ARUP

Low-Carbon Futures for
Existing Buildings

Transform & Reuse

Shaping a Better World

Low-carbon futures for existing buildings

Our world is facing an environmental emergency. Precious resources are being consumed at an unsustainable rate and our climate is warming. The built environment is a major contributor to these challenges, so it must also be part of the solution. Together, we need to transform and reuse existing buildings wherever possible, innovating and collaborating at this pivotal time.

SHAPING A BETTER WORLD

As the world's population grows, demand for homes and amenities will soar. Another 2.5 billion people will be living in urban areas by 2050, putting immense pressure on resources and infrastructure.[1]

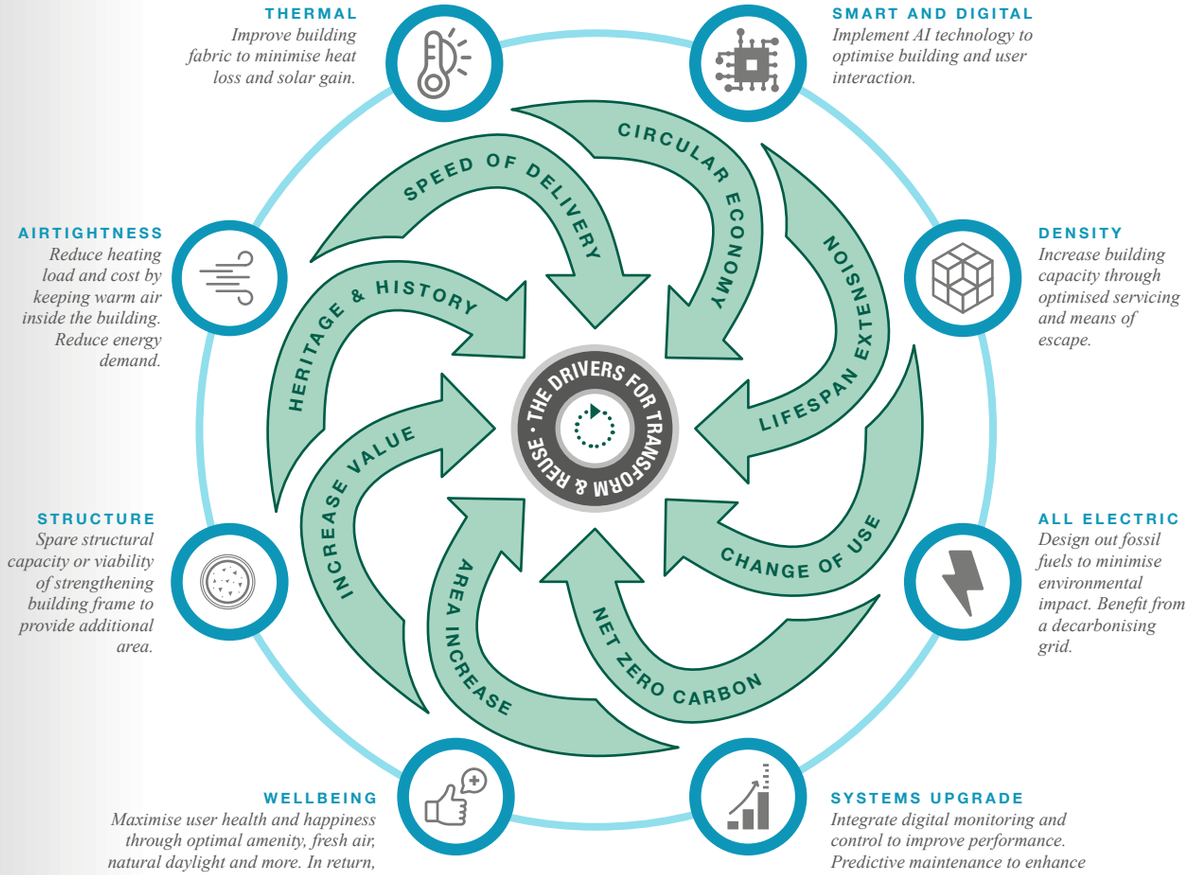
Demolishing reusable buildings and constructing new ones in their place will only add to stresses on our planet's finite natural resources. It is time for change on a dramatic scale.

With the built environment responsible for almost 40% of energy-related carbon emissions globally, we must find new ways to design and construct our cities.[2] It is untenable that the lifespan of many modern commercial structures is often closer to 20 years than 100.

Given that up to 87% of today's buildings will still be occupied in 2050[3], we must improve their performance towards zero carbon as soon as possible.

This document has been created to challenge perceptions and show that second hand doesn't mean second rate. Our projects prove that refurbished buildings are some of the most exciting and dynamic places in the built environment. With industry-wide collaboration and a radically different mindset, the opportunities to create great buildings whilst driving down carbon are limitless.

1. United Nations World Urbanization Prospects (2018)
2. UN Environment: Global Status Report (2017)
3. National Statistics (2012)



THE DRIVERS FOR TRANSFORMING AND REUSING EXISTING BUILDINGS

Along with environmental benefits, transforming and reusing existing buildings often delivers greater commercial and social returns than demolishing and reconstructing. It can be far more cost-effective for clients, create characterful places for occupiers and preserve heritage value for communities.

TECHNICAL DRIVERS
BRIEFING DRIVERS

Adaptive Reuse

Creating new futures
for existing buildings

COAL DROPS YARD
London, UK

Adaptive Reuse

Coal Drops Yard
London, UK

How do you transform derelict industrial yards into a new shopping district for London?

AT A GLANCE

At Coal Drops Yard in King's Cross, Arup helped turn three largely derelict heritage buildings into a popular shopping and dining district.

An expansive new upper level with a sculpted roof unites the whole, while bridges provide additional links. Victorian brick viaducts are now home to modern retail brands and restaurants, with space in-between for events, art installations and markets. Vestiges of the past are everywhere.

BUILT
1800s

CLIENT
Argent

LOCATION
King's Cross, London

COMPLETION
2018

ARCHITECT
Heatherwick Studio

HERITAGE ARCHITECT
Giles Quarme Associates

ARUP SERVICES
Structural engineering
Geotechnical engineering
Façade engineering
Contamination services

RECOGNITION
The ICE Bazalgette Award for Sustainability 2019
RIBA London Award 2019
DRIVENxDESIGN London Design Awards 2019
RIBA National Award 2019
World Architecture Festival Awards 2019 – Best Completed Building Shopping category

BUILDING ON OUR HERITAGE

Built in the 1800s for distribution of coal, much of Coal Drops Yard had lain derelict for years, becoming severely overgrown by vegetation. In the 1980s, a large area was gutted by a fire, destroying or damaging the original timber structure; the few cast iron beams and columns that survived were in unknown condition. Another area hosted some of London's most iconic nightclubs, with the structural fabric painted black or hidden behind plasterboard.

MINIMISING RISK BY BUILDING INSIGHTS

In the absence of structural information on the original construction, it was vital to build understanding of the site's structural capacity and condition, to make it possible to retain the Victorian architecture. Through Arup's knowledge of construction history, and by uncovering evidence relating to the site and working closely with the heritage architect, Giles Quarme Associates, we established an archaeological understanding of each phase of development.

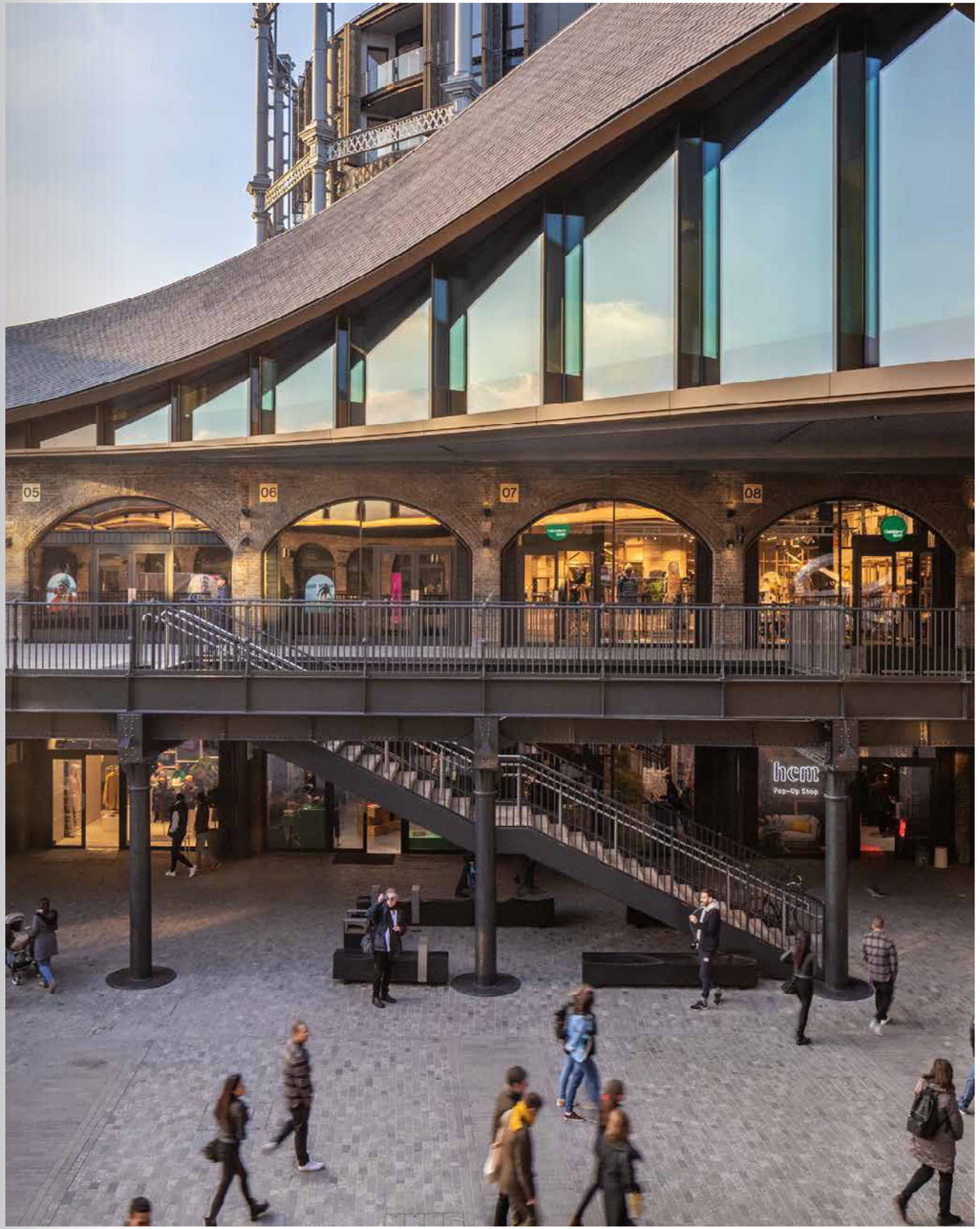
INNOVATING TO SOLVE CHALLENGES

We established early on that the existing structure had limited capacity for additional loads. So we made the structure for the new upper level and roof independent from the existing structure. Instead, they are supported on steel and concrete framing, threaded through the original buildings and founded on new mini-piles squeezed within internal bays.

The upper level is enclosed in a tapering 8m tall structural glass façade. This spans vertically between the slabs and trusses, relying purely on the glass panels arranged in a folded geometry. The system is bonded with structural silicone to increase the stiffness and load-bearing capacity of the façades. The sculpted roof has a 32m clear span and supports a suspended floor via steel hangers.

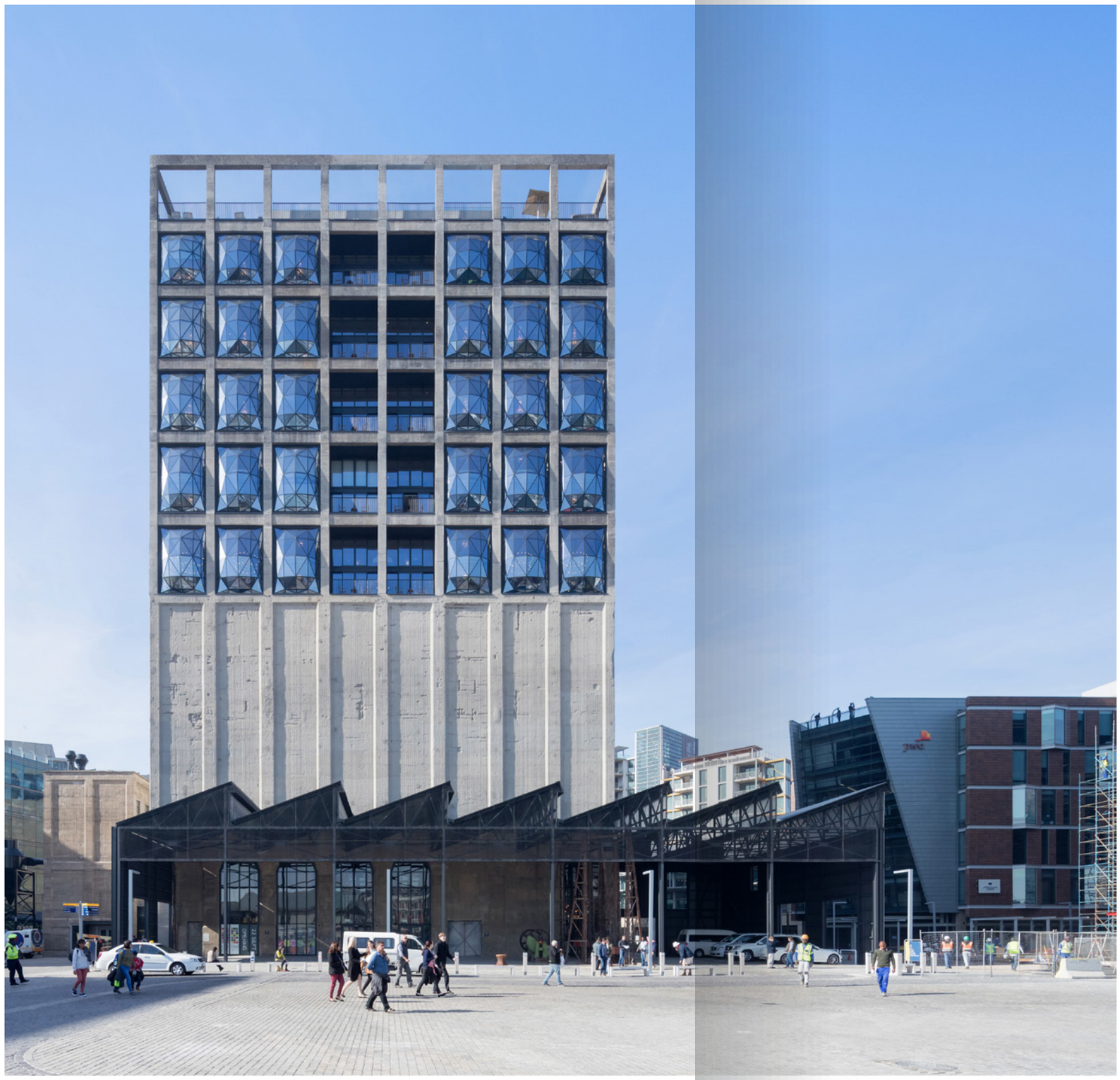
COLLABORATING TO TRANSFORM AND REUSE

Arup worked in partnership with the project team, local authority and Historic England, via workshops, meetings and site visits. Together, we refined and engineered the design to retain as much of the existing structure as possible, while upgrading building performance.



Zeitz Museum of Contemporary Art Africa

Cape Town, South Africa



How do you transform abandoned grain silos into a celebrated cultural hub?

AT A GLANCE

Constructed in 1924, Cape Town's prominent grain silo was once used to store and grade maize from all over South Africa.

But, with the advent of containerised shipping, the huge piece of concrete infrastructure was decommissioned and in need of a new purpose. Today, it provides visitors with 6,000m^2 of exhibition space in 80 gallery spaces, a rooftop sculpture garden, bookshop, restaurant, bar and reading rooms, along with storage and conservation areas.

BUILT
1924

CLIENT
V&A Waterfront
Zeitz Museum of Contemporary Art Africa

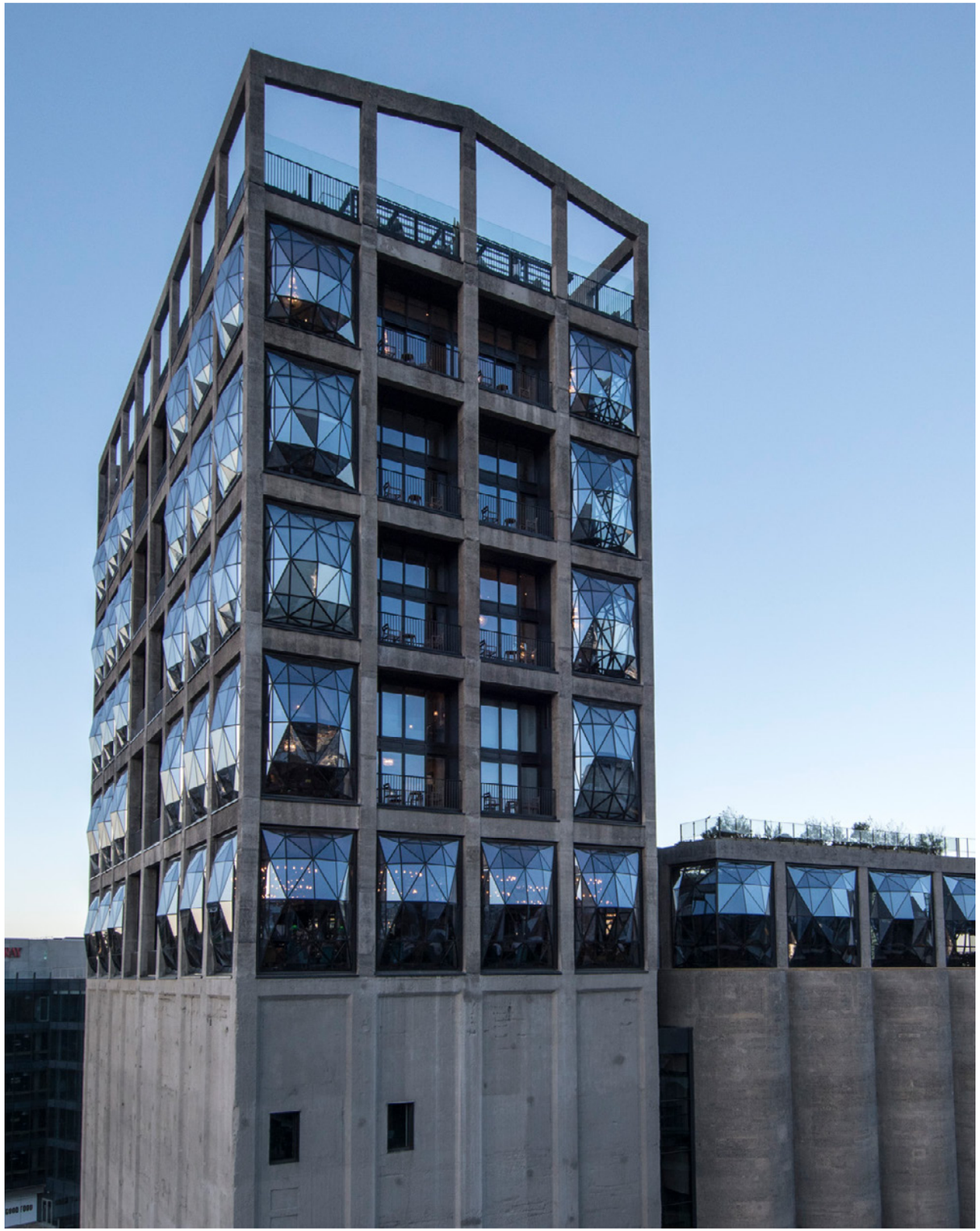
LOCATION
Cape Town, South Africa

COMPLETION
2017

ARCHITECT
Heatherwick Studio

ARUP SERVICES
Structural engineering
Building services (MEP) engineering
Façade engineering
Wind engineering
Security
Artificial and daylighting studies

RECOGNITION
Fulton Awards 2017
Innovation in Concrete (joint winner)
Architectural Concrete (winner)



BUILDING ON OUR HERITAGE

The grain silo complex is made up of a series of buildings, the largest two elements being a grading tower and a storage block comprising 42 tightly packed, 33m tall concrete tubes. Due to its historic significance and prominence on the skyline, the scheme was heritage-listed, despite being disused since 1990. Rather than resorting to wholesale demolition, the project team took on the challenge to reimagine the interior and unify the separate buildings, while retaining the silo's industrial character.

MAKING THE MOST OF HERITAGE

We applied our engineering expertise to take advantage of the scheme's greatest design value, the geometry and workings of the historic silos. When the new design carved out an opening so large that there was no structural integrity left in the building, we engineered a parallel reinforced-concrete wall that precisely followed the original structure but was entirely independent of it. We achieved this through slip forming, mimicking the exact technology used in 1923 to build the silos.

MINIMISING RISK THROUGH SMART ENGINEERING

How to ensure that the unreinforced brittle concrete stays in place and avoids major cracking over the next 100 years of wind and earthquakes? We created a structure that is less stiff than the rigid matrix that stood for the last 100 years. Subtle soft joint seams cut through the old, allowing far more movement.

INNOVATING TO MAXIMISE VALUE

Our mechanical team designed the museum's environmental controls to international best practice standards, opening up opportunities for loans from international art institutions. In a first for Africa, the museum uses Category A climate controls in the galleries. Endorsed by the International Council of Museums, the technology offers the highest level of protection for collections and is the most advanced climate control technology available at present. Energy efficient design also reduces power consumption and the building's demand on municipal infrastructure.

1 Finsbury Avenue *London, UK*

How do you transform a listed office building into flexible workspace, shops and cinema?

AT A GLANCE

Designed by Arup in the 1980s, 1 Finsbury Avenue is a Grade II listed building at Broadgate, London.

Over 30 years later, we collaborated with architect Allford Hall Monaghan Morris (AHMM) to reimagine the commercial building to provide 247,000ft² (22,950m²) of flexible workspace and 40,000ft² (3,700m²) of retail space, restaurants and a boutique cinema. Over 50% was let a year before practical completion, attracting the desired mix of tech and co-working occupiers. This is part of our wider role supporting British Land and GIC's £1bn transformation of Broadgate, the largest pedestrianised neighbourhood in central London.

BUILT
1980s

CLIENT
British Land

LOCATION
Broadgate, London

COMPLETION
2019

ARCHITECT
AHMM

ARUP SERVICES
Structural engineering
Building services (MEP) engineering
Façade engineering
Vertical transportation
Fire engineering
Security
Transport
Waste
Acoustics
Sustainability
ICT
Design services

RECOGNITION
BREEAM Very Good

ADDING VALUE THROUGH BUILDING INSIGHTS AND DESIGN

Our multidisciplinary design team accessed detailed records from our archive and carried out surveys to build a thorough understanding of the existing building. This yielded valuable insights into the building's structural condition and spare capacity, along with existing services distribution, plant capacity and life expectancy. By interrogating original calculations, we pinpointed columns and foundations with spare capacity, and added new loads to these locations with minimal physical intervention.

Targeted design interventions to add value included the creation of new roof terraces and an acoustically isolated boutique cinema in the basement. We enabled this by designing a new box-in-box structure sat on acoustic bearings, which could be constructed within the existing basement. We designed the removal of floors to create the necessary double height space, whilst maintaining the stability of the building.

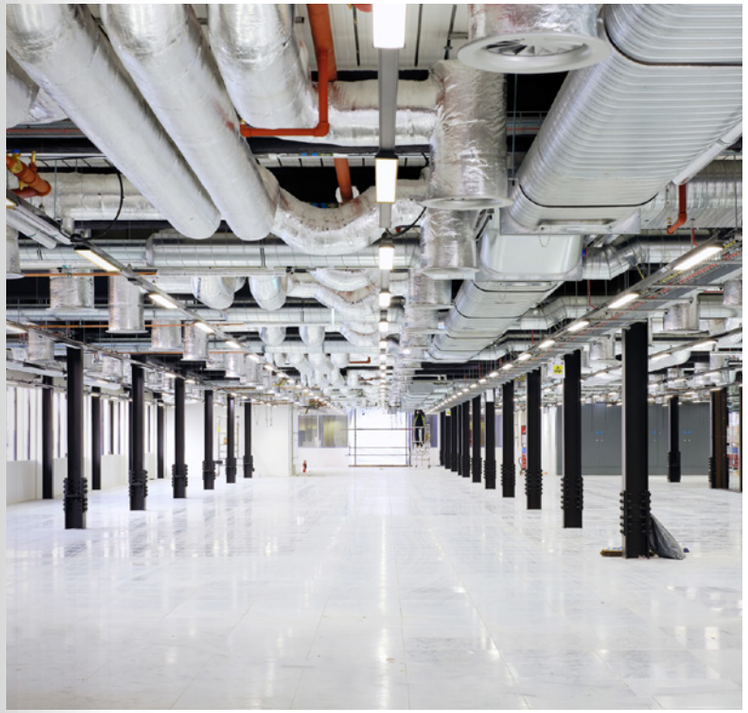
CONTRIBUTING TO OUR LOW-CARBON FUTURE

Given the high quality of the original building, the project team reused as much of the structural frame and façade as possible. Together, we renovated and reused many elements that would normally be replaced in office redevelopments, resulting in significant cost savings and reduced lifecycle carbon emissions. This included retaining existing double-glazed units, for a heritage-sensitive upgrade. We also challenged the convention that plant such as chillers, pumps, transformers, panels and generators needed to be replaced simply because of age.

As a result, we reused 90% of the central plant systems, while improving the building's energy efficiency performance.

CONSERVING HERITAGE VALUE

Our heritage consultants assessed the condition and historic significance of 1 Finsbury Avenue's heated façade, which was the main reason for the building's listing and a much-loved feature for early occupiers. This distinctive 1980s façade carried hot water inside the hollow steel sections that support the glass, flowing around the whole building like a giant external radiator. We modified this 30-year-old system to suit the new development and keep it operating, conserving heritage value.



How do you transform the BBC's former HQ into a vibrant new hub for London?

AT A GLANCE

Television Centre is one of London's most ambitious redevelopment projects. It turns an iconic 1960s building and 30-acre site into a 1.7 million ft² (158,000m²) neighbourhood, with new homes, offices, television studios, restaurants, a cinema and hotel. Appointed by Stanhope to provide an array of services, Arup's involvement spans from pre-purchase feasibility studies through to multidisciplinary design across the existing residential elements of the masterplan.

BUILT
1960s

CLIENT
Stanhope PLC

LOCATION
White City, London

COMPLETION
2018 (Phase 1)

ARCHITECT
AHMM

ARUP SERVICES
Civil and structural engineering
Building services (MEP) engineering
Infrastructure consultancy
Geotechnical engineering
Façade engineering
Acoustics
Vertical transportation
Sustainability and wellness consultancy
Materials consultancy
Fire engineering
Logistics
Access and maintenance
Heritage
ICT
Environmental consultancy

RECOGNITION
BCO Commercial Workplace Award 2019
BCO Best of the Best Award 2019
RIBA London Region Award 2019
AJ Mixed Use Project of the Year 2018

Television Centre
London, UK

BUILDING ON OUR HERITAGE

The new Television Centre honours the original design of the Grade II listed former BBC headquarters. The design team worked with the existing structure, exposing it and restoring heritage features, such as a mosaic mural by John Piper, floating cantilevered staircase and ceramic tiling in the Helios Courtyard. Arup's team included heritage experts who worked closely with the architects, construction managers and our building engineers to minimise any impacts on heritage features, including monitoring during construction. Combining reuse and new build projects, the first phase of Television Centre is now complete and the second phase under way.

MINIMISING RISK THROUGH DIGITAL DOUBLES

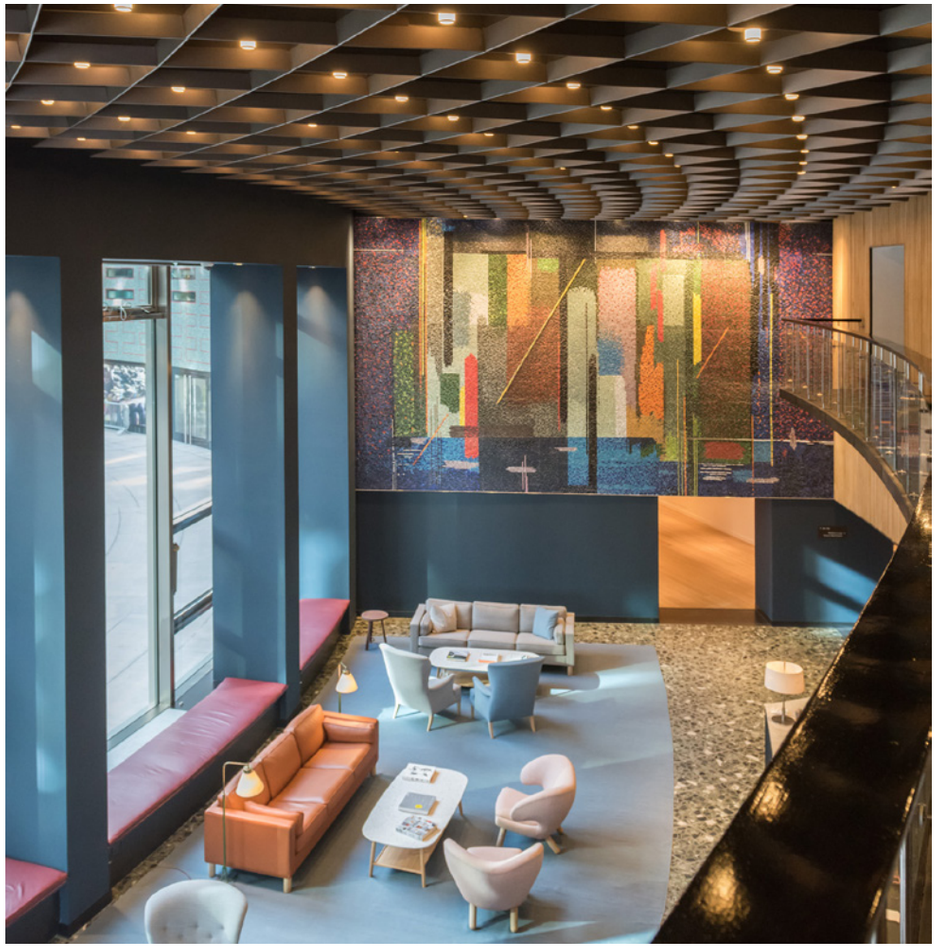
Through Building Information Modelling (BIM), Arup developed detailed 3D models for each individual building, drawing on archive data and validating this through targeted surveys. This empowered the diverse team, including architects and engineers, to model within the digital twin. This made effective collaboration and coordination much easier across the incredibly complex site and improved the accuracy of cost and programme forecasting, significantly reducing risk.

COLLABORATING TO MAXIMISE VALUE

We worked collaboratively with masterplan architect Allford Hall Monaghan Morris (AHMM) and multiple other architects for individual buildings to maximise value. This included helping increase rental values across 550,000ft^2 (51,000m^2) of new office space by creating a lean floor sandwich. Building services are exposed, contributing to an aesthetic with appeal for creative and media industries.

CONTRIBUTING TO OUR LOW-CARBON FUTURE

We investigated conditions across the site, including reuse of existing foundations to minimise embodied carbon and environmental impact, which led to the development of a low-energy design, reducing environmental impacts, construction costs and long-term running costs. Individual buildings seamlessly plug into the site-wide infrastructure. The site also connects with local transport infrastructure, parkland and facilities, for a low-carbon and wellbeing focused world.



The Standard
London, UK

How do you transform unloved council offices into a popular destination hotel?

AT A GLANCE

The former Camden Town Hall Annexe is a curvaceous brutalist building, one of the few still surviving in London.

Arup was part of a team appointed by owner Crosstree to turn these former council offices into the first Standard Hotel in Europe. Together, we have revitalised the original building and added three new levels and a roof terrace with spectacular views. This has created a distinctive 266-bedroom hotel.

BUILT
1970s

CLIENT
Crosstree Real Estate Partners

LOCATION
King's Cross, London

COMPLETION
2019

ARCHITECT
Orms

ARUP SERVICES
Building services (MEP) engineering
Vertical transportation
Sustainability consulting
BREEAM assessment

INTERIOR DESIGNERS
Archer Humphryes
Shawn Hausman Design
The Standard design team

RECOGNITION
BREEAM Very Good

BUILDING ON OUR HERITAGE

Located opposite St Pancras, the eight-storey town hall Annexe was built in the 1970s by Camden's in-house architects and engineers. When put up for sale in 2015, developers jostled for the prime site. All except one wanted to demolish the original and start again. We are proud to be part of the team that has given new life to this icon of brutalist design, which is enjoying a resurgent appeal.

REUSING TO MAXIMISE VALUE

Arup collaborated with Orms to retain and restore the building's façade and primary structure, cutting capital costs, minimising demolition impacts and reducing the project's carbon footprint, whilst maintaining the architectural aesthetic of the building. Precast concrete panels forming the façade were cleaned and restored, the new slim-framed windows replaced tired originals. Together, we have upgraded the façade's thermal performance to achieve modern-day standards.

INNOVATING TO SOLVE CHALLENGES

Our multidisciplinary team intricately threaded new building services systems throughout the existing structure. We reused existing risers and air shafts to minimise space impacts and reduce the need for costly structural interventions. We also engineered services to guest floors to work within the existing floor to floor heights to make bedrooms as generous as possible. An external shuttle lift glides up the north face, opposite St Pancras.

CONTRIBUTING TO OUR LOW-CARBON FUTURE

Designed to the BREEAM Very Good sustainability standard, energy efficient technologies are an intrinsic part of the design. Along with the upgraded façade, low-energy lighting, ventilation, heating, cooling and controls reduce running costs and carbon emissions. A heat recovery system recoups over 40% of wastewater heat from showers and reduces unwanted internal heat gains.

Gasholders London
London, UK

How do you transform Victorian gasholder frames into contemporary homes?

AT A GLANCE

Gasholders London in King's Cross is home to the only apartments in the world to be built within a trio of historic gasholder frames.

The Grade II listed ironwork frames were dismantled, restored and relocated along the Regent Canal to create a residential development of 145 apartments. Arup helped create a new future for these industrial structures that would otherwise have been left to decay.

BUILT
1860

CLIENT
Argent

LOCATION
King's Cross, London

COMPLETION
2018

ARCHITECT
WilkinsonEyre

ARUP SERVICES
Civil and structural engineering
Façade engineering
Geotechnics
Wind engineering
Fire engineering

RECOGNITION
RIBA London Award 2018
International Property Awards 2016
World's Best Architecture
Best International Architecture
Multiple Residence

BUILDING ON OUR HERITAGE

Originally built in 1860, the triplet of interlocking gasholder frames are masterpieces of Victorian craft. Abandoned as heavy industry moved to the outskirts of the capital, the frames were dismantled in 2001 to allow for construction of the Channel Tunnel Rail Link. Today, they elegantly house three circular residential buildings.

MAKING THE MOST OF HERITAGE

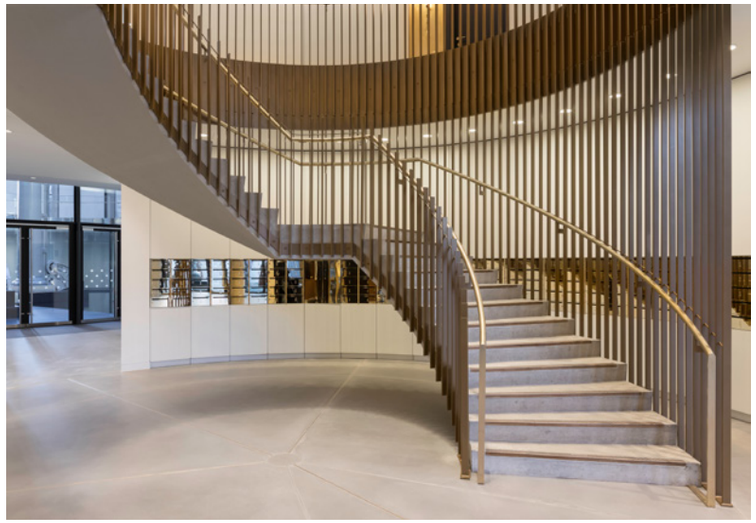
As the apartments sit within the Victorian framework, the façade was developed to respect the constraints of the original structure while creating well daylit internal and external living spaces. The project team drew on our diverse skills in developing the strategy for restoring and repairing the cast and wrought iron guide frames, allowing them to stand independently of the new buildings. We also designed two slender steel bridges in the central courtyard that weave through the Victorian ironwork and are supported as lightly as possible to maximise the contrast between past and present.

MINIMISING RISK THROUGH TESTING

A key feature of Gasholders London is a veil of motorised shutters that residents can individually open or close at the touch of a button for shade and privacy. At 4m high, these shutters are unusually tall and, with four panels operating concurrently around a curved façade, particularly complex. Their reliability and operation were essential to the façade's success. So, we developed a full test programme, including an operational life of up to 10,000 open/close cycles and resistance to impact and wind loads. This gave everyone confidence that the shutters could withstand even gale force winds in any configuration.

INNOVATING TO OVERCOME CHALLENGES

The gasholder frames restricted construction access for the façade, preventing some traditional installation methods. So, we introduced a unitised system that could be installed as the gasholder framework was rebuilt from the ground up. Additional façade features, such as prefabricated shutters and balconies, were then hoisted into place. This efficient and flexible approach sped up the construction process.



Here East
London, UK

How do you turn the London Olympic Games Media Centre into a creative hub for tech, learning and innovation?

AT A GLANCE

Situated in the Queen Elizabeth Olympic Park, Here East is the spectacular 1.2 million ft^2 refurbishment of the London Olympics 2012 Broadcast, Media and Press Centre buildings, transforming the site into a technology and innovation hub.

The service gantry for the broadcast centre has been transformed to provide studio spaces for designers, artists and craftspeople.

BUILT
2012

CLIENT
Delancey / Laing O'Rourke

LOCATION
Queen Elizabeth Park, London

COMPLETION
2016

ARCHITECT
Hawkins Brown

ARUP SERVICES
Structural engineering
Geotechnical engineering
Building Services (MEP) engineering
Civil engineering
Fire engineering
Environmental consulting

RECOGNITION
RIBA London Awards 2019 – Regional Award
BCO National Awards 2018 – Refurbished/Recycled Workplace
AJ Retrofit Awards 2018 – Offices (over 10k m²)
AJ100 Awards 2018 – Building of the Year
AJ100 Awards 2018 – Best Use of Technology

OPENING UP OPPORTUNITIES IN AN EXISTING BUILDING

Assessment of the building structure resulted in a significant increase in space, revealing capacity for three additional floorplates without the requirement to strengthen the existing structural columns. Our innovative design approach reduced the necessity for foundation strengthening across the building. In areas where this was required, pile caps were extended and additional piling was implemented as an effective solution, without the requirement for temporary works and delays to construction programmes. Full height atria in the entrances were designed by removal of floor slabs without compromising the stability of the building. Modifications to the perimeter structure have been incorporated to achieve the performance requirements for the new façade which is a key aspect of the architectural vision.

COLLABORATION TO MAXIMISE VALUE

By developing an integrated design to optimise space, Arup multidisciplinary engineers combined components of the building services into the structural elements of the building, maximising floor heights and opening up the space for Hawkins Brown's remarkable architectural scheme. With no ceilings within the building, careful detailing of building services was imperative to achieve the desired appearance of the spaces.

A 3D design of the utilities and external levels integrated with a BIM model provided an extremely effective visualisation tool to streamline the construction process.

CONTRIBUTING TO OUR LOW-CARBON FUTURE

Repurposing buildings at Here East has been an important role in the legacy of the London 2012 Olympic Games.

The structural engineering techniques used on this project made it possible to reuse the majority of the building. Where new materials were required, such as to strengthen the foundations, more sustainable alternatives like cement replacement were selected.

Thanks partly to energy-saving measures such as solar shading and a connection to the local district heating system, the building has achieved a BREEAM Excellent rating.

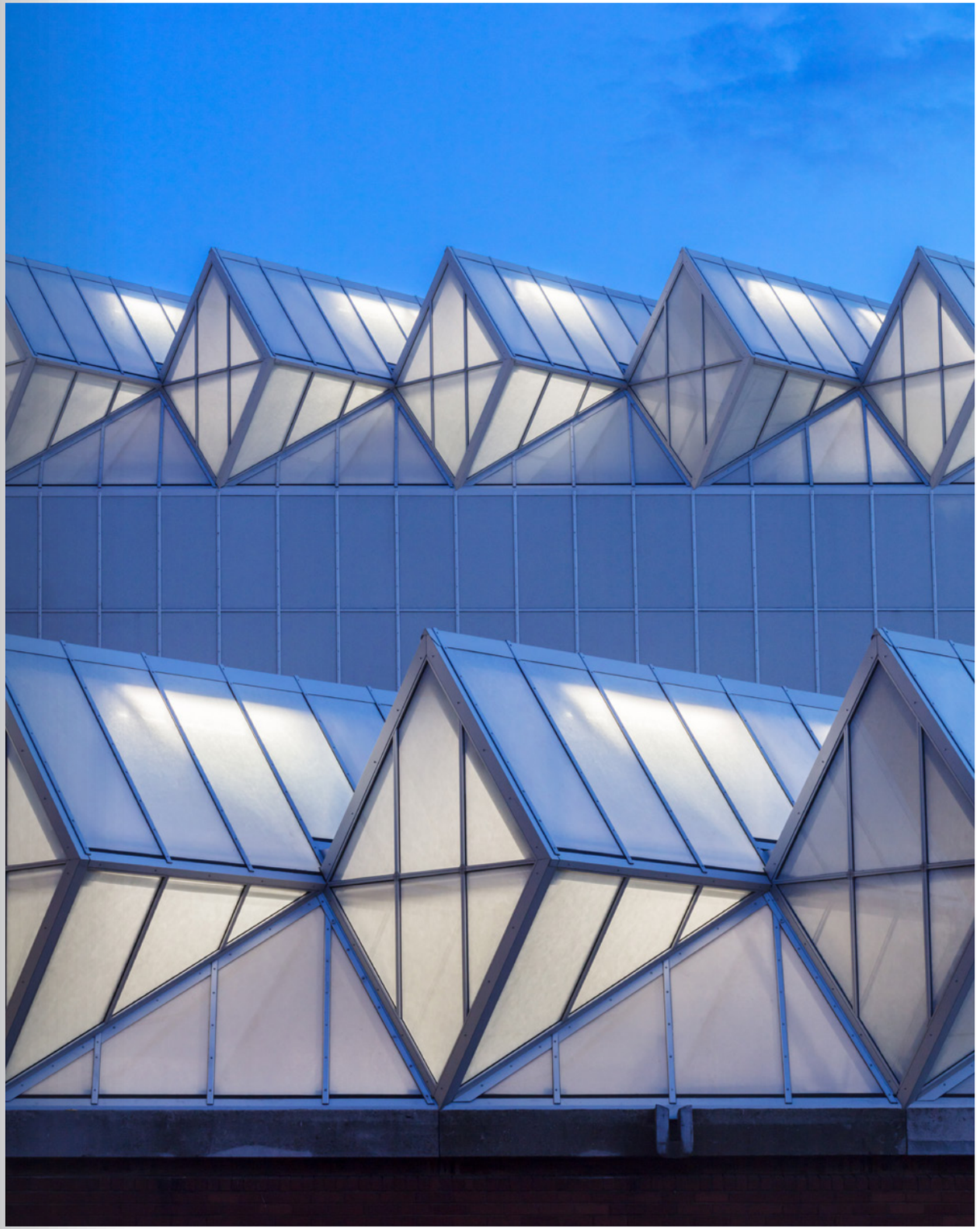
Elsewhere on the site, the gantry structure (used to house plant for the broadcast and media centres during the Games) was due to be demolished but, alternatively, could be converted into studio spaces.

HOW ADAPTIVE REUSE CAN UNLOCK VALUE IN EXISTING BUILDINGS

Adaptive reuse involves converting existing buildings to a new purpose. This allows us to delve into a building's past and breathe life back into it. As a structural engineer, I have been fortunate to be involved with some exceptional examples of this form of refurbishment and have seen first-hand the value that it can unlock – economically, environmentally and socially.

When people first look at vacant, existing buildings that may be run-down or past their former glory, they often focus on the risks rather than the potential rewards. Assessing the technical feasibility of reuse early on can uncover opportunities to add tremendous value. Although reuse is not appropriate for every building, where there is understanding of potential risks and rewards, clients can make informed decisions.

HELENE GOSDEN
Associate



10-75% lower costs
than demolition and rebuild

15-70% quicker
to bring back to market

In the last 10 years
office to residential conversions have been prevalent

Up to 70%
embodied carbon cut in reuse projects

DESIGN MUSEUM, LONDON
© Allies and Morrison

MAXIMISING VALUE THROUGH ADAPTIVE REUSE

There is compelling evidence that adaptive reuse projects can deliver substantial benefits for developers and landlords.

Cost-effective: Looking at projects of comparable size, refurbishments typically have 10-75% lower costs than demolition and rebuild, depending on the level of intervention.[1] Capital outlay for new buildings exceeds that required for all but the most complex modifications to comparable existing buildings.[2]

Faster to complete: Reuse projects tend to be 15-70% quicker to bring back to market than demolition and rebuild, depending on the level of intervention.[3]

Heritage value: The most successful adaptive reuse projects refresh and bring out the best aspects of a building's history and character, which can enhance its value.

Environmentally responsible: Reuse projects can cut embodied carbon by up to 70% compared to demolition and rebuild.[4] Reusing existing superstructure and materials saves natural resources and associated costs.[5]

Socially positive: Regenerating existing buildings, such as vacant industrial premises, can engender positive changes in attitudes within communities.[6]

There can also be planning advantages. In the UK, the Department for Communities and Local Government has extended Permitted Development Rights, so that change of use from office to residential no longer requires a formal planning application, with some exemptions such as listed buildings and ancient monuments. This is intended to 'support an increase in housing supply, encourage regeneration of offices and bring empty properties back into productive use'.[7]

▲

1-2 STEPHEN STREET
London, UK
© Matt Chisnall

This award-winning project transformed TV studios, underground parking and a loading bay into flexible office space for creative occupiers. We provided a range of services, including structural, building services and façade engineering, as well as BREEAM and logistics consultancy. The project increased lettable area by 10% and significantly increased rental values. The installation of efficient building services systems and lighting also improved energy efficiency and delivered higher floor to ceiling heights of up to 3.3m.

1. *Addy, N. (2014), Making Sustainable Refurbishment of Existing Buildings Financially Viable, in Burton S. (ed) Sustainable Retrofitting of Commercial Buildings, Routledge, Oxon, UK.*
2. *Highfield, D. (2000), Refurbishment and Upgrading of Buildings, E&FN Spon, London, UK.*
3. *Addy, N. (2014), Making Sustainable Refurbishment of Existing Buildings Financially Viable, in Burton S. (ed) Sustainable Retrofitting of Commercial Buildings, Routledge, Oxon, UK.*
4. *Derwent London (2012), Sustainability Report p14.*
5. *UK Green Building Council (2015), Tackling embodied carbon in buildings p2.*
6. *Ball, R.M. (2002), Re use potential and vacant industrial premises: re-visiting the regeneration issue in Stoke-on-Trent. Journal of Property and Research 19 (2) pp93-110.*
7. *DCLG Department for Communities and Local Government (2013) Relaxation of planning rules for change of use from offices to residential p1.*
8. *Gosden H (2015) Understanding the Influence of Technical Constraints on Feasibility Assessment for Adaptive Reuse in London, University of Cambridge.*

MINIMISING RISK IN ADAPTIVE REUSE

With time and money at a premium at project feasibility stage, it is important to know where to focus. Through extensive interviews and workshops with engineers, architects, cost consultants and clients experienced in adaptive reuse, we have identified priority constraints to consider early: [8]

- Condition of the existing building
- Availability of archive information
- Floor to ceiling heights
- Party wall conditions
- Depth of the building
- Internal space, layout and access (including vertical circulation)
- Historic listing
- Building structure (type of frame)
- Load capacity
- Redundancy
- Foundations

Whilst not an exhaustive list, these issues are felt to present the biggest challenges, when not considered soon enough. They provide a useful framework for early feasibility studies.
Reuse is not the answer in every case but, more often than might be expected, early assessment can reveal exciting opportunities that would otherwise be missed.

Below, we explore some of these technical constraints in more detail:

Condition of the existing building: Buildings of certain eras are prone to certain forms of degradation or problems associated with construction of the period, such as asbestos or high alumina cement concrete. As with most other risks, there are mitigation strategies available and the sooner they are considered, the better.

Floor to ceiling heights: These are worth reviewing early on. Office buildings typically have higher floor to floor heights to accommodate service requirements, making conversion straightforward. With longer spans however, there are often downstand beams, which can be difficult to accommodate. High floor to ceiling heights tend to be particularly desirable for premium residential developments.

Depth of the building: Deep floor plates can be problematic in achieving minimum daylight levels in every area. Sometimes, lightwells can overcome this, although there are associated costs.

Internal space layout and access (including vertical circulation): All new developments, including refurbishments, must comply with the latest safety standards. Lifts, escape routes and travel distance are fundamental to residential developments but may not align with existing commercial building layouts, where there may be central cores in deep floor plates. Lifts and alterations to cores, which often provide stability to the building, are among the most expensive structural interventions.

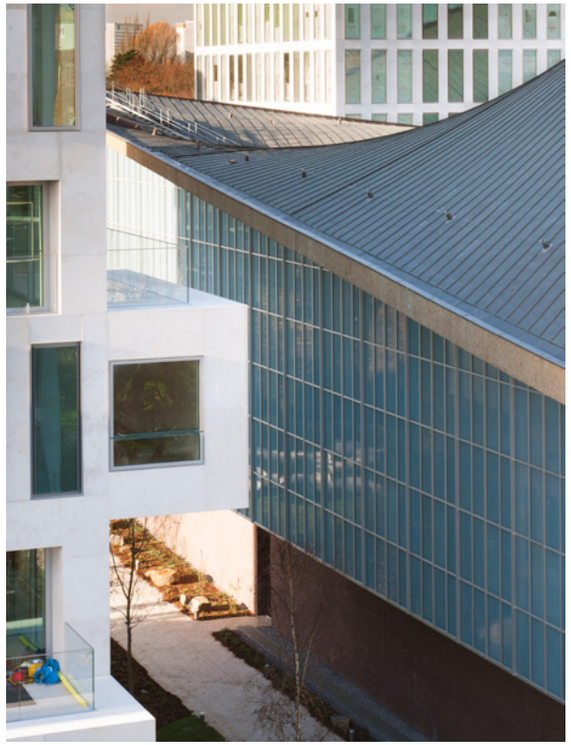
Load capacity: ‘Straightforward’ office to residential conversions tend to have inherent structural capacity as their everyday load is often lighter, with less equipment, furniture and people. Of course, life is rarely straightforward. Additional storeys, removal of troublesome columns by means of transfers and relocation of lift cores can require detailed back analysis of the existing building and extensive surveys to reduce the risk.

WHERE NEXT?

Over the last decade, we have seen a growing trend for change of use, with office to residential conversions particularly prevalent. Yet there are still so many missed opportunities. In terms of costs, refurbishment tends to be an easy win versus demolition and rebuild. However, more imagination is required at project feasibility to recognise that the end product can also be desirable.

We need to design buildings now that can flex and adapt. We may not be able to predict the future, but we can prepare for it. Therefore, new buildings should be designed with a view to how they will be regenerated in 20, 40, 60 and 80 years.

When submitting plans for an office block in the early 1990s, could anyone reasonably have foreseen, for example, the explosion of tech companies or the exponential growth in demand for co-working and collaborative workspaces? Adaptive reuse is the future.



▶

DESIGN MUSEUM

London, UK
© Allies and Morrison

To relocate the Design Museum in its new home on Kensington High Street, formerly the Commonwealth Institute, the design team embraced the possibilities that the Grade I listed building offered. Our engineering team enabled the retention of existing structure and creation of a new space worthy of the collection it houses and worth visiting for the architecture alone.

▲

80 CHARLOTTE STREET

London, UK
© Make (render)

At this Derwent London development, part of the Saatchi building regeneration, Arup provided multidisciplinary engineering support to Make Architects, helping the design team work with the existing façade in a conservation area, to maximise daylight in internal spaces. Now Arup's London headquarters, the building is configured to provide a modern workspace with high levels of digital enablement and low levels of operational carbon.

Expansive Reuse

Upgrading and adding new space to existing buildings

NEW SCOTLAND YARD
London, UK
© Tim Soar

Expansive Reuse

How do you add a five-storey basement while keeping a five-star hotel operational?

AT A GLANCE

When the owners of the world-famous Claridge's Hotel in Mayfair first proposed to build a basement underneath the nine-storey building, 15 years ago, they were advised they would have to close during construction.

Revisiting the idea with Arup and McGee ten years later, we developed a creative solution to excavate and construct a five-storey basement while Claridge's remained fully operational.

Claridge's Hotel
London, UK

BUILT
1856

CLIENT
McGee

LOCATION
Mayfair, London

COMPLETION
2019

ARUP SERVICES
Geotechnics
Structural engineering
Tunnel design
Hydrogeology
Building Information Modelling

RECOGNITION
British Geotechnical Association Fleming Award 2018

BUILDING ON OUR HERITAGE

Originally constructed 160 years ago, Claridge's is an iconic, Grade II listed London building. Working collaboratively, we have added another five storeys underground, creating an additional 5,500m² of space for a spa, swimming pool, wine cellar, additional plant and back-of-house facilities. It was all constructed without impacting guests.

INNOVATING TO SOLVE CHALLENGES

Due to the project's location, materials going in and out of the site needed to pass through a single window opening. Our response involved hand-digging small tunnels under the existing ground-bearing raft slab. Circular shafts, 1.8m in diameter, were hand-dug up to 30 metres deep under each of the 62 existing building columns. A total of 25,000m³ of materials were excavated.

Working in exceptionally tight spaces, five-storey-high reinforced concrete columns were built within the shafts, up to the underside of the existing raft, providing vertical support to the building above. To protect the hotel, the team introduced real-time monitoring and facilities to jack settlements at every column location to mitigate the impact of ground movements. The hotel's original foundation slab is now completely supported by the new columns and piles.

COLLABORATING TO REDUCE RISKS

Claridge's shows the benefits of multidisciplinary design. Arup's structural engineers, geotechnical engineers, advanced technology experts and research specialists worked closely with McGee to prove the concept and demonstrate that the scheme was buildable. Together, we spent almost six months carrying out detailed analysis, material tests and site trials, including developing a programme of dewatering, jacking and monitoring to minimise risks.

1 Triton Square
London, UK

How do you double office space and cut carbon in a 1990s office building?

AT A GLANCE

1 Triton Square was designed by Arup for British Land in the 1990s. 20 years later, British Land asked us to update the building for the latest workstyles and performance standards.

The result? Three extra floors, twice as much net office area and a BREEAM Outstanding sustainability rating, all while retaining façades and superstructure and without increasing plant space. Once complete, 1 Triton Square will provide an environmentally responsible, socially active workplace for 4,000 people. It secured the West End's biggest pre-let in over 20 years.

BUILT
1990s

CLIENT
British Land

LOCATION
Camden, London

COMPLETION
2020

ARCHITECT
Arup

ARUP SERVICES
Architecture
Structural engineering
Building services (MEP) engineering
Vertical transportation
Geotechnical engineering
Façade engineering
Acoustics
Sustainability consulting
Fire engineering
Wind engineering

RECOGNITION
BREEAM Outstanding
BREEAM Awards 2020 – Best commercial project, design stage
World Architectural News Awards 2019 – Best Future Workplace

40,000
tonnes of carbon saved

35,000
tonnes of concrete saved

1,900
tonnes of steel saved

54%
total carbon saving

◄
1 TRITON SQUARE
1998
© Alan Williams / Arup

CREATING PLACES PEOPLE PREFER

All design services are provided by our architects, engineers and specialists who co-locate as a single team. Like Olympic athletes looking for marginal gains, we chipped away at every aspect of the project to deliver the best working environment for customers and improve performance. Five panoramic terraces open up opportunities for socialising, working, exercising and relaxing. Floor to ceiling glazing, 2.7m tall, fills offices and stairwells with natural daylight. Over 500 cycle spaces support active lifestyles and nearly 500m^2 of biodiverse green roofs encourage nature in the West End.

INNOVATING TO MAXIMISE VALUE

The traditional approach for an old glazed façade would be to buy new. Instead, we pioneered a circular economy façade, removing and refurbishing 3,500m^2 of panels at a pop-up facility nearby. This approach has saved 1,270 tonnes of carbon and generated a 66% cost saving against a like for like replacement.

We also implemented our first carbon fibre column wraps. Instead of using concrete or steel, where possible, we wrapped carbon fibre around the original columns. This added substantial strength, was faster to install and, at only 4mm thick, maximised retained floorspace.

CONTRIBUTING TO OUR LOW-CARBON FUTURE

We reused as much of the existing structure and fabric as possible – 3,300m^2 of limestone, 35,000 tonnes of concrete and 1,900 tonnes of steel. This accounts for 45% of the total carbon saving, the remainder of which stems from our marginal gains approach. These gains and sustainability innovations mean that the building will achieve a 54% carbon saving in construction and operation versus a typical new build alternative. The saving is equivalent to the annual energy consumption of over 10,000 UK homes.

This exceeds the reduction curve for the UK's ambitious carbon target, set out in the Climate Change Act to meet our national commitment to the Paris Agreement. In fact, we have saved more carbon in design and construction than the building will produce in operation for over 40 years.

Royal Academy of Arts
London, UK

How do you unite buildings and create new exhibition spaces, while keeping existing galleries open?

AT A GLANCE

Through our ten-year collaboration with David Chipperfield Architects, Arup helped the Royal Academy of Arts unveil an expanded campus for its 250th anniversary.

This offers more space than ever before for visitors to enjoy the arts and architecture. Together, we united the Royal Academy's Grade I listed Burlington House and Grade II listed Burlington Gardens, creating 70% more public space, along with new galleries and a 260-seat auditorium. This was all achieved while the Royal Academy remained fully operational.

BUILT
1768

CLIENT
Royal Academy of Arts

LOCATION
Piccadilly, London

COMPLETION
2018

ARCHITECT
David Chipperfield Architects

ARUP SERVICES
Building services (MEP) engineering

LIGHTING
Fire engineering
Security
BREEAM

RECOGNITION
BREEAM Very Good

COLLABORATING TO SOLVE CHALLENGES

The Royal Academy was determined for existing buildings to remain operational and services kept live during construction. So, we set about overcoming the challenges this posed, given the many interfaces between existing and new systems, and critical services changeovers. We engaged with the Royal Academy to gain in-depth understanding of their operational regimes and exhibitions programme.

Our solution embedded a series of small enabling works packages into the construction sequence in phases, to prepare existing systems to connect to new services without interruption. This also minimised the risk of discovering hidden services and structures that could otherwise cause technical complications, potentially leading to costly programme extensions.

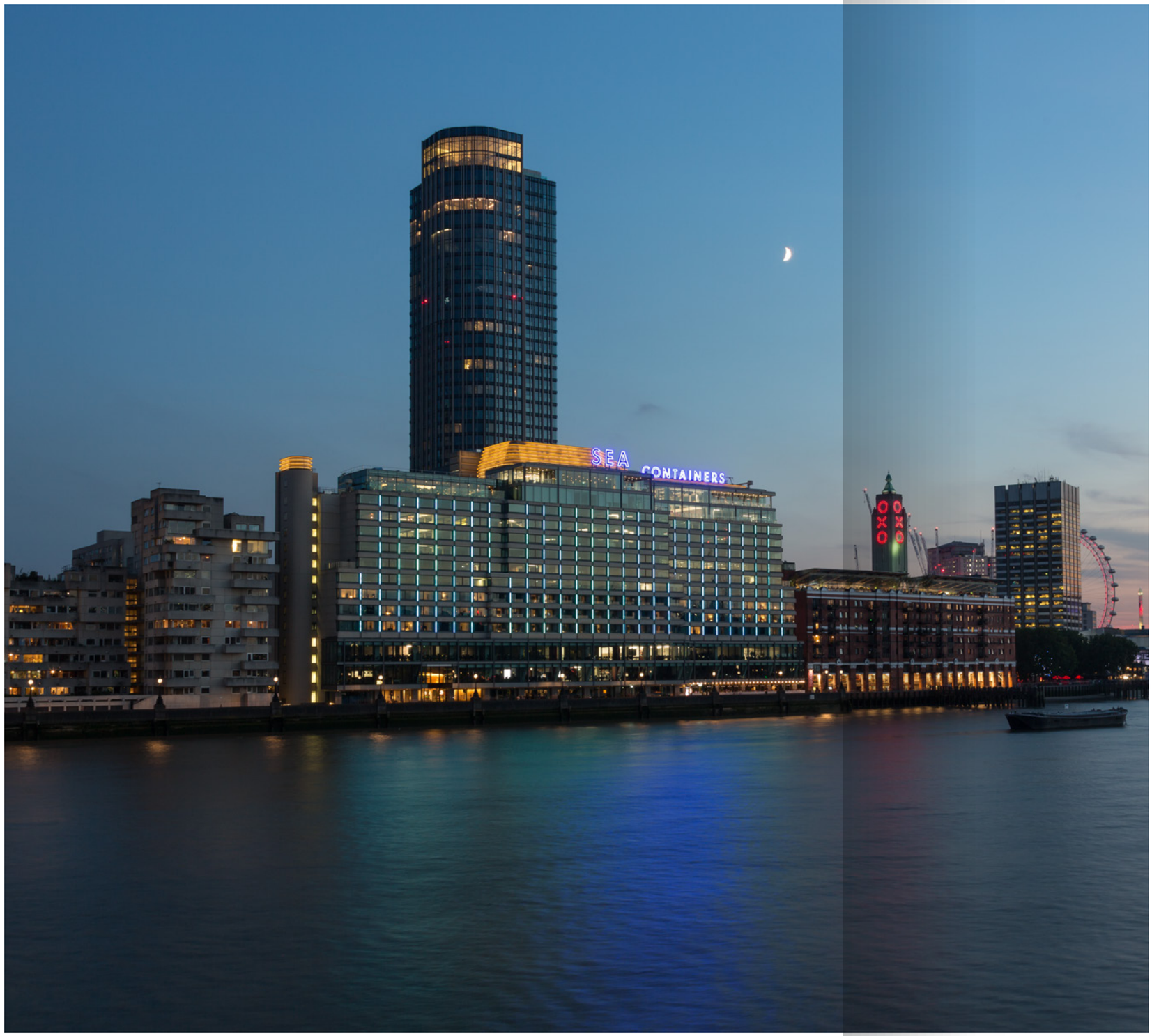
ENGINEERING INNOVATIONS IN A HERITAGE SCHEME

We rethought how engineering systems are arranged across the Royal Academy campus. Our engineers and specialists sensitively integrated 21st century air conditioning, power and lighting systems into a 19th century building, which predated Edison's invention of the lightbulb by a decade. This included introducing modern standards of gallery environmental controls, offering a range of scenarios from fully daylit to dark galleries.

The team introduced services by unobtrusive and often invisible means, creating a seamless backdrop for the art. We used chimneys and lightwells to carve out strategically located plant rooms, routes and risers for building services. Without impacting the heritage setting, changes increased the resilience of systems, enhanced facilities management capabilities, cut carbon emissions, reduced operating costs, released valuable space and created a better environment for visitors. Subtle interventions by our fire engineers also enabled the Royal Academy to welcome more visitors, making the most of existing circulation paths in the Victorian building.

70%
more public space

260
seats in the auditorium



Sea Containers House
London, UK

How do you turn ageing offices into modern workspace with a panoramic rooftop extension?

AT A GLANCE

Arup supported BDG Architecture + Design and Matheson Whiteley in creating 20,000m² of modern office space at Sea Containers House, re-energising existing floors, creating new links between floors and adding a two-storey glazed rooftop extension.

This prominent 1970s building on the River Thames, originally designed as a luxury hotel by American Modernist architect Warren Platner and Arup, was refurbished by the landlord after use as a traditional office. Arup undertook the SMEP design for the revitalised office space.

BUILT
1960s

CLIENT
Ogilvy Group UK

LOCATION
South Bank, London

COMPLETION
2015

ARCHITECT
Arup Architects, BDG Architecture + Design and Matheson Whiteley

ARUP SERVICES
Structural engineering
Building services (MEP) engineering
Acoustics
Access
Fire engineering
Theatre consulting
Sustainability
Security
ICT

RECOGNITION
BREEAM Excellent
BCO Innovation Award 2017

▲
© Maris Mezulis

BUILDING ON OUR HERITAGE

Enjoying a landmark location next to Blackfriars Bridge, overlooking the Thames, Sea Containers House was originally designed in the 1960s as a premium hotel and then repurposed to commercial offices in the 1980s. Fast forward 30 years, and three floors were converted into a luxury hotel, with the floors above and below turned into modern workspace, arranged around multi-purpose circulation areas.

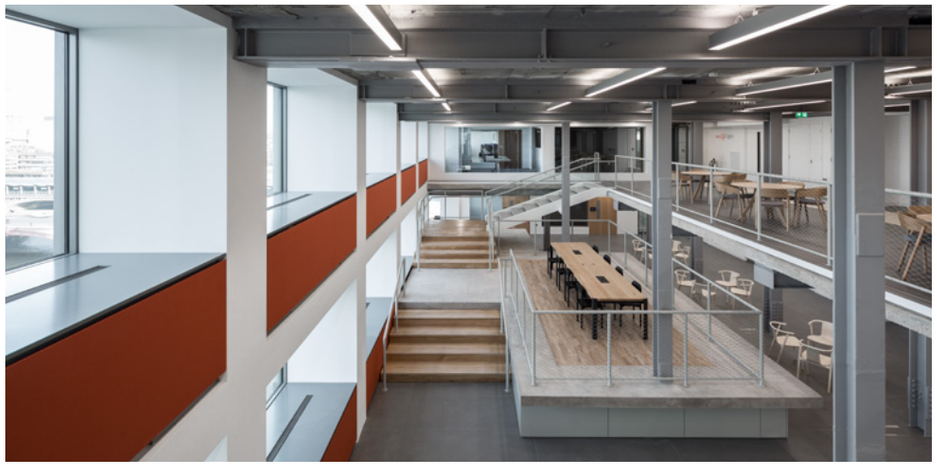
INNOVATING TO MAXIMISE VALUE

As part of the office fit-out, new spaces include a stunning auditorium between levels 12 and 13, with a café, bar and space for events and presentations. Above, a new roof terrace offers panoramic views of the Thames and a cocktail bar for people to enjoy. New staircases at all levels link floors, open up views and create breakout areas where people come together to exchange ideas, work and socialise.

The Arup team enabled major interventions to the base build, made more challenging by low floor to ceiling heights in the original building, successfully engineering generous floor to ceiling heights and an exposed structure. We added an additional storey, and also created a large amphitheatre-type space which meant developing a long span structure (column removal) whilst keeping the existing roof intact.

CONTRIBUTING TO OUR LOW-CARBON FUTURE

Our sophisticated building management system helped Sea Containers House achieve the BREEAM Excellent sustainability standard. Repurposing the existing building has prolonged the original buildings life for a further 20 or more years. This regenerative design has deferred the construction of a new 20,000m^2 office building which may have consumed from 12,000 to 24,000 Tonnes CO_2 (source: RICS Practitioners Guidance to Whole Life Carbon Assessments). Arup developed the office HVAC design to minimise energy consumption and used a sophisticated building management system, which helped Ogilvy & Mather (owners of Sea Containers House) tenants realise energy savings and contributed to obtaining the project BREEAM Excellent certification.



New Scotland Yard
London, UK

How do you strip out decades of unplanned changes and add new space to create an award-winning HQ?

AT A GLANCE

In partnership with architects Allford Hall Monaghan Morris (AHMM), Arup helped remodel and extend the 1930s Curtis Green building to create an award-winning headquarters for the Metropolitan Police Service.

Our multidisciplinary team engineered high quality, flexible and efficient offices that support the productivity and wellbeing of the police force. A new glass entrance pavilion, rooftop pavilion and reworking of existing accommodation increased the gross internal floor area by more than a third, from under 8,700m^2 to around 12,000m^2.

BUILT
1930s

CLIENT
Metropolitan Police Service

LOCATION
Victoria Embankment, London

COMPLETION
2016

ARCHITECT
AHMM

ARUP SERVICES
Civil and structural engineering
Building services (MEP) engineering
Façade engineering
Acoustics
Ecology
Sustainability (BREEAM)
Lighting
Fire engineering
Transport planning
Security
AV and ICT

BUILDING ON OUR HERITAGE

The neoclassical Curtis Green building holds special heritage interest and sits in the Whitehall Conservation Area. It is located in a prominent position on the River Thames, close to the Palace of Westminster. With decades of short-term refurbishments carried out in the building, the design team needed to strip out these interventions and take the building back to its historical core – an early steel frame, encased in concrete, with a masonry and stone façade.

BRINGING EXPERTS TOGETHER TO MAXIMISE VALUE

Our engineers and technical specialists worked together to maximise usable floor area. Through geotechnical investigations, we identified an opportunity to add a floor and reduce the density of columns on floor plates, with minimal groundworks. We also integrated all plant into the existing structure. This means that the new pavilions are free of plant, maximising usable area and allowing space for green roofs.

SOLVING CHALLENGES THROUGH SMART ENGINEERING

The client needed a well serviced, resilient building that operated 24/7, allowing for high density occupancy in a positive working environment. Challenges to achieving this included the constraints of the existing building structure, with shallow floor to floor heights, and planning conditions due to its prominent location.

To enhance the working environment, we raised floor to ceiling heights by combining ventilation and pipework systems within floor voids. This also minimised the need for holes in the existing structure, reducing costs and saving time. High intensity power and data cabling makes high density occupancy possible. A new glazed façade also increases daylight indoors for wellbeing, with shading to reduce glare. As standard for Arup, everything was rigorously tested for safety and resilience.

MINIMISING RISK THROUGH DIGITAL DOUBLES

Using Building Information Modelling (BIM), Arup developed architectural and engineering 3D models for the wider design team throughout the project duration, keeping models updated as the project progressed. Combined with regular virtual design reviews with the team, this informed decision making and improved the accuracy of cost and programme forecasting, reducing risk for the works on site.

RECOGNITION

BCI Prime Minister's Better Public Building Award 2017
Building Magazine Project of the Year 2017
Architect's Journal Retrofit Award Best Office over 10,000m² 2017
RIBA National Award 2017
RIBA London Award 2017
BREEAM Excellent

20 Old Bailey
London, UK

How do you upgrade and grow a 1980s commercial building for today's workstyles?

AT A GLANCE

The design team was tasked with breathing new life into 20 Old Bailey, an ageing 1980s commercial building opposite the UK's Central Criminal Court.

Arup's involvement enabled two extra floors to be added without the need for substantial strengthening works, as well as improvements to existing floors and building services. The final design increased the net internal area by 20%, adding around 5,100m² of space. The scheme was fully let soon after completion, reflecting its contemporary appeal.

BUILT

1980s

CLIENT

Severn Investment, Blackstone

LOCATION

City of London

COMPLETION

2017

ARCHITECT

Buckley Gray Yeoman

ARUP SERVICES

Structural engineering
Building services (MEP) engineering
Façade engineering
Vertical transportation
Fire engineering
Materials consulting
Transport planning
BREEAM assessment
Initial security
Access and maintenance
Acoustics

RECOGNITION

BCO Award shortlisted 2017
BREEAM Excellent

OPENING UP OPPORTUNITIES IN AN EXISTING BUILDING

Collaborating with Buckley Gray Yeoman Architects, Arup prepared several options for refreshing 20 Old Bailey, each with differing levels of intervention. The client chose the most ambitious option, adding two extra floors, with views to St Paul's and the City of London. Through detailed analysis of the existing structure, we were able to achieve this without substantial strengthening works.

Structural changes included adding a single central core containing a staircase, lifts and washrooms, as well as relocating the atrium and replacing a significant area of façade to improve the experience for people in the building. We joined steel beams to existing concrete connections to form new openings for the atrium and the core. Works were carefully programmed for delivery in one of London's busiest business districts, near high-security law courts.

MAXIMISING VALUE THROUGH SMART ENGINEERING

Working closely with the architect, our engineers tightly integrated services and structure, improving the net to gross efficiency for the office floors to around 85%. We relocated rooftop plant to the basement, freeing up office space and allowing for the creation of additional roof terraces. We also upgraded building services to provide occupiers with a comfortable working environment to Grade A office standards.

CONTRIBUTING TO OUR LOW-CARBON FUTURE

The combination of façade improvements, highly efficient plant, heat pumps that recycle waste heat from the cooling system and a rooftop photovoltaic array that generates clean power, have improved operational energy performance, cut carbon emissions and reduced operating costs. This helped the building achieve its BREEAM Excellent sustainability target, including two innovation credits.

The digital revolution is transforming our work in the world of existing buildings. Refreshing and reinventing buildings has never been more important or exciting, creating sustainable, new places.

Reinvigorating existing buildings can be more attractive than demolishing and rebuilding them. Along with potential financial benefits, the drivers for reuse include protecting heritage and reducing whole-life environmental impacts. Imaginative reuse projects have generated a fresh sense of excitement and inquiry for designers and occupiers. But each existing building has its own constraints and opportunities, so working in this area demands a high level of engineering experience, creativity and integration. Here we explore how technology is helping us create great new places for people within older infrastructure; dynamic, healthy and interesting spaces that people love.

JAMES WARD
Associate Director

▶
THE STANDARD, LONDON
© ORMS

DIGITAL TOOLS UNLOCKING EXISTING BUILDINGS

Cheap and ubiquitous laser scanning and photographic conversion allow us to create detailed models of existing architecture, structure and MEP systems with unprecedented accuracy and speed.

At the city scale, drone and digital conversion mean we can create topographic surveys in days, not months.

Laser scanning with precision, we can create a 1:1 impression of existing landscape, building, façade, structure and services, converting this to a base model for the design team to work from as needed. Where we cannot expose parts of the building for inspection, skilled surveyors and engineers can interpret and interpolate to complete the picture. Artificial intelligence will soon join these dots for us.

Using technology, we can interrogate the performance of a building to make informed decisions. For instance, infrared surveys show surface temperatures, revealing where heat or cooling is escaping through a façade or whether remote radiators are working at the correct temperature. Building management systems can tell us how well (or not) services are working and identify historical issues.

Days, not months
to create topographic surveys

Laser scanning
to create a precise 1:1 base model

3D models
to explore virtual design options

Virtual reality
to transform design options

▲
COAL DROPS YARD, LONDON
© John Sturrock

USING TECHNOLOGY TO IMPROVE COMMUNICATION, DESIGN AND CONSTRUCTION

Visualisation technologies can overlay design option onto existing building fabric, to show how they will look. This is improving how we engage with planners, heritage consultants and interested members of the public. Technologies include camera matching techniques that replicate the perspective of the lens in the software, both on static images and on fly-through footage. These can also be used to test alterations well in advance of procurement, making sure they are sensitive to the existing context.

Once we create 3D models, the design team can explore virtual design options with the wider team and optimise solutions using parametric techniques. By explaining changes to occupiers, contractors and operators in 3D and with data in the model, they gain clearer understanding. For instance, 3D annotated models can communicate clearly to contractors exactly what needs to be removed. As construction progresses, quick rescanning of exposed areas empowers the design team to make timely changes.

Virtual reality has enormous potential to transform how teams consider design options, collaborate and make informed decisions, reducing risk and waste. At the design stage, we are already using simple goggles with client smartphones to explore issues and opportunities. Sending a link to a remote client means that designs can be understood and discussed quickly and easily.

Wearing a cordless headset, clients and potential occupiers can also walk through their existing space with alternative designs mapped onto reality (augmented reality), experiencing spatial clarity and making informed decisions in a way that has not been possible before.

USING TECHNOLOGY TO IMPROVE BUILDING OPERATIONS

Refurbishments often involve complex reworking of existing structures and services. Historic records are critical to unlocking a building's next life. We create 3D videos and live walkthroughs for clients, overlaying models of electrical systems, heating, ventilation and air conditioning components and structural design. This allows the user to 'see through walls' to find out where everything is located, making future changes easier. We also flag components that are operating outside their design parameters and may be faulty. The Internet of Things brings growing potential for granularity, wider reporting parameters and live reporting, which can be used to improve experiences for people in buildings.

WHERE NEXT?

Circular economy principals are driving reuse and recycling of whole areas of the built environment. Refurbishment plays a strong part in this economy, and the whole industry needs to prepare for the next life of buildings. Maintaining information during a building's entire lifespan makes its reinvention more likely and straightforward. Looking ahead, it is exciting to think how technology will increase opportunities to design and construct for demountability, reuse and repurposing. These are all areas that will make refurbishments easier, cheaper, faster and more sustainable.

▶
Virtual reality viewers share alternative designs for clients and project teams to experience.
© Paul Carstairs / Arup

◀ ▲
CIRCULAR HOUSE
Constructed for the London Design Festival 2016.
© Daniel Imade / Arup

▶
QR code shares information at 80 Charlotte Street, London.

Proactive Reuse

Enhancing performance and extending the life of existing buildings

ENGINEERING BUILDING
UNIVERSITY OF LEICESTER, UK
© Simon Kennedy

Proactive Reuse

The Grand Hotel
Birmingham, UK

How can you unlock the commercial future of a listed building at risk?

AT A GLANCE

Among the best surviving examples of Victorian architecture in Birmingham, The Grand Hotel had ceased trading and fallen into a state of disrepair.

When the owners looked at the cost of repairing the Grade II* listed building's façade, they were advised it would be prohibitively expensive. They invited Arup to explore what might be possible and we found a way to complete the restoration work at a fraction of the cost. We went on to design and specify the successful conservation project, helping unlock a new commercial future for this iconic building.

BUILT
1870s

CLIENT
Hortons' Estate Ltd

LOCATION
Birmingham

COMPLETION
2015

ARUP SERVICES
Heritage consultancy
Façade engineering
Materials consultancy
Structural engineering

RECOGNITION
Victorian Society West Midlands Conservation Award 2016
RICS West Midlands Commercial Award 2017
IStructE Midland Counties Structural Engineering Awards Structural Heritage for Buildings Award 2017

BUILDING ON OUR HERITAGE

The Grand Hotel was originally built by Isaac Horton in the 1870s and is still owned by the Horton family today. Constructed to designs by Thomson Plevins, The Grand is the largest building on Colmore Row, often described as the city's most prestigious commercial address. The Horton family ran the hotel until 1969. It was subsequently managed by a number of operators until it closed in 2002. After a piece of masonry dropped from the building's cornice in 2003, a crash-deck scaffold was erected around the upper floors to catch any further falling debris. The building was Grade II* listed in 2004.

SOLVING HISTORIC CHALLENGES

The hotel stonework was covered in a hard and inappropriate render – a thick build-up of cement, paint, bitumen and resin – which was cracking apart. This render had trapped moisture within the stone behind and, in places, the stone was soft enough to tear by hand. The render was, in effect, holding the unstable masonry together but was itself decaying – a concerning situation.

Along with a history of insensitive repairs, we uncovered issues with the original design. These included weathering details that did not work correctly; rather than pushing rainwater away, the cornices and string courses, by now covered with a thick crust of concrete, were absorbing it. The stone itself also appeared to be of poor quality, unsuitable for areas of heavy exposure.

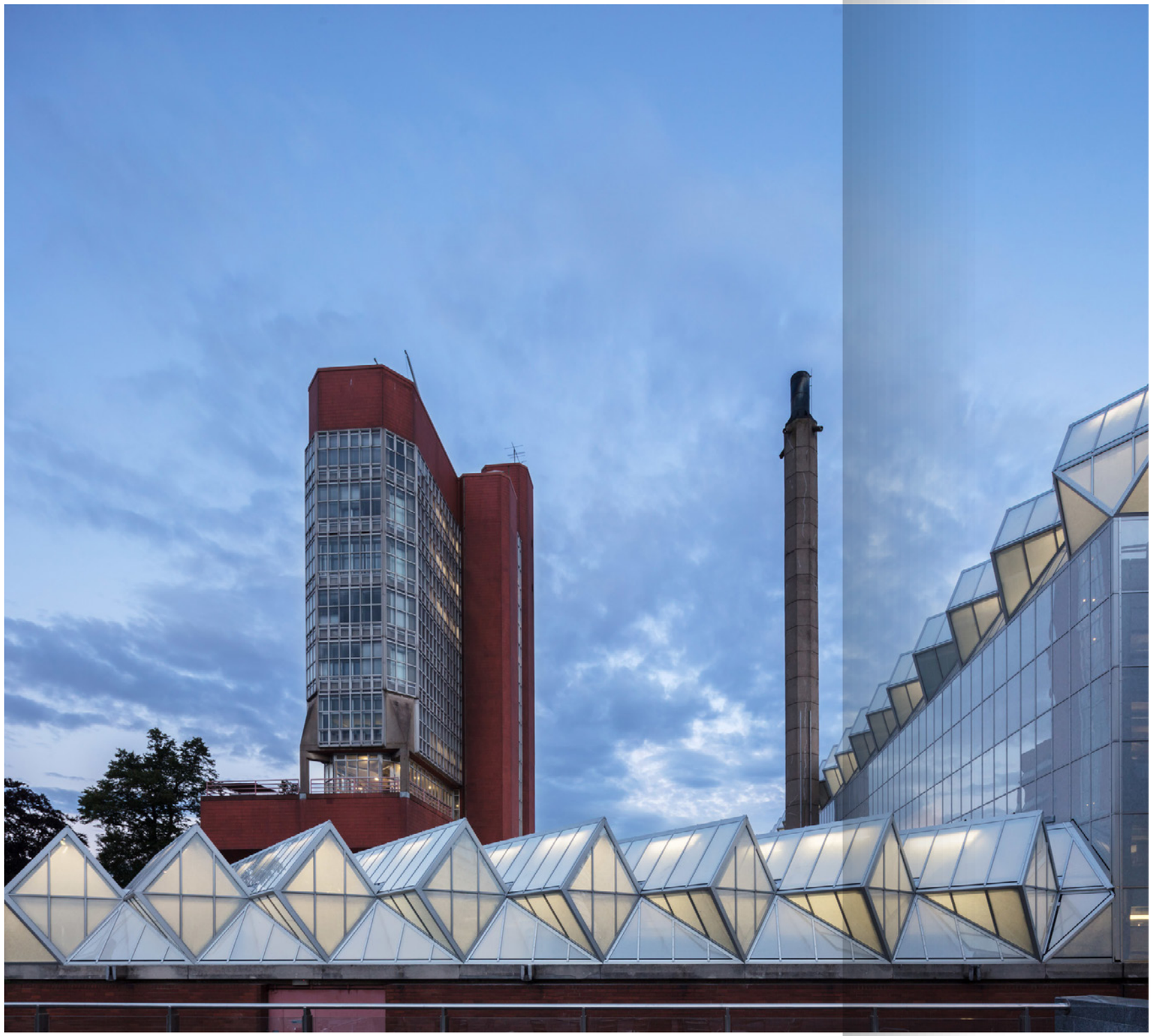
Stripping away the coatings and stabilising the damaged stonework would eat significantly into the façade, destroying its carved details and strict planar relationships. Arup developed a set of conservation principles to sympathetically restore the façade. We reinstalled the entire ornate finish of the building, keeping the quantity of new stone to a minimum.

Our structural engineers were subsequently engaged in works to redesign the internal structure, in preparation for its reopening as a luxury hotel, offices and shops.

▲
DETAILS
© Thomas Pearson

SOURCING LOCALLY

The restoration project sourced both labour and materials locally where possible, supporting local businesses and craftspeople. Masons from Midland Conservation Ltd carried out repairs using traditional tools and techniques. Working by hand, they conserved almost every piece of decorative carving and most of the plain ashlar stone. In 2015, English Heritage described the scale and traditional nature of the stonemasonry at The Grand Hotel as unique for a non-ecclesiastical building.



Engineering Building
University of Leicester, UK

How do you conserve an early postmodernist building to meet 21st century standards?

AT A GLANCE

The University of Leicester's Engineering Building, designed by James Stirling and James Gowan, is an early example of postmodernist design that continues to inspire architects today.

After over 50 years of service, the University needed to replace the distinctive roof and façade areas, and upgrade the building services. Arup was lead designer for a project which solved these challenges, while remaining true to the original architecture, creating a positive environment for students to learn and be inspired.

BUILT
1963

CLIENT
University of Leicester

LOCATION
Leicester

COMPLETION
2017

ARUP SERVICES
Heritage consultancy
Façade design and engineering
Structural engineering
Building services (MEP) engineering

RECOGNITION
East Midlands Property Dinner Awards 2017
Construction Project of the Year
SFE Façade of the Year 2018 Refurbishment
AJ Retrofit Awards 2017 Listed Building Over £5m
Shortlist

BUILDING ON OUR HERITAGE

Opened in 1963, the Grade II* listed building was named among the ten best post-war buildings in Britain by Historic England in 2015, who described it as ‘a synthesis of traditional and modern elements that is wholly British’. Sadly, the condition of the building’s famous workshop glazing had deteriorated, and Arup was commissioned to solve problems including leaks, poor thermal performance and a lack of safe access for maintenance, with the thin glazing and roof structure making access for cleaning and repair impossible in places.

GETTING THE DETAIL RIGHT

It may seem simple to remove an old roof and replace it with one made to the same shape and of similar materials. However, the new roof had to allow for significant distortions in the retained structure to meet today’s stricter performance and safety standards. It also needed to satisfy the local authority conservation office, Historic England and the Twentieth Century Society.

We refined every detail to make the restoration authentic and successful. This included replacing 2,500 glass panels on the roof, shaping each one to fit the existing warped structure. These double-glazed units are twice as heavy and more than twice as thick as the original single glazing, requiring a geometrical offset to each surface. The change in width of the framing was limited to a few millimetres in all cases. Significantly narrower than industry standard, the new glazing bars provide structural integrity while replicating the visual lightness of the original design. The new envelope is watertight and airtight, with natural ventilation openings to relieve high temperatures. Building on the success of this project, Arup was nominated as Conservation Champion for the building.

INNOVATING TO SOLVE CHALLENGES

We upgraded building services, replacing dated equipment with more efficient technologies and refurbishing original components where possible. We hid new elements in floor trenches or designed them to complement the functional interior design. We also introduced a control system that can be adapted to changing patterns of use and linked with additional systems, fulfilling the engineering department’s needs today and into the future.

Combined with the more efficient façade, this updated system supports the University’s commitment to reduce carbon emissions across its campus.

St Thomas' Hospital East Wing
London, UK

How do you make a leaky hospital wing fit for purpose without affecting operations?

AT A GLANCE

Constructed in the 1960s, St Thomas' Hospital East Wing was no longer fit for purpose and needed a major overhaul. Yet, as the hospital's home for cardiac and intensive care, it also needed to stay fully functional for patients and staff. This was our top priority.

BUILT
1960s

CLIENT
Guy's and St Thomas' NHS Foundation Trust

LOCATION
Lambeth, London

COMPLETION
2015

ARCHITECT
Hopkins Architects

ARUP SERVICES
Structural engineering
Building services (MEP) engineering
Façade engineering
Fire engineering
Logistics

RECOGNITION
Schueco Excellence Awards
2016 Health Project Award
European Healthcare Design Awards
2016 Design for Conversion or Infill Award
AJ Retrofit Awards
2016 Health and Wellbeing Project

COLLABORATING TO OVERCOME CHALLENGES

The 13-storey East Wing contains over 200 beds, catheter suites, clinical offices, teaching facilities, ancillary plant and stores. The ageing structure was suffering from water leaks, poor energy efficiency, excessive solar gain and inadequate lifts. Working in partnership with Hopkins Architects and contractor ISG, we devised a way to fix this without interrupting hospital operations.

Together, we retained the existing façade while adding a new layer of glass to create a double skin façade with timber louvres in the cavity. This has weatherproofed the building, improved its energy performance and reduced solar gain.

At the rear of the building, we expanded the second skin glazing to create two bright and airy atria. These accommodate large, urgently needed lifts for patients, speeding up transfers and improving privacy. The atria also give the building a more attractive, contemporary identity.

COLLABORATING TO REDUCE RISKS

We brought together a multidisciplinary team to minimise risks. Our building, façade and fire engineers engaged closely with the hospital's facilities management team to reroute essential services through the busy site. Our geotechnical and structural engineers carried out detailed site investigations before connecting new build elements and existing structure. Our façade and fire engineers worked together to design lightweight ETFE roofs for the atria. The result is an attractive, energy efficient environment that supports the wellbeing of patients and the hospital team.

Broadgate Circle
London, UK

How do you reimagine 1980s retail, restaurant and events space for today's visitors?

AT A GLANCE

Originally designed by Arup in the late 1980s, Broadgate Circle is a heritage space at the heart of Broadgate, next to Liverpool Street Station.

Fast forward nearly 30 years and British Land asked us to reimagine the space for today's visitors. Broadgate Circle is now a food, drink and leisure destination, home to 11 restaurant brands and a mix of street food traders. It hosts a range of events and attracts thousands of visitors. This is part of our wider role supporting British Land and GIC's £1bn transformation of Broadgate, the largest pedestrianised neighbourhood in central London.

BUILT
1980s

CLIENT
British Land

LOCATION
Broadgate, London

COMPLETION
2020

ARCHITECT
Arup

ARUP SERVICES
Architecture
Structural engineering
Building services (MEP) engineering
Geotechnics
Façade engineering
Acoustics
Fire
Lighting
Security
Transport planning
Vertical transportation
Wind engineering

BUILDING ON OUR HERITAGE

Celebrating the original qualities of the Circle, we retained and restored the colonnade of 54 travertine columns, rising 14m high. We meticulously matched new travertine panels to the original stone, selected from Tivoli, Rome. Stonemasons crafted the rebates and curved sections at interfaces.

CREATING PLACES PEOPLE PREFER

We designed infrastructure, lighting, planting and maintenance, so Broadgate Circle could be transformed effortlessly, day and night. The 4,150m^2 space now hosts an array of events year-round, including live music, pop up retail, theatre, cinema screenings and outdoor sports.

We reinvented how people are drawn into the space and move around. The upgraded southern entrance and north-west entrance now have clear sightlines. Three wide new staircases make it easier for people to move between ground and lower ground levels.

We lowered the elevated circle to improve the quality and scale of retail space and enhance sightlines. Through clever structural surgery, retail units that were once hidden from view and struggling, are now transformed into an open, thriving retail environment.

CONTRIBUTING TO A GREENER FUTURE

We retained more than 80% of the existing structure, reducing lifecycle carbon emissions and cutting construction costs. To support local biodiversity, we planted ecologically valuable climbing plants, such as honeysuckle, on existing living walls and a green trellis. These connect to Broadgate's wider green network that offers people opportunities to encounter nature, which, studies show, boosts wellbeing. We also introduced a highly efficient irrigation network, with rainwater harvesting and an automatic watering system that adapts to changing weather patterns.

St Pancras station is a strong example of the power of heritage to add value to large-scale urban development.

Arup was lead designer for the regeneration of this railway station, where high-end shops, bars, restaurants and a luxury hotel sit alongside a complex transport interchange of metropolitan, regional and international rail services.

Arup has provided creative and technical services for some of the world's most beautiful heritage projects, from initial surveys and listed building consent applications to detailed design. Working with stakeholders and partners, we enable development opportunities in historic places, successfully integrating old and new.

THOMAS PEARSON
Associate

▶
ST PANCRAS INTERNATIONAL
LONDON, UK
© Hufton + Crow

"Here is a gothic fairy tale brought up to date, setting a new standard for Britain's railways, and bringing new life to one of Europe's most compelling buildings."

THE GUARDIAN

BUILDING ON OUR HERITAGE

St Pancras turns 13 in 2020 but is, of course, far older than its teenage years. The station was originally built in 1868 to the designs of the Midland Railway's engineer William Barlow. Its mighty iron roof, arching unobstructed across the original train shed, was once the largest free-spanning structure in the world. The dramatic gothic hotel at the front was designed by George Gilbert Scott, one of Victorian England's most distinguished architects.

By the middle of the 20th century, the building was unloved and decaying badly. It was nearly destroyed as London, like much of the UK, looked to replace its 'vulgar' and 'outdated' Victorian buildings with sleek modernist structures, considered more fitting for an optimistic post-war future. Euston station suffered this fate in 1962. Euston's destruction and the survival of St Pancras brought about the conservation movement as we know it today in Britain. The rebirth of St Pancras in 2007 made it influential again in a new way, as an exemplar of heritage as a catalyst for regeneration.

REBIRTH

We approached St Pancras with a clear brief to preserve as much as possible of the Victorian station's unique character. We consulted with wide-ranging stakeholders, including various heritage groups, to establish priorities before and during the project. The key design move was to devote Barlow's huge shed to trains and hide new elements below – shops, ticket halls, walkways and transport interchange movements. We then cut out a slot at platform level to open up views of the magnificent roof within the precinct below. We also introduced a new shed to the rear to accommodate the longer trains of the Eurostar service to Paris and Brussels.

These adaptations were not without their compromises – the transition between old and new train sheds, for instance – but the project achieved a startling success in allowing the original building to work in a new way. The most important aspects of its original design are framed and celebrated in a modern context. Changes are, for the most part, expressed 'honestly', meaning that new materials can be clearly seen as distinct from old, which is another key principle of good conservation practice. The composite building is satisfyingly multi-layered and architecturally stunning.

LEGACY (SO FAR)

After 13 years, St Pancras remains a prime example of a key principle of modern urban design: that transport interchanges should be centres for activity and economic growth. The redevelopment of St Pancras opened the door for central London's largest brownfield site to be brought back to life.

The economic stimulus of public transport can be profound. St Pancras prompted the renewal of neighbouring station, King's Cross, and a cascading sequence of investment in previously inaccessible 'railway lands' to the rear of both. Contaminated former goods yards, previously serving the Midland and East Coast main railway lines, have been transformed. Two major educational institutions have moved in: Central Saint Martins arts and design college to a converted grain warehouse and the Francis Crick Institute into a new building drawing architectural cues from Barlow's station. Offices, homes and shops have followed, including Coal Drops Yard and Midland Goods Shed, both inhabiting former railway buildings, and Gasholders London, set inside three conserved Victorian gasholder frames. Gilbert Scott's station hotel has also been completely renovated. Arup has had a hand in all these projects.

Today, St Pancras stands as a gateway for rail passengers into London – and for Londoners into a rediscovered part of the city. It acts as a standard-bearer for intelligent, sensitive city development that celebrates heritage and uses it as a driver for positive change. In Arup's work at other stations (including Grade II* listed York), we still reference our achievements and lessons learnt at St Pancras in creating a new urban quarter with high quality public space around a carefully conserved historic station. Here, Victorian engineering powers dynamic 21st century life.

HOW DIGITAL DOUBLES CAN IMPROVE PERFORMANCE IN EXISTING BUILDINGS

A building's digital history spans design, construction, maintenance and operational performance.

By bringing all this data together in a single, open-source digital model, we can improve building performance. This is expanding the concept of the digital double – a virtual model of a building – adding important layers of live information.

STEPHEN HILL
Associate

RECOGNISING THE VALUE OF DIGITAL DOUBLES

In design and construction, the power of Building Information Modelling (BIM) to reduce risk and improve the accuracy of cost and programme forecasting is well recognised. Data captured via laser scanning is being used to create digital doubles of existing buildings, aiding design. 3D models are increasingly improving information flow from design into construction too.

In operation, the situation is quite different. There is not yet a clear understanding of the value that digital doubles could add. The image of operation and maintenance files gathering dust on shelves may be a thing of the past for new buildings, but we are now seeing the digital equivalent. Project teams pass online portals over to facilities management teams, but models are not maintained and quickly go out of date. In many older buildings, dusty folders on a shelf are still the reality. New tools to create 3D models of existing buildings, using combinations of photographic and scanning technologies, are developing rapidly and costs are reducing all the time. These could dramatically reduce risk on complex refurbishment projects, but the opportunity has yet to be fully grasped.

Clearer briefs for operational BIM at the start of projects would lead to 3D models that are more useful for facilities management teams. With greater 'pull' from the facilities management industry, there would also be more investment in software tools to integrate digital models with maintenance records.

EXPANDING DIGITAL DOUBLES TO IMPROVE PERFORMANCE

Advances in building control systems, Internet of Things sensors, online analytic platforms and artificial intelligence have the potential to transform how buildings are managed, adding valuable layers to digital doubles.

For instance, by looking at live occupier satisfaction, environmental sensor and energy consumption data together, we get a more rounded view of operational performance. We can go beyond the current schedule-based maintenance contracts and instead incentivise maintenance contractors on performance outcomes. In turn, this will create an incentive to generate the skills needed in the industry.

The skills gap is a key barrier to the use of digital doubles in facilities management. Existing maintenance contracts have led to a gradual deskilling of the maintenance workforce, driven by commercial incentives to minimise costs.

Getting the most out of digital doubles also requires a different set of skills to conventional maintenance contracts, skills such as those of cloud computing specialists and data scientists. Creating the market transformation needed for digital doubles to be effectively used and maintained is undoubtedly a bigger challenge than creating the doubles in the first place.

GAINING INSIGHTS INTO THE FUTURE THROUGH DIGITAL DOUBLES

As well as improving how buildings are managed, digital doubles can help us forecast their future performance more accurately. By calibrating potential outcomes against current performance, we can predict the impact of marginal improvements on areas such as environmental comfort and energy performance. We can also use expanded digital doubles for more significant projects, as they provide a well calibrated starting point. Arup AssetMAP integrates architecture and engineering data with financial and risk analysis. This helps us quickly identify which retrofit and refurbishment options for a building offer the best value outcomes. We can then prioritise opportunities to enhance commercial returns, reduce carbon and reduce risk. This is virtual rapid prototyping for buildings.

A FUTURE LINK BETWEEN DIGITAL DOUBLES AND ASSET VALUE

Demonstrating building performance is increasingly important in the UK property market. Design and construction assessments, such as BREEAM ratings and Energy Performance Certificates, now sit alongside assessments that look at operational performance. These include WELL certification and the Better Buildings Partnership's Design for Performance rating, which seeks to create an operational energy performance rating for the UK, similar to the successful Australian NABERS programme.

In a market where operational performance is ever more important, a building that demonstrates good performance is likely to be more valuable than one that cannot. An expanded digital double is not only a tool to improve building performance, it can also evidence that performance. So, as the link between building performance and asset value becomes stronger, digital doubles will become a critical part of maintaining and enhancing asset value.

Our services

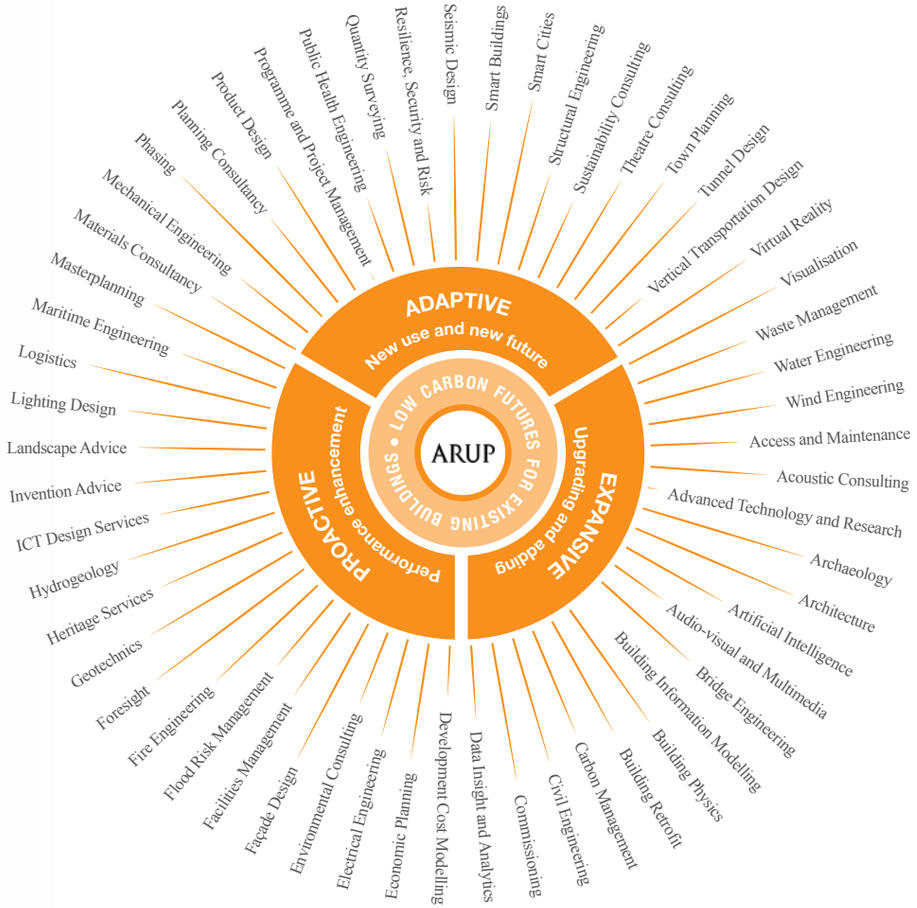
Arup's portfolio spans over 70 years and thousands of reuse projects. During this time, we have worked with incredible clients, collaborating and innovating to deliver award-winning buildings, often recognised for their sustainable credentials. Here, we share a few examples illustrating how we are transforming and reusing existing buildings for the benefit of all.

SUPPORTING YOUR SUSTAINABLE GOALS

Our teams have access to colleagues with expertise in every aspect of the built environment. This allows us to rethink and reuse existing buildings in exciting and sustainable ways. Working collaboratively across Arup and with external partners, we develop tailored solutions for our clients. This includes turning ageing offices into flexible workspaces, derelict yards into shopping districts and industrial structures into homes, as well as extending the life of historic buildings and upgrading their performance.

As the examples in this brochure show, all our projects are unique, informed by our experience in an ever-expanding number of disciplines and sectors. We design and adapt buildings and places, so they produce the greatest value for clients and the best experiences for people.

In today's increasingly low-carbon, digital and wellbeing focused world, our projects are underpinned by a philosophy and commitment to fulfilling client aspirations by creating smart and healthy buildings for happy and satisfied people.



The Encyclopedia of Arup

Bringing together our diverse skills to future-proof your investment

In transforming existing buildings, the unexpected often happens.

Whatever challenges our clients face, Arup has the skills and services to help. We bring together strategic, technical, environmental and operational design experts to create the best environments for today's needs and generations to come.

Image credits

FURTHER INFORMATION

Melanie Heath
Marketing and Business Development Lead | Buildings London
melanie.heath@arup.com
+44 (0)20 7755 6517

Credits
This document is produced and published by Arup. Designed by Philip Jones.

We shape a
better world

arup.com

transformandreuse@arup.com