete Elegance event takes place on 18 April 2012 at The Building Centre, Store Street, London. For more details, go to www.concretecentre.com

HOP TO THE HEPWORTH …

The Concrete Centre is hosting a seminar at David Chipperfield's £35m Hepworth Gallery in Wakefield to reveal the secrets of this unique structure. The seminar will take place on 8 March and begins at 6.15pm.
For more information and to book a place, visit www.concretecentre.com/events

THE 8,000M² CONCRETE TEXTBOOK

The young designers of Loughborough University can learn a lot from Burwell Deakins' magnificent – and highly sustainable – new faculty building, says **Tony Whitehead**

PROJECT TEAM
Client Loughborough University
Architect Burwell Deakins Architects
Contractor Shepherd Construction
External glazing Schueco
Interior glazing Planet Partitioning

Efficiency, functionality and robust good looks form the basis of good design – so it is as well that the £21m East Park Design Centre at Loughborough University ticks all three boxes. It has a provisional BREEAM rating of Excellent, has won plaudits from its users, and with its zinc, glass and concrete exterior, has a classy "designer" look about it.

The 7,900m² three-storey centre houses a multitude of design courses ranging from sculptural art to automotive engineering. It features an unusual angled footprint, flowing interior forms, and the bespoke spaces and rooms within are of many different made-to-measure shapes and sizes.

All this is as you might expect of a design centre, but there is no pretension here. This is a design faculty, and it has to look the business – or as the client told architect Nicholas Burwell, it should be "a centre for high-quality design-thinking on campus that would communicate the university's expertise to industry and the wider world". The brief also called for state-of-the-art facilities that would allow a broad spectrum of design disciplines to collaborate within an open and transparent environment, including workshops, laboratories, teaching studios and lecture space.

"From the start we looked to see how we could get the conversation going between different design groups so they could see and learn from each other's ideas," says Burwell. "That meant having an

ABOVE
Monolithic planes of concrete run the full height of the building

open, transparent interior – one which would also serve to show off the university's design expertise to visitors from industry."

But there was a problem. Some of the workshops and studios house machinery that can be noisy, or give rise to vibrations. There was also an issue with fumes from paint and glue. The challenge was to ensure none of this disturbed other building users – those in seminar rooms and lecture theatres obviously require quiet, and clean air.

Burwell's solution was essentially twofold. First, he arranged the layout on either side of a long circulation area, or street, which runs the length of the building and which also contains staircases. This space has been used to separate workshops and machine rooms, situated to the rear of the building, from lecture theatres and offices, placed towards the front along with open, flexible teaching areas. Large glass partitions keep the escape of noise and fumes from workshops to a minimum, while simultaneously retaining a visual connection with the rest of the building.

"Secondly, our choice of concrete for the frame, floors and walls was also very important here," says Burwell. "Concrete is very good at damping noise and vibration and making sure it doesn't carry through the building."

Burwell is a concrete enthusiast – "we like the aesthetic" – and he is particularly positive about its contribution to the building's

ABOVE
A central "street" runs the length of the building

environmental efficiency. "The most important things in achieving a low-energy building are orientation and thermal stability," he says. "Using concrete gives the building a substantial thermal mass and it is this which really underwrites the building's low-energy usage."

The principal of using thermal mass in this way is now well understood: on hot days the heat generated during the day is absorbed by the concrete mass, which warms up as a result. The building is then ventilated at night, allowing the concrete to cool so it is again available to provide cooling the next day. Conversely, in winter, when heat generated by computers, body heat or solar gain is absorbed by the concrete, minimal ventilation means that much is retained to ensure the building is kept warm overnight.

Various ventilation systems can be used to facilitate this process, but at Loughborough the cooling effect largely results from having a lot of exposed concrete throughout the building. As well as the frame, the walls, floors, ceilings and even the roof (see box, below) are all made from concrete.

"Exposed concrete gives us a robustness you can never achieve with plasterboard," says Burwell. "It is ideal for the kind of heavy usage the building can expect – but it also gives us the direct cooling effect of the concrete."

Air is allowed into the building in a number of ways – most obviously through windows the occupiers can open, but also through louvres in the exterior, with heating batteries behind them to warm the air if necessary.

"We cannot rely on simple cross-ventilation

Zigs, zags and zinc: Constructing the concrete saw-tooth roof

The exterior character of the East Park Design Centre owes much to its roof. On the rear elevation, this comprises 13 pitched slabs, giving it an industrial-style, saw-toothed profile.

As with the rest of the building, it has been carefully designed with energy efficiency in mind. Simon Parks, project architect, says: "The roof contains north lights [windows facing north], which allow plenty of light into the building without the risk of too much solar gain."

It is a technique more commonly seen in factories, but here it gives the building a purposeful business-like air, and the quality of the materials prevents any suggestion that this is a tin-shed facility. The 11m x 7.5m roof sections are formed from in-situ concrete, and to prevent the 12° gradient from causing "slumping", a high-viscosity concrete was used. In total, it required more than 80 pours. The architect had considered building the roof from steel but, with a concrete subcontractor already on site, this solution proved more cost-effective.

Parks adds: "Above the slabs is a layer of insulation, topped with plywood and then the zinc standing seam. The roofs cover the workshop bays to the rear of the building, and we have carried one of these right over to the front elevation. This provides some cover for plant on the roof, and also breaks up the long elevation to the left of the front facade."

The rear elevation comprises 13 pitched slabs

There is more zinc on the rear facade where the non-glazed vertical elevations are formed from zinc-clad Metsec panels. Parks says: "On the facade, the zinc has a metal honeycomb backing to give it extra rigidity. Without this, zinc is soft enough to be dented by rugby balls flying off the sports pitch to the rear of the building."

The south elevation also continues the zigzag theme of the roof, with the zinc cladding overlapping the glazed element of the adjacent workshop bays. "This means that once you get past a certain time of day the cladding begins to shade the glazing in the next bay along," says Parks.

though", says Burwell, "because we have had to partition off the workshop spaces."

In the open spaces around the central circulation area air can simply pass over the great areas of exposed concrete walls and soffits, and make its way up to the opening roof lights above the "street": the "basic Victorian way of ventilating large spaces", as Burwell puts it.

But the enclosed areas required something more: "Here we have placed vertical ventilation shafts every 7.5m. These have fans that gently draw air from the more enclosed spaces through wall louvres. They are basically chimneys which exit on the roof where they coincide with the saw-tooth roof pattern."

The system is not immediately noticeable – the shafts simply being built into toilet blocks and other parts of the rear of the building. "They are designed neatly enough," says Burwell, "but we are not trying to be too clever. I didn't want to make a visual song and dance about them. They do a job."

Overtly functional ventilation shafts are clearly too fussy for Burwell's taste and would have been at odds with the building's main aesthetic theme – large expanses of plain concrete. This is especially evident around the front entrance, which is flanked by monolithic planes of concrete running the full height of the building and from the exterior through to the interior.

It looks like a massive cold-bridge, sufficient to drain all the heat from inside, but it does of course contain a thermal break. "We used a system called Isokorb," says Burwell. "It is essentially dense insulating polystyrene with reinforcement running through it. It is placed into a break in the standard reinforcement and concrete is poured either side. On the front entrance the break joint is concealed behind the edge of the glazing."

The business of concealing joints in the concrete has called for considerable cooperation between designer, contractor and concrete subcontractor. The architect designed bespoke formwork and specified where all visible joints should lie in order to avoid joint lines spoiling the concrete's good looks. In some cases, secondary formwork was placed over a basic structure and a second pour used to achieve a more neatly jointed finish.

This attention to detail has certainly paid off. There are no visible joint lines that look at odds with their location. In places, such as the ceiling of the main lecture theatre, the concrete has been coaxed into precision curves and softer lines. Burwell says: "Concrete has this plastic quality which allows you to create shapes that would be impossible – or at least extremely costly – to achieve with other materials."

The centre opened in time for the start of the new academic year in October 2011, and has been a hit with the client. Professor Tony Hodgson, dean of Loughborough Design School, says: "It is a great building. From a practical point of view it worked 'out of the box' and we are still enjoying our new surroundings. As you explore the building there is surprise and delight around every corner – and the engineers especially love the concrete!"

In the wash: Keeping the colour constant

With the exception of the high-viscosity mix used to create the sloping roof panels, all the concrete used in the design centre is standard structural concrete. This means that the finish has a natural roughness with some variations in the colour.

Andrew Wilson, contracts manager with contractor Shepherd Construction, says that the levels of natural variation were possibly higher than usual: "We were working through the exceptionally cold winter of 2010-11, and different temperatures can result in different curing characteristics, and this does affect the shade of the finished concrete."

Architect Nicholas Burwell likes the aesthetic of concrete, but looked to obtain a little more consistency by specifying a specialist Keim wash to the visible interior concrete surfaces.

Wilson says: "The wash does not affect the roughness of the concrete, but makes it look more regular by making the colour more consistent. In some areas where there were marked differences

in the colour of the concrete, we applied an extra coat or used a different dilution."

Burwell adds: "I think at first the client was a little concerned about the natural appearance of the concrete, but the Keim wash really knocks back the blemishes, and the finishes of the veneers of steel provide a great contrast to the exposed natural concrete."

LEFT
Solar shading – one of the features that has led to a provisional BREEAM rating of Excellent

BELOW
Exposed concrete is a feature of all the internal spaces

SHINING EXAMPLE

At Shine-ZC, Simon Foote Architects has transformed an unpromising derelict warehouse site in Derby into a blueprint for affordable carbon-neutral living

Located in the heart of Derby, Shine-ZC is a compact urban housing scheme consisting of six terraced homes and three apartments, developed by a consortium led by East Midlands Renewable Energy and Loughborough University. That catchy name belies a rather cumbersome acronym: Shine-ZC stands for the Sustainable Housing Innovation Network of Excellence – Zero Carbon. It has been designed and constructed to achieve level six of the Code for Sustainable Homes, the highest government rating for carbon-neutral properties, with the intention of illustrating how an integrated whole-system approach can provide sustainable homes of the future at a realistic cost.

The development uses a combination of intelligent design, system integration and control, and innovative passive sustainability. A major feature is the use of a basement as a seasonal heat store. This uses masonry from the demolished warehouse building that previously stood on the site to store heat generated from the solar roof panels, helping to increase the effectiveness of the domestic hot water and space heating system.

The walls are constructed using insulating concrete formwork, or ICF. This consists of hollow, high-strength, lightweight polystyrene moulded blocks that are assembled and then filled with concrete. The forms remain permanently in place (see box, above). Heat and power generation is via a small CHP unit, fuelled by recycled vegetable oil, with solar panels also providing hot water. Each home has a mechanical ventilation and heat recovery system, and windows can be opened to provide additional cross ventilation. There is also a monitoring system to supply the evidence that the homes will meet their sustainability targets, which include the delivery of a positive net carbon balance and total energy consumption of less than 60kWh/m^2 per year.

These homes provide real, long-term cost-effective, zero-carbon performance. Who would have thought that an inner-city site in Derby, with the added ingredients of insulating concrete formwork and vegetable oil, could offer a blueprint for the future?

A wall story

The external walls were built using ICF blocks with a 158mm concrete core. These use grey "graphite enhanced" expanded polystyrene (EPS) and provide a U-value of 0.15W/m^{2}K. The party walls also have a 158mm core, but only 70mm of EPS on each side. The concrete mix was a C30/35, CIIIA, S3 mix pump with 10mm stone, to help it flow and reduce cover requirements.

The floors in the houses were supported on engineered timber joists, while the apartments use 150mm HD (sound) precast units.

Large sections of the building have unreinforced walls, with reinforcement used only where required for structural reasons.

RIGHT
The scheme includes six terraced houses
ABOVE
The houses adjoin a block of three apartments

Photos: Simon Foote Architects

PROJECT TEAM
Client East Midlands Renewable Energy
Architect Simon Foote Architects
ICF supplier Logix UK

The precast concrete envelope captures waste heat, which can then be recycled

Photos: Florian Holzherr

STRICT DISCIPLINE

A rigorous approach to airtightness and insulation has helped the Martin Luther School in Marburg to reduce energy use by 90%

ABOVE
The circulation hall allows light to flood in from above
ABOVE LEFT
The interior finishes make full use of exposed concrete
LEFT
The precast concrete cladding has an embossed surface

Don't be fooled by the name – the PassivHaus standard for energy efficiency is not just for houses, as this German school expansion project proves. Designed by architect Hess/Talhof/Kusmierz, the new building at Martin Luther School in Marburg in the state of Hesse provides classrooms, a cafeteria/event hall and associated ancillary rooms. It is designed to meet stringent PassivHaus standards for thermal performance and use of minimal energy for space heating.

The building has a highly insulated envelope, and a south-north orientation, with the classrooms and event hall in the south and the ancillary rooms in the north. A central circulation hall running the entire length of the scheme allows daylight to flood in to the spaces from above. The interior finishes are robust: exposed concrete with a fine wood grain pattern, natural rubber flooring and slatted acoustic panelling. Externally, the precast concrete clad envelope has an embossed surface, cleverly patterned with the negative imprint of exposed aggregate.

PassivHaus is very much a "fabric first" philosophy, which proposes maximising energy efficiency over the life of a building as the most cost-effective way of reducing CO_2 emissions. For the school to meet PassivHaus standards, the envelope had to be extremely airtight and highly insulated. Closed exterior surfaces are limited to U-values of 0.15W/m^{2}K, and the triple-glazed windows achieve a below-average U-value of 0.80W/m^{2}K. This keeps heat loss to a minimum.

A mechanical ventilation system with heat recovery introduces fresh air to classrooms and vents exhaust air via ancillary rooms. In winter, when heat loss from ventilation is most critical, fresh air supplied from outside is warmed by the stale air as it is pumped out, as the pipes run alongside each other. The high thermal mass of the precast cladding means that the school also captures and recycles free waste heat from sources such as lighting, computers and occupants. In summer, windows can be opened for additional ventilation and to allow excess heat to escape.

As a PassivHaus project, the building has been designed and built in such a way that it uses less than 90% of the energy required for heating and cooling a standard building. The use of precast concrete for the building's envelope demonstrates that heavyweight materials can work well with the low-energy PassivHaus philosophy, while also helping to ensure the longevity of the structure.

PROJECT TEAM
Client Universtatsstadt Marburg
Architect Hess/Talhof/Kusmierz
Structural engineer A.Hagl Ingenieurgesellschaft

ABOVE
An automatic light control system responds to natural light and occupancy levels

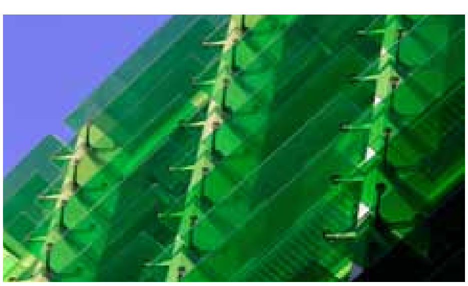
LEFT
The structural stained glass entrance by artist Kate Maestri

PROJECT TEAM
Client Westmark
Architect Alec French Architects
Main contractor Sir Robert McAlpine
Structural engineer Arup

AGENCY OF CHANGE

The Environment Agency's new headquarters in Bristol has achieved a formidable BREEAM score of 85.06%, setting down a marker for other offices to follow

BELOW
Adjustable brise-soleils help to prevent overheating



Photos: Simon Doling Photography

Developed by Westmark and designed by Alec French Architects, Horizon House was chosen by the Environment Agency as its new headquarters. With such a tenant, only the highest environmental standards would do.

The 6,600m^2 office building is part of a larger, mixed-use development in the centre of Bristol. Its Bath stone and bronze panelled facade has a structural stained glass entrance by the artist Kate Maestri, which provides a dynamic new street frontage. The office space is predominately open plan, based around a five-storey atrium. From the beginning, the aim of the developer and design team was to go beyond the 70% score for an Excellent BREEAM rating. In the end, the building achieved an unprecedented 85.06%.

Every aspect of Horizon House has been built with the environment in mind. From the very start of the project, 85% of the building that formerly occupied the site was recycled, with the demolished concrete being crushed and graded and then re-used for Horizon House's sub-base. The post-tensioned concrete floor slab uses less material than traditional types of construction, minimising the environmental impact of the structure.

Energy use is minimised through a mixed-mode ventilation system, with effective natural ventilation achieved by design features such as underfloor fresh air circulation. The building generates energy through a ground source heat pump and photovoltaic panels, while the roof includes a wildflower meadow and collects rainwater, which is used to flush the toilets. A lighting control system detects when the offices are occupied and dims the lights during the day.

The results of these measures are impressive. Horizon House uses 69% less mains water and 37% less energy than the offices it replaced. The ground source heat pump provides 17% of the building's energy, which is expected to yield annual savings of £29,000.

This project's success is due to its wholehearted embrace of the aims of BREEAM. The building performed well across all categories, achieving full credits in the management, transport and water sections, and over 90% under health and wellbeing. Overall, this building has set a benchmark for the environmental quality of office developments.

SOMETHING IN THE AIR

The playful facade of London's 55 Gee Street is actually part of an innovative natural ventilation system

Photos: Dennis Gilbert/Viewpictures.co.uk

RIGHT
The terracotta brick facade breaks up the horizontal mass of the long, thin building

PROJECT TEAM
Client Durley Investment Corporation
Architect Munkenbeck + Partners
Main contractor Morgan Sindall
Structural engineer Dewhurst Macfarlane and Partners

LEFT
The storey-height glazing is set back from the facade
BELOW
Recessed lights are staggered across the concrete soffit

Munkenbeck + Partners' 55 Gee Street in Clerkenwell, London is an eight-storey mixed-use building with six apartments perched on top. Crammed onto a tight urban site, the £6.5m building's playful appearance belies a coherent sense and understanding of function. Nowhere is this more effectively demonstrated than the facade, which consists of a jumble of extruded piers of terracotta perforated airbricks. This serves two purposes: it breaks up the horizontal mass of the long, thin building; and the perforation of the bricks encourages natural ventilation without having to open the storey-height glazing, which is recessed and fully shaded from the sun.

This natural ventilation is part of an experimental air-mixing system that aims to ensure that the interior does not require cooling or heating as long as the external temperature is between 0 and 28°C. Ventilation and night-time purging is provided through the innovative use of two vertical shafts with rooftop baffles that mix recirculated and fresh air. A raised floor void distributes air throughout the building and optimises the thermal mass of the exposed concrete soffit.

In the offices, coffers are staggered across the concrete soffit to provide recesses for light fittings. These are connected via conduits cast in the slab, thereby avoiding the need to surface-mount or impinge on the floors above. The concrete slabs are post-tensioned and incorporate 50% ground-granulated blast-furnace slag (GGBS) cement replacement, significantly reducing the embodied CO_2 of the structure.

Awarded a BREEAM rating of Very Good, 55 Gee Street proves that natural ventilation can work in high-quality office space, that a rigorous low-carbon agenda is not the enemy of playful architecture, and that there is no reason why speculative builds should not have their own architectural verve.