



Urban Sciences Building, University of Newcastle

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**Bowmer
& Kirkland**



Client:-
Newcastle University,
Newcastle Upon Tyne

Architect:-
Ryder, Newcastle Upon Tyne

Structural Engineer:-
Mott MacDonald, Newcastle
Upon Tyne

Quantity Surveyor:-
Turner and Townsend,
Newcastle Upon Tyne

M&E Engineer:-
NG Bailey, Ilkley

Concept Architect:-
Hawkins Brown

Science Central is the North East England's landmark location for science, business, living and leisure. Once supporting a colliery and then a brewery (The original home of Newcastle Brown Ale) the site spans 24 acres of prime City-Centre development land in the heart of Newcastle upon Tyne. The area is currently being transformed to support a thriving community, rewarding jobs and ground breaking scientific advances that will be the foundation of a new generation of industries and endeavors centered on knowledge and innovation.

Delivered by the Newcastle Science City initiative, a long-term committed partnership between Newcastle City Council and Newcastle University, this unique location has sustainability at its heart and brings together the public sector, academia, industry and communities to shape a future to benefit us all.

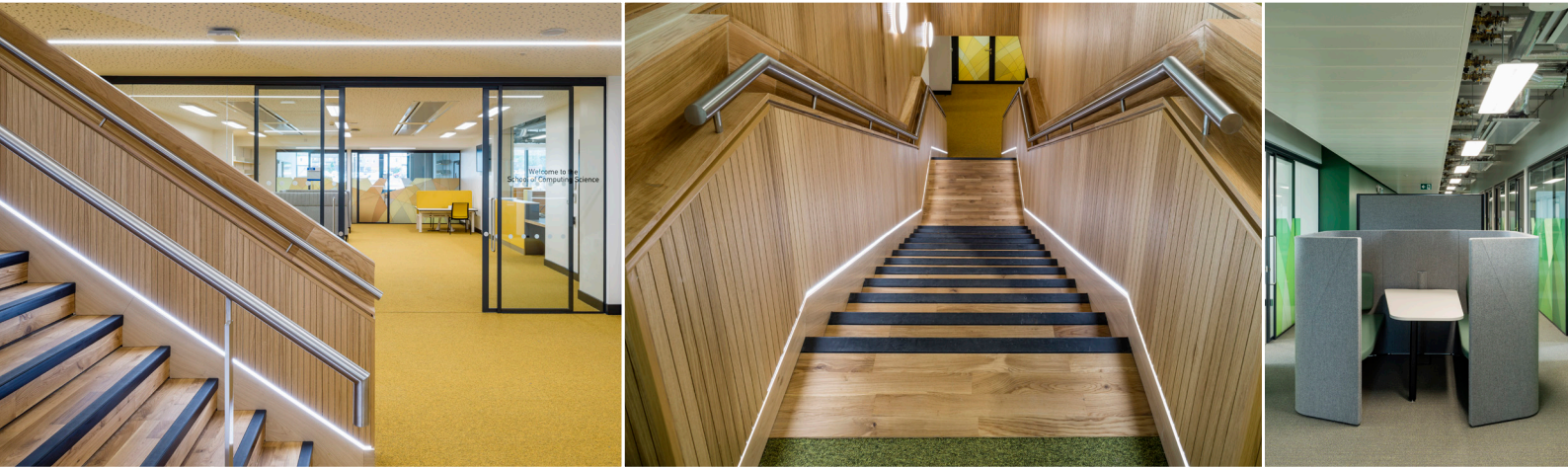
The Urban Sciences Building (USB) is the second building constructed on the Science Central site, and represents a commitment by Newcastle University to lead international research into digitally enabled urban sustainability. This state-of-the-art facility therefore accommodates an Institute for Sustainability and Computing Science, amongst others. The building and its surroundings combine cutting-edge architecture with new public spaces to house world-renowned scientific expertise and leading-edge companies, basically an innovation hub where investors, businesses, entrepreneurs, students, scientists and citizens collaborate to plan and develop solutions for tomorrow's cities.

The flexibility incorporated into this building provides long-term agility to respond to societal and market changes and consequently improve financial sustainability. The design of the building as an experimental 'laboratory' Building as a Lab (BaaL) allows for inter-disciplinary high quality research, where solutions can be tested, demonstrated and commercialised, creating a lasting legacy of science and innovation for the North East, and contributing significantly to the University's objectives in research, learning, teaching and engagement.

This 7 Storey building provides 3,500m² of flexible teaching, research and forum space, predominately open plan office and teaching accommodation with light workshops / laboratories, with associated administration, meeting breakout and collaborative spaces.

Floor Area - 13,000m²
Form of Contract - NEC 3 Opt A

Value - £46.4m
Completed - August 2017
Contract Period - 86 weeks



CONSTRUCTION

As a Level 2 BIM project delivered in line with industry standards and best practices, defined by PAS1192-2:2013 we were able to streamline information flows and collaboration, avoiding waste and mitigating clashes, we reduced the number of changes and generally provided a better service through visualisation and improved design coordination. This approach also improved handover information, by creating data-rich models and an asset information database to support the operation and maintenance of the building.

The construction methodologies and the materials used on this project pushed boundaries in line with the Universities academic research aspirations. Considerable advances were made to understand and manage build tolerances in a series of models, which positively impacted on how we were able to assess buildability issues and communicate alternative design solutions.

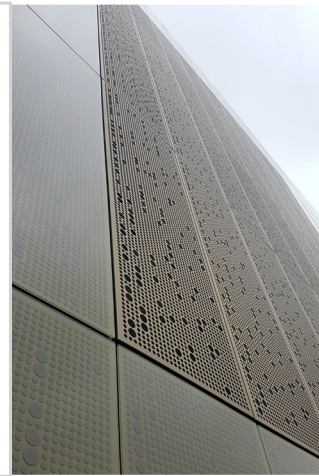
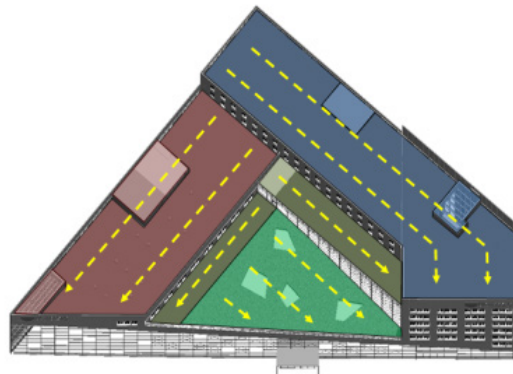
The construction phase itself commenced with a formidable cut and fill exercise through the engineered fill left as part of the open cast works, this allowed the necessary grouting to be done in collaboration with the local coal authorities. CFA piles were driven to an average depth of around 17m, penetrating the coal seam and founded within the mudstone.

The Reinforced Concrete frame was split into two sections; the 5 story side was post tensioned floor slabs to allow for a large 12m span required for the flat floor teaching facilities and the 2 story lecture theatre. The 7 Storey side was a more traditional RC frame and sequencing was dependent of the slip form stair / lift cores being poured in advance of the floors.

Reinforced Concrete Super Structure

For the erection of the false works we utilised a traditional formwork table system, so when the edge shutters were in place it provided a cast for the concrete to be poured against. This was mainly due to the complex shapes and angles formed around the cores. The concrete slabs were poured using both pumps and skips to suit the works as they progressed. The sequence was very carefully coordinated to allow sufficient time for curing ahead of loading out for progress to the next slab, which in turn allowed the propping system to remain in place for the minimum curing period.

Other notable works was the installation of steel stairs as the building riser up stands to the roof perimeter, and prior to finally capping each core we landed the riser services modules. The slip form cores were constructed to house 18nr bespoke plant rooms which were designed, pre-fabricated and manufactured off site. This approach was deemed very successful as the fully fitted out plant rooms were lowered into position in just 2 days.



Approximately mid-way through the construction period we commenced with the steel frame installation within the main atrium, steelwork end plated were subsequently cast and tied into the concrete structure. These were erected using a mobile cranes and cherry pickers and involved an enormous amount of management, supervision and collaboration to allow the coordination of the erection to coincide both with commencement of the façade and the 1st fix M&E. The steel work phase ended with the erection of the feature glulam joists at roof level, with each joist treated prior to arriving on site to ensure its condition and aesthetic appearance.

Façade

Externally the Façade is frameless and flush to achieve unity across the elevations. There are four different panel types including: - 1.Transparent double glazing (with and without opening windows), 2. Solid panels composed of glazing panelling and back painted glass behind rigid insulation and internal linings. 3. Solid panels of etched metallic anodised aluminium and 4. Vented panels of perforated patterned metallic anodised aluminium, to allow fresh air into the decentralised plant spaces.

Repetitive patterning was also used across the glazing, with bespoke digitally printed patterns in the central spaces. The artwork is based on the client's website and internet connectivity, which hints at the main tenant of the building being Newcastle University's School of Computing Science.

Roof

The roof construction was split into three main sections – 5 Storey, 7 Storey and Atrium. The main 5 and 7 story sections of the building involved the application of a fast drying primer direct to the concrete surface, followed by an elastomeric vapour barrier which was torch applied. This process was followed by placing the insulation to falls, laying a self-adhesive membrane and capping sheet which again was torch applied.

The atrium was the last of the main roof areas to be completed, and followed a similar construction, from which we fixed the reservoir boards, fleece membrane and protection matting. This allowed us to place the imported substrate ahead of installing the irregular quadrilateral Mono-pitch Natural Span glass roof lights, prior to completing the planting of the wildflower pre-grown intensive blankets.



Atrium

On entrance to the building, the expansive atrium provides a focal point for the building interior, this large flexible welcoming social area, has the potential to be used for exhibitions, and accommodates the buildings reception area and five no. passenger lifts, including a café and male / female toilets. The commanding living stair is at the heart of the atrium and central to accessing the upper floors. The staircase is not only a distinctive access route, but it also accommodates breakout space for groups sitting and socialising. This is supported with circulation areas and additional breakout and study space overlooking the atrium to ensure active usability.

Internally the atrium ceiling comprises of an elaborate lattice arrangement of steel box section rafters with timber glulam beam infill's with Cross Laminated Timber overlays. The structure spans between a mixture of RC concrete frame, PT concrete frames, circular steel and concrete columns each of which required its own connection design solution to achieve the tolerance standards. We achieved this through careful 3D modelling to ensure that the structural components could be pre-fabricated, delivered and assembled on site without compromising the high quality finish of the exposed structure.

High Specification Cat-B Fit Out

As would be expected from a building of such prominence, the internal fit out was to an exceptionally high standard utilising hardwearing, durable and low maintenance materials throughout. The extensive Cat-B fit out comprising of Café, Event Space, Research Labs, Teaching Rooms, Class Rooms, Break-out space, Meeting Rooms, Cellular Offices, Staff and welfare facilities.

In addition and located within the west wing of the building at first floor level there is a two Storey 303 seat acoustically isolated auditorium. The walls and ceiling of the auditorium were finished with a combination of acoustic panels and high quality timber acoustic linings. Feature arching bulkheads with recessed glow lighting span the width of the auditorium and extend down the walls to floor level to create a series of stepped goal posts which help reduce the room volume and leads to a warm and welcoming feel. Twin projectors and a large screen provide a flexible split screen teaching facility, and each seat has a power / charging point and data provided by a comprehensive WiFi network.

M&E

The building is a multi-zoned, comprising of a total 25 plant rooms linked by 3 energy loops, utilising heat pump technology to offer zoned control over all 7 floors. 18 of the 25 plant rooms as mentioned were fabricated off site and were dropped into place down 3 concrete cores during construction. The associated benefits of this off-site manufacturing approach include a streamlined construction programme, reduced waste material, reduced labour on site and reduced transport requirements.

Effectively the building is divided into 3 vertical zones, each of these serviced by a heating and chilled water energy loop fed from the primary plant room located on the roof, comprising of boilers, pump sets, plate heat exchangers and dry air coolers. These energy loops maximise efficiency within the building by taking waste heat from areas such as a communications room and redistributing this around the building, through the secondary plant rooms located on every level.

Secondary plant rooms comprise of an air handling unit, heat pump and circulation pumps to distribute heat around each zone. The heat pumps provide the main source of heat for the building, taking the low grade heat from the energy loops and converting this to heat or cool the active chilled beams within each space using refrigeration technology to maximise efficiency. Tempered fresh air is supplied to all the zones through the active chilled beams. In Spring and Autumn, free cooling is available using the energy loops and when conditions dictate night cooling can be employed to cool the high mass of concrete within the building.

Control of temperature and air flow to each space is achieved through a combination of the BMS and KNX system.

- KNX – This system comprises of a loop of CO₂, temperature, occupancy and lighting sensors to ensure that each space is provided with the correct environmental conditions for the users and also allows the control and dimming of lighting via Dali ballasts within the luminaires.
- BMS – The BMS system employed on site is the Siemens Desigo CC control system. The BMS takes all the information from the KNX system to drive the controls to create the correct supply conditions to each space. As well as the standard features of this BMS system, it uses a dynamic intelligent system to learn as it controls to achieve optimum plant conditions.

For monitoring purposes, extensive metering is provided to all plant in each of the plant rooms in the form of energy, flow and electric meters linked to the BMS and a separate system for general energy monitoring. In some areas, the metering is further enhanced by micro-metering which allows real time data to be collected at 1 second intervals for voltage, current, active power, reactive power and power quality.

In addition to the above, slab sensors were fitted to monitor the effects of the buildings concrete slabs on the building environment and a full weather station installed to correlate the buildings operation with the external environment. A PV array is located on the roof to generate electricity, and there is also a separate PV-T system to provide hot water as well as DC power to a 48V DC grid located on the second floor.

Overall, the services installed provide the University with the correct environment, with the facility to modify areas with minimum disruption as well as a facility for the Academic Staff to interrogate the building for data to carry out their experiments

Innovation, Sustainability and Environmental

With the building being the new home for the 'Institute of Sustainability' there was a particularly strong emphasis on innovation, sustainability and environmental performance. So in addition, to the more common BREEAM principles, there was a bespoke Sustainability Framework in place to drive sustainability beyond BREEAM with an auditable approach that was designed to enhance targets during construction and operation.

Close working relationships with the client were developed to support and provide research data to improve a variety of sustainable initiatives, ranging from improved monitoring and management of dust and noise issues through to analysing embodied carbon within the structure, and utilising models to assess buildability.

Where the building really differs from any standard building, is the fact that the whole building is a laboratory (BaaL) and has several key features which allow the operations of the building to be scrutinised by academics with a view to enhance performance, including extensive metering and sensor networks.

Key deliverables / achievements included:

BREEAM Excellent

CEEQUAL Very Good

EPC Rating – 'B'

Building integrated energy generation and management – In addition to 29kW of PV, a dedicated area is used to host energy storage equipment allowing for electric demand response, where locally generated and stored energy is used at specific times to eliminate peak time tariffs or even input into the national grid to supplement supply during high usage periods. The system also benefits from a PVt system to generate hot water

Smart Grid technologies - An area of the building is fed directly from the PV system generating Direct Current. Data will be monitored and assessed to determine if DC is more efficient than standard AC power.

Micro-metering: A system to allow the monitoring of electricity for quality at 1 second intervals. All metering far exceeds typical protocols to allow for fine level monitoring and improved efficient management.

Slab temperature sensors: Sensors strategically inserted into the concrete slab to gain an understanding of how the concrete mass of the building contributes to the overall building heating and cooling.

Super-efficient WC's: Low water usage toilets installed throughout the building, all of which are metered to determine how much water can be saved using such devices for future buildings.

SuDS: The Sustainable Drainage Systems (SuDS) around the site was of particularly significance for ongoing research purposes into key water issues that are vital to urban sustainability. In general the facility and the wider site included:-

- SuDS demonstrators.
- Experimental swales that can test attenuation of natural flood management measures such as 'leaky barriers' during simulated heavy rainfall events;
- Large scale, modular, green infrastructure experimental facilities (lysimeters); and,
- Comprehensive monitoring through Newcastle's Urban Observatory that is linked to water monitoring within the building, performance of site-wide SuDS and Green infrastructure, including city-wide observations of hydrological processes.

Landscaping: Hard and soft landscaping on roof terraces and around the building footprint enhances the immediate environment for building users, visitors and local ecology – all of which connect with surrounding public realm spaces and pocket parks. There is also a 'living green roof' spanning the atrium

Waste Management: All aspects of waste were accurately managed through the implementation of our project specific SWMP. We achieved a total recycle rate of 99.7%.

Labour Practices:

Supporting the University's and the Councils prosperity initiatives, local sub-contractors and local labour was used throughout the project. Consultants and sub-contractors, such as the Architect, M&E Engineers, Civil and Structural Engineers, Windows, Cladding / Rainscreen, Dry-lining and suspended ceiling specialists, for example, were all located within 15 miles of the site and utilised their own local workforces.

Waste Analysis				
Criteria	Construction	Demolition	Excavation	Total
Landfill Waste (Ton)	7.1	0.0	188.9	196.0
Re-used/Recycled (Ton)	712.5	180.0	62015.0	62907.5
Recycling Rates	99.0%	100.0%	99.7%	99.7%
m3/100m2	6.89			
ton/100m2	5.66			
m3/£100K	1.9	0.3	109.9	112.1
ton/£100k	1.6	0.4	137.3	139.3



A project specific Employment & Training Plan was set up and used to encourage and monitor new starters and training for people living within Newcastle itself. This ranged from providing work experience and site experience to students in education (school and University), work placements and additional specialist training, through to supporting sub-contractors to create opportunities for local apprentices and new starters.

Particular focus was given to training University staff on BIM Level 2 requirements and up-skilling them to understand the tools available to support BIM during construction, notably around modelling, COBie information, Common Data Environments and improving the quality of models and information. Two BIM Champions were developed through the project.

Site staff have also supported a number of careers advice and industry based careers sessions to encourage Higher Education students to explore career paths in construction management, with notable focus on BIM and Sustainability.

Community Issues:

With our partner membership to the 'Considerate Constructors scheme', our ISO 26000 Planet Positive Accreditation to 'Social Responsibilities' and our 'Business in the Community' certification, we were fully committed to minimising any negative impacts on and around the USB site. We promoted a positive image of construction at all times and supported local activities whenever practical. This included the sponsoring of Newcastle University's sport teams, working with local charities to reuse wood waste, supporting local businesses and local education facilities.

Noise pollution preventative measures were undertaken with strategically placed monitors around the site, with measurements taken twice daily. These were then compared to noise pollution readings taken by the University's research facility that also assessed the affectivity of noise protection measures implemented. Other pollution issues, such as dust and air quality, were also monitored in conjunction with research undertaken by the University.

A Twitter account was established to keep everyone informed of activities, and to help members of the public see the work being undertaken behind the hoardings. Over 1000 tweets were published during the course of the project with 307 regular followers from the local community. The proactive use of social media opened new channels of communication which were considered essential to support and promote the local community and engagement events. This also allowed the project to achieve a far greater reach than typical when relying on newsletters and information on hoardings.

Throughout the project, in excess of 180 school children have been engaged in the classroom or on-site with site visits and work experience placements. Over 400 University students and staff have been engaged through the project, by way of guest lectures and seminars through to specialist workshops, site tours and student placements. We give careers sessions to the Industry Advisory Board and we engaged pro-actively with professional bodies such as the Energy Institute. We also used our experiences and knowledge to educate the client, students and supported specific placements and PhD candidates in their research.

Client References & Team Testimonials



Contracts Manager – Wayne Denham

"Wayne Denham has been the Bowmer and Kirkland Contracts Manager at the USB building on Science Central. Works commenced on site in November 2015 and are still on programme for completion in August 2017. Wayne has developed an excellent, open and honest working relationship with the University ESS team, external PM and University academic staff. As the project developed the client team has made a number of demands including the additional SUDS works (at circa £2m) and challenging the design for example the seating layout and AV works to the lecture theatre. The approach has always been a 'can do' attitude and contractually dealt with in a reasonable way, this is a very refreshing attitude and helps significantly in the delivery of large and complex buildings. I would have no hesitation in working with Wayne and Bowmer and Kirkland on future projects"

James Adshead, Capital Manager, Newcastle University

Commercial Manager - Andrew Marshall

I have known Andrew for 18 months whilst working with him and his team on the University's Urban Sciences Building project. Andrew acts as the commercial lead for the project; this is a role that he impressed me with in his aptitude for attention to detail and for communication and negotiation with the supply chain. He always has a clear way of communicating key issues to further project progress and to keep the client team on track. Andrew has impressed me also with some innovative ways of dealing with procurement to present the university with the best value solutions.

Richard Johnson, Senior Project Manager, Newcastle University

BIM Manager – Laura Brown

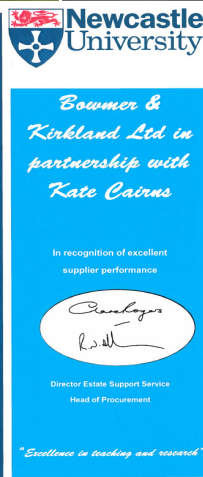
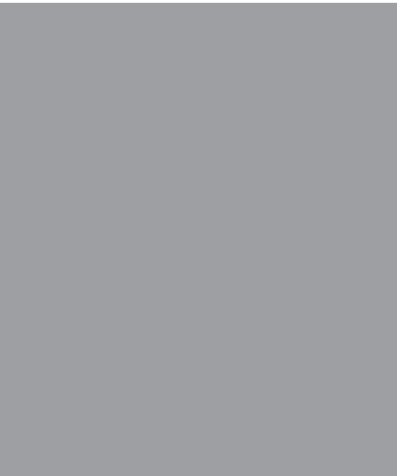
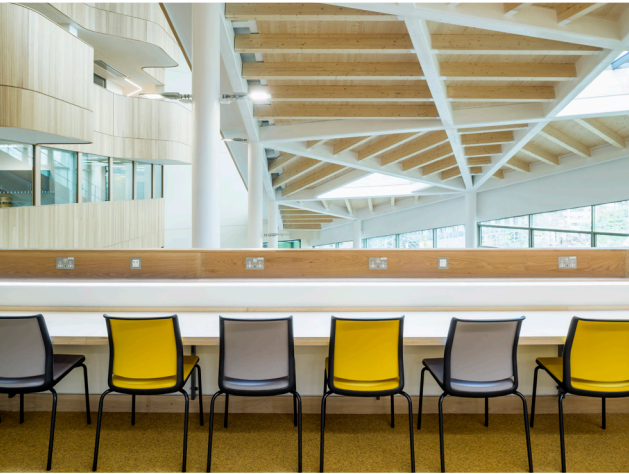
Laura has given her time to support in introducing our students to BIM. This has played an essential part in ensuring a successful re-accreditation panel visit earlier this month, which is crucial in ensuring that our courses are accepted as providing the academic basis for our graduates to become chartered engineers. In recognition of her continuing instrumental role in embedding BIM into the curriculum, Laura has recently become the youngest member of the School's Industrial Advisory Panel.

Dr Charlotte Paterson Director of Excellence in Learning and Teaching – Newcastle University

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