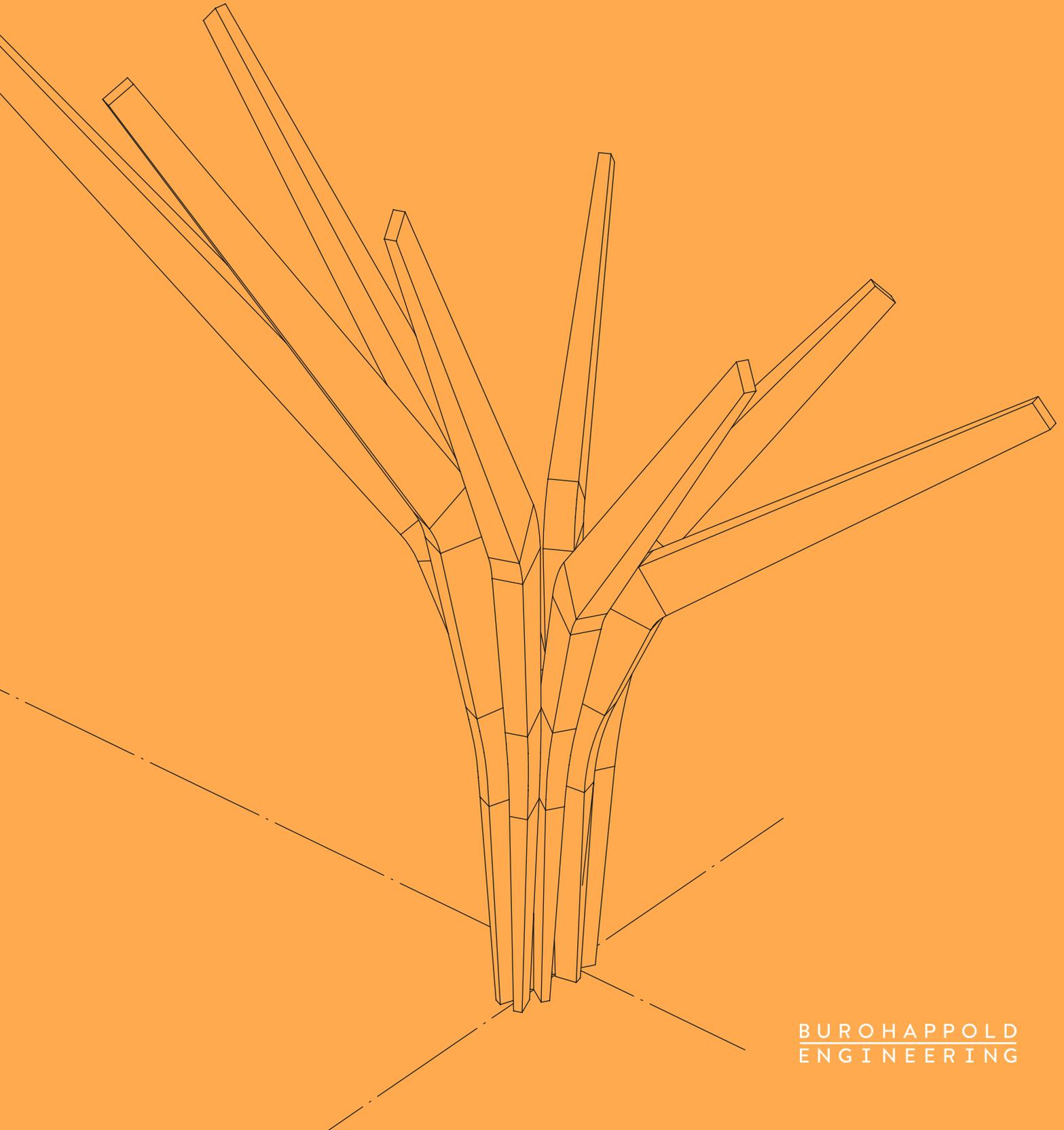


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ANNUAL REVIEW



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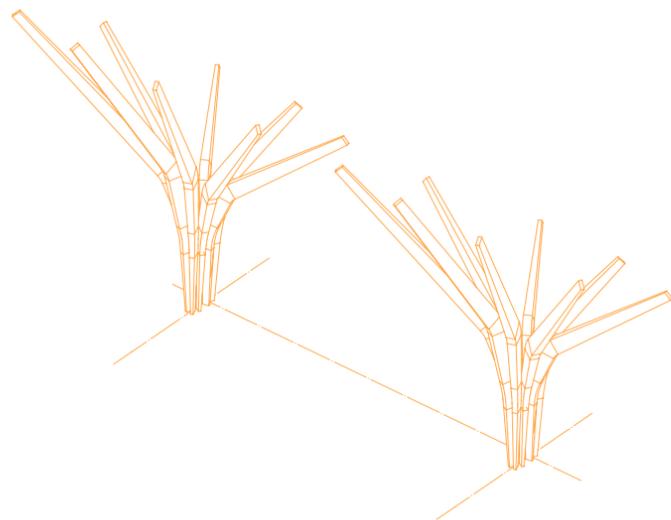
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“
We will always
strive to deliver
solutions with
a sense of
economy for our
planet and its
resources.
”



Image: Harry Borden

Finding solutions is what we do. What we at BuroHappold know is that the solution to a particular problem does not come fully formed.

Using all the tools at our disposal, our people examine each issue from every angle before arriving at an answer. Our promise to clients is that this answer will not only address an issue, but also add real value to your project.

Excellent engineering design is at the heart of our business, and always will be. But we want to create more of a balance. Building and infrastructure design currently makes up 68% of our work, with advisory services at 24% and consultancy at 8%. We see the future of BuroHappold as providing more solutions and creating value for our clients in the advisory and consulting streams, as well as design.

Our future also lies in creating scale in regions where we have much more potential. In creating a stronger balance, we position ourselves as better able to provide a comprehensive service to our clients, wherever they are located.

As we reach further out in scale, expanding our client reach from campus to city, advisory to consultancy, we develop a richer, deeper offering.

To us, advisory means applying our deep technical or specialist knowledge to the issues being faced by our clients.

This might inform a design solution. Perhaps an alternative solution that doesn't require construction or other intervention might be the answer.

Consultancy is about making that technical expertise accessible. Our in-house consultants use their breadth and depth of knowledge and serve it up in an accessible way. We can be reactive and flexible as well as drawing on deep competence and authenticity in our advice, based on over 40 years of understanding our clients.

To fill the space created by our expansion into new areas of business, we need our greatest asset — our people. We are training a new generation of BuroHappold consultants and our advisory services are growing as we conduct more in-depth research into important current issues and develop tools that offer clients advanced data-based solutions.

Every person in our firm contributes to our culture of creative, intelligent problem-solving. We will always strive to deliver solutions with a sense of economy for our planet and its resources. Choose BuroHappold and we will transform your business.

Neil Squibbs
Chief Executive Officer



“
 Our people examine each issue from every angle before arriving at an answer. Our promise to clients is that this answer will not only address an issue, but also add real value to your project.
 ”
 Neil Squibbs Chief Executive Officer

THE MUSEUM OF THE FUTURE
 DUBAI, UAE
 Services provided by BuroHappold:
 Lead design consultancy, structural engineering, facade engineering, building services engineering (MEP), civil engineering, geotechnical engineering, mobility, bridges, people flow modelling, fire and life safety, specialist lighting, sustainability, acoustics, waste and logistics.



Image: Harry Borden

“
Responding to the climate emergency is a key pillar in our project work. We will lead by example and test sustainable and responsible design solutions to offer our clients.
 ”

It is a pleasure to introduce our Annual Review 2018/19 and present to you the activities and performance of BuroHappold during our last 12 months. This is a year that has seen the efforts of our highly motivated community of engineers, planners and consultants complete many wonderful projects across all our markets. Through these projects we believe that we have achieved our objective – to exceed our clients’ expectations and aspirations that they define for their investment.

Each of these projects is a remarkable challenge. This means we must continually evolve our design and consultancy skills while encouraging our people to develop a truly holistic appreciation of the fundamental challenges of the day facing our sector. We must consider social change, technology advancements within and beyond our industry as well as our ultimate obligation, to care for our natural environment. Together with our people, clients and collaborators, it is a challenge that we relish.

We have always believed in the social value of our work and the importance of demonstrating that value in a way that goes beyond financial return for our clients. This principle must also apply to our own organisation, and our goal is to build a confident, diverse and representative BuroHappold.

I am delighted that we can demonstrate sustained, strong commercial performance to support the investment ambitions that are essential to our future. We are actively planning to build a sustainable and prosperous BuroHappold that can respond to the key challenges that we face.

We recently committed to utilise our skills and knowledge in response to the climate emergency, and have a radical action plan to reduce our own emissions as we undertake our activities. Responding to the climate emergency is also a key pillar in our project work. We will lead by example and test sustainable and responsible design solutions to offer our clients.

Enjoy our Annual Review, and we look forward to a successful and collaborative year ahead together.

Paul Rogers
 Senior Partner



“
 We have always believed in the social value of our work and the importance of demonstrating that value in a way that goes beyond financial return for our clients.
 ”
 Paul Rogers Senior Partner

BATTERSEA REDEVELOPMENT
 LONDON, UK
 Services provided by BuroHappold:
 Flood risk management and river engineering, civil and structural engineering, highways, ground engineering, facades, fire engineering, inclusive design/DDA.



//
 Our strategy of growth in target markets, and expansion of our advisory and consulting offers, will ensure that BuroHappold continues to succeed.
 //



Image: Harry Borden

A successful year for BuroHappold, with an increase in operating profit by 30% to £22.1 million. This is a fantastic achievement and is down to the skills and commitment of our exceptionally talented employees worldwide.

I am happy to report that, in line with our strategy to reduce our dependence on our two major markets of the UK and Middle East, we saw significant growth in our targeted European and US markets. Buoyant market conditions in the USA helped turnover there increase by 32%. Results have been good in Europe, too, with an increase of 20%. That's not to say our UK market is suffering; despite all the doom and gloom, UK turnover has increased by 1.5%. The Middle East saw a slowdown as we get to the end of some major projects. However, we expect to see a turnaround in future years as we focus on some significant "giga" masterplan projects. In China, we have opened an office in Shenzhen as part of our Asian expansion.

Science and Technology has seen strong growth as more clients seek out our technology-based solutions for research effectiveness. Our reputation as reliable, transformative experts is also why the Urban Development and Cultural sectors have experienced a jump in turnover compared to 17/18. Air and Rail has seen a slight increase too.

How are we doing in terms of liquidity? Pretty well. There has been a 16% improvement in net cash, largely driven by our ability to convert improved profitability to cash rather than it being required for ongoing working capital. Working capital management remains a key focus for the group, as evidenced by the 10% reduction in trade debtors and reduction in Days Sales Outstanding (DSO) from 122 to 103 days.

Next year is certain to bring some challenges. A devalued pound, thanks to Brexit, means that the UK is currently a low-cost base for international operations, both in terms of central operational support costs and as

an export base for engineering and consultancy on non-UK projects. This may change, but I am certain that BuroHappold is prepared for any outcome. We have increased our financial resilience by targeting more international work to reduce our exposure in any one market. We hire and retain the very best people and continue to invest in technology while streamlining our processes. We remain a strong business with a solid set of results. I am confident that our continued strategy of growth in target markets, and expansion of our advisory and consulting offers, will ensure that BuroHappold continues to succeed for many years to come.

James Bruce
 Chief Operating and Financial Officer

KEY PERFORMANCE INDICATORS

	2019 (£'000)	2018 (£'000)	Change
Turnover	173,300	163,638	▲ 6%
Operating profit*	22,122	16,984	▲ 30%
Operating profit margin*	13%	10%	▲ 3%

* Operating profit, and operating profit margin are all shown before other operating income/(expense) as this assists with understanding the underlying performance of the group.



“
BuroHappold has increased our financial resilience by targeting more international work. We hire and retain the very best people, and continue to invest in technology.
”

James Bruce Chief Operating and Financial Officer

JEWEL CHANGI AIRPORT
SINGAPORE
Services provided by BuroHappold:
Structural engineering, facade engineering.

A MATTER OF DEGREES

CAN ENGINEERS REALLY MAKE A DIFFERENCE AS WE COMBAT THE BURGEONING GLOBAL CLIMATE CRISIS? WITHOUT A DOUBT WRITES DUNCAN PRICE, BUROHAPPOLD'S DIRECTOR OF SUSTAINABILITY

What is a climate emergency? It is a recognition of the need to rapidly scale up and accelerate action on climate change. In 2018, the UN Intergovernmental Panel on Climate Change released a report saying that we have 12 years left to abate the acceleration of climate change, to "bend the curve", as they say. The Committee on Climate Change also identified that there was a need to set targets for net zero carbon in the UK.

The UK is already one degree warmer than it was in pre-industrial times. We are halfway towards the two-degree maximum rise agreed in Paris in 2015, and two-thirds from the 1.5-degree aspirational target. The UK has now recognised those targets and adopted the recommendations by the Committee on Climate Change that commit us to being on a trajectory for net zero greenhouse gas emissions by 2050.

CO₂ has been a big part of this but there is also unsustainable resource consumption and pollution. There are many driving forces behind that, but the use of resources and pollution of the biosphere, oceans and soil have been manifest. It is phenomenal – sixty per cent of species have disappeared or become extinct since 1970. This has been driven by a population that is not only significant but also increasingly urbanised.

As a practice, BuroHappold has both a responsibility and an opportunity to make a significant positive difference to the world. We have many of the tools in the box required to identify, analyse

and resolve complex system challenges – we can provide evidence that gives decision-makers confidence to act. For example, we developed the evidence base for energy efficiency targets that apply to all new major developments in London. We were able to do that because we have a deep understanding of what it takes to design and operate buildings. We also understand the energy flows in different building types.

Right from the genesis of our organisation, low carbon and energy efficiency have been key themes in the philosophy of how BuroHappold designs solutions for buildings and cities. We are members of the Aldersgate Group, which is a multi-sector leadership alliance advocating for strong policies on climate change. Through that group, we have been lobbying for government action in this area. We also have been working within the sector, in particular with the UK Green Building Council, to get the property development and building side in a similar space.

In simple terms, what we are trying to do is decarbonise the whole of the built environment. That means improving the energy efficiency of our buildings, then enabling those buildings to use clean, renewable energy imported through either the electricity grid or another energy distribution system, such as a district heating. Not every building will be able to have renewable energy, so we will probably have some electricity coming from the National Grid; by 2050 we expect that it will predominantly be a zero-carbon grid.



“It is good to unpack sustainability into different components, different ways of thinking. Essentially, it is about projects where both people and planet can thrive.”

Duncan Price, Director of Sustainability



By joining up this agenda across disciplines, we have found new ways of thinking. This includes the work that we have been doing with C40 Cities, which is looking at the air quality, health and economic benefits of urban climate action. That has yielded new methodologies, new insights, new ways of thinking about projects. This helps lift the aspirations and confidence of city decision makers enacting policies, which may not have happened before, and that may be scaled up as a result of what we are doing. I am really excited by that. I see this as an interesting way of capturing the imagination of 1,700 brilliant BuroHappold engineers and consultants that see a greater purpose in what they are doing and love a challenge. We have given them a clear challenge on which to apply their creativity and problem-solving abilities. Their desire to network and do that in a much more integrated way helps us to attract, retain and nurture the very best talent.

It is good to unpack sustainability into different components, different ways of thinking. Essentially, it is about projects where both people and planet can thrive. It is important to bring some numbers to that too. So, is it zero carbon? Is it clean air? Is it going to provide comfort in 2050? Is it efficient? Bringing in some science and making sure that the projects we are working on are helping us towards that overall objective are ways of giving substance to the concept of sustainability. The idea originally stems from the Rio Earth Summit of 1992. They coined this phrase “sustainable development”, which is development that meets the needs of today without prejudicing the needs of future generations to do the same. That necessitates working within the ecological limits of the planet and meeting the

needs of society at the same time. So, making sure that we are not consuming resources at a rate that is faster than the world’s ability to replenish them.

We know from the research that C40 Cities has done that around 40% of the Paris Agreement on climate change can be delivered through action in cities and towns, the urban environment. Many of our clients are in the process of declaring their own climate emergencies and setting ambitious targets to scale up and accelerate action on climate change. It was in this context that BuroHappold declared our own climate emergency and we are encouraging others in the industry to do the same.

Spearheading the adoption of climate and biodiversity emergency declarations among our peer group is absolutely the right thing to do. This transcends any individual business need. However, we are aligning our whole business to this agenda, so if we can get our clients and peers pointing in the same direction it will lead to new opportunities and de-couple economic success from negative impact. We want to align business success with positive social and environmental outcomes. This is the trajectory that we intend to pursue.

At a macroeconomic level, investment in building energy efficiency makes a lot of sense; it is good for jobs, good for skills innovation and it reduces imports of gas. The economic multiplier that comes from energy efficiency is better than almost any other infrastructure project. It just makes good sense. Think of it as an investment rather than a cost. The benefits are enormous.



Image: Connie Zhou

It is not just about the design of new buildings; operation and improvement of existing building stock is absolutely critical too. Now, buildings are important for people – they affect our health, happiness and productivity – but they also have a strategic importance in the fight against climate change. The buildings we are designing now have to be fit for the future and be able to withstand warmer climates.

If we are to meet our targets, then we need to fundamentally change the way that we live. That means being aware of the impact that we have. Who doesn’t want clean air and communities where people thrive in close proximity? To accomplish that, we need to think about where and how we live and work, how we move and the way that we engage with our towns and cities.

National governments and international organisations have set the direction of travel, but the action needs to happen at a regional level. UK government had its own Climate Change Act, which is arguing for an 80% reduction before 2050; local authorities have declared climate emergencies in recognition of the fact that the UK government wasn’t reacting fast enough. We need to respond to the science, and the science tells us that we need to be moving quicker.

There are huge challenges to face. However, I feel like we are at a tipping point in public consciousness. That has occurred alongside action from governments, cities, businesses and civic society all coming together at the same time. In the last year there has been an alignment of international recognition

through the IPCC, national recognition through the Committee on Climate Change and the UK government, and we’ve had corporates – many of our private sector clients and public sector clients, such as city authorities – all saying, “Yes, we need to adopt science-based targets, we need to be recognising that there is a requirement of all sectors of the economy and all actors to move in unison”. There’s a political space that’s been opened up by the school climate strikes and Extinction Rebellion mass movements; the groundswell of public opinion has given politicians the confidence to act. I have never seen this happen before, that mixture of top-down and bottom-up. That creates opportunities for new services, new ways of living and new ways of working that, I think, will be better. I am cautiously optimistic.

It takes strong leadership and we are part of a system that needs to change, but, as engineers, we have a very influential voice. We bring science, evidence, and rigour, but we also design spaces that affect people so we have a strong understanding of that relationship between built assets that consume energy and the quality of the experience that this energy produces. We can engineer the whole system; we can design whole towns, cities and buildings for cleaner, healthier, more productive lifestyles that are also resilient for the future.

As engineers, we have the skills to make a considerable positive impact on the world. This is exactly the right time to be applying those skills. **BHE**

Duncan Price, Director of Sustainability, pictured speaking at Zero Carbon Cornwall, the Eden Project, 3 September 2019.

Top
The Tower at PNC Plaza (Pittsburgh, PA) is a BuroHappold project that combines cutting-edge design with the very latest green technology to exceed LEED Platinum criteria.

Right
Two St. Peter’s Square (Manchester, UK) is another of our sustainable buildings, mixing retail capacity with BREEAM Excellent, Grade A Energy Performance Certificate (EPC) office space.



SPORT AND ENTERTAINMENT

Matthew Birchall
Sport and Entertainment
Sector Global Lead



BuroHappold's experience in the creation of sport and entertainment venues does not end with the venue itself. As a global team of engineers, consultants and specialists, we draw upon expertise across multiple design fields to ensure that our tailored process not only brings new venues to life but also contributes to the surrounding community.

Upon gaining a thorough understanding of the operational requirements and expectations of the fans, we work tirelessly to deliver a unique venue that maximises returns from both a commercial and visitor perspective. BuroHappold has an in-depth understanding of a venue's needs, covering every aspect from design to handover. Our technical teams work together to provide a single coherent solution that enhances the experience for all.

This year saw the completion of the new Tottenham Hotspur stadium. Much has been made of our concept for this headline project's ingenious sliding pitch, and rightly so. However, our involvement goes much further than just the playing surfaces.

We have helped the client across a broad range of disciplines — including technology, sustainability and MEP — and developed our capabilities in overcoming challenges to successful delivery. Either individually or as a project-specific ensemble, these advanced disciplines will benefit clients whose requirements are slightly more modest than having an entire ultramodern stadium built from scratch. The same is true of our cricket venue expertise, which is helping the MCC to deliver their masterplan for Lord's. As a global practice, we can easily transpose these skills to benefit new clients in territories where we already operate, such as the Indian subcontinent.

With an expansive portfolio containing some of the world's major iconic stadia and arenas, BuroHappold takes great pride in our ability to design venues for some of the most demanding and exciting sport and entertainment events in the world.

TOTTENHAM HOTSPUR STADIUM

LONDON, UK

Providing an exceptional fan experience, the new Tottenham Hotspur stadium is a precise realisation of the club's grand vision. Successful construction of this landmark venue has been made possible by our team's determination to overcome a series of challenges while maintaining design intent. Tottenham's aspiration for the project was simple — to be the best. Not just the best in north London or the English Premier League. No, this had to be Europe's number one venue for playing and enjoying football.

The plan was not only to position fans as close to the pitch as possible but also increase capacity from approximately 36,000 to over 62,000. Another key objective was to bring the NFL to north London by incorporating an

uncompromised American Football capability. Crucial to BuroHappold's contribution has been engineering innovation and the use of long span structures. Such ingenuity included eliminating 40% of the columns to provide open concourses and hospitality spaces. We also managed to slide a 70m x 110m turf pitch under 17,500 people while controlling the structural dynamics.

The sliding pitch is the first in the world to have a full grass surface that splits into three parts before rolling away beneath the stands. When NFL games are hosted at a typical football ground, players standing on the sidelines obstruct spectator views from the lower rows so hundreds of seats cannot be

used. This is not a problem at Tottenham, where a dedicated NFL field under the retractable pitch sits 1.5m below the first row of seating. As well as providing optimum sightlines, the seating capacity is identical for football and NFL games. The entire "pitch switching" process takes just 25 minutes.

This stadium, which opened to universal acclaim in April 2019, stands as the centrepiece of a broader regeneration programme that is reinvigorating the surrounding area. Working with the architect, Populous, over 230 BuroHappold people worked directly to deliver this spectacular project.

KEY PERFORMANCE INDICATORS

Sector turnover	£10.8m
As percentage of company turnover	6%

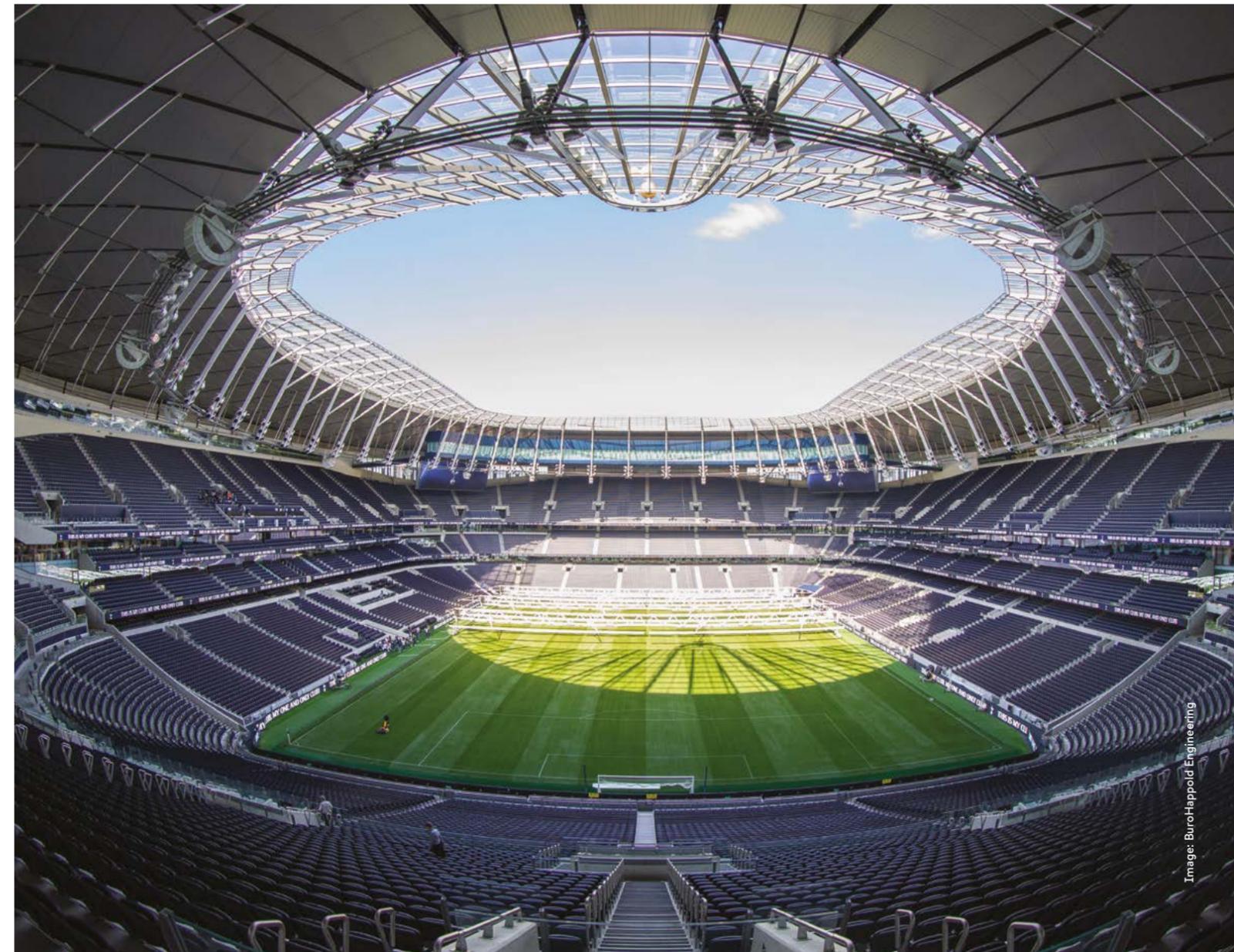




Image: MCC

LORD'S CRICKET GROUND

LONDON, UK

Responding to an increasingly competitive sporting environment, Lord's is undergoing upgrade work to steadily improve facilities in accordance with a staged masterplan. This approach allows continued hosting of matches at the north-west London ground while increasing operational efficiency to enhance spectator experience. The second phase of the masterplan encompasses redevelopment of the Compton and Edrich stands, which are situated either side of the distinctive media centre – another BuroHappold project, opened in 1999 – at the famous Nursery End. A three-tier arrangement will take capacity of the new stands from 9,000 to 11,500 seats. By understanding client aspiration for the stands and how this relates to broader venue objectives, our experts are helping the MCC to ensure that Lord's remains the best place in the world to watch and play cricket.

SAP GARDEN

MUNICH, GERMANY

The multifunctional SAP Garden will be the new home for the Red Bull München ice hockey team and FC Bayern München Basketball. Located on the site of the former velodrome in the Munich Olympic Park, it will have a capacity of up to 11,000 seated guests. The design of the arena, enhanced by a green roof and vertical facade structure, blends into the world-famous Olympic Park.



Image: 3XXN

EVERTON

LIVERPOOL, UK

This fully accessible venue will have a capacity of 52,000 seats, all with uninterrupted views of the pitch. A "Football First" design approach will enhance fan experience by intensifying the atmosphere to maximise home advantage. Our integrated team is consulting on 17 disciplines for the construction of this waterfront stadium, which will be the cornerstone of a transformative community initiative known as The People's Project.



Image: Everton FC

WEST END STADIUM

CINCINNATI, OH, USA

Scheduled to open in March 2021, the new 26,000 capacity soccer-specific stadium will be the home of FC Cincinnati. Taking this Major League Soccer team's goal of creating an iconic and groundbreaking design for the city while prioritising and amplifying the fan experience, this unique stadium will be among the world's most distinctive sporting venues.



Image: Populous & FC Cincinnati



There's no place like home

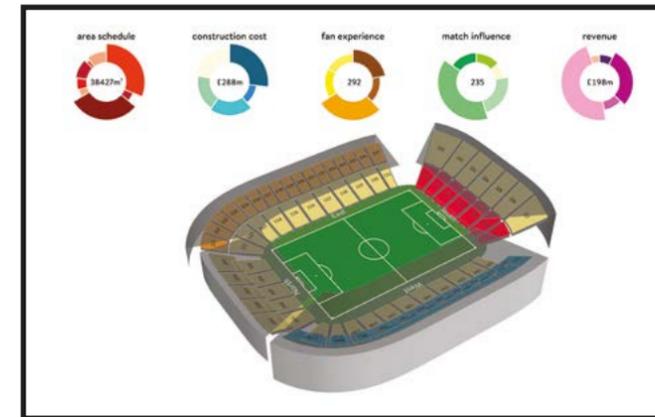
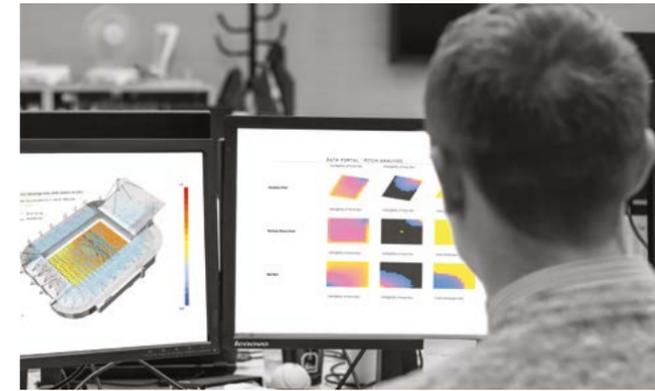
Outperform the opposition with data-driven venue engineering

Return on Investment. As a multidisciplinary engineering consultancy specialising in Sports and Entertainment, this metric drives everything that we do. Gone are the days when clients would expect us to handle just the pipes and wires, the sticks and bricks. Forward-thinking clubs now realise that the best design teams can be challenged to deliver a range of measurable outcomes that transcend exceptional construction:

- Doubling revenue over the next 10 years.
- Creating a stadium that is better than a rival ground.
- Expanding demographic and geographic range of the fan base.
- Being capable of hosting high-profile touring musical acts.

- Attracting a top-tier naming rights partner from the outset.
- Making money on more than 200 days a year.

Let's consider some examples that illustrate what can be achieved through intelligent collaborative design. Developed with fan experience, revenue and club reputation in mind, the new Tottenham Hotspur stadium has triggered local regeneration schemes including new homes, public spaces and civic amenities. The People's Project at Everton FC will be similarly transformative for club and community. Realising these kind of benefits is, however, not exclusive to big-budget, headline projects; the £45m upgrade of Ashton Gate Stadium in Bristol has created a multipurpose regional venue that not only stages football and rugby



matches but also draws global music acts such as Rod Stewart, Take That and Muse.

In the context of Return on Investment, clubs can make better expenditure decisions once provided with a clear understanding of how their stadium could deliver desired outcomes. Of course, it is all too easy for consultants to talk a good game after the event. Things are going well? That's thanks to our brilliant advice. Not going so well? That's down to some other factor that is entirely unconnected to our brilliant advice.

Counteracting this culture of hazy accountability, BuroHappold has substantiated our offering by going beyond the anecdotal. We can devise models that predict construction cost and programme along with other

influential elements such as experience, bowl behaviour, revenue, dwell time, digital impressions and sponsor appeal. This is underpinned by our Venue Performance Rating (VPR) system, which we created to bring science and substance to the pursuit of outcomes. This approach lets us explore options collaboratively and make informed decisions tailored to client needs. Together we can assess how changes will affect revenue, reputation and results. VPR also works as a tracker that indicates how we are doing against a club's core principles throughout an entire project.

By assessing and combining thousands of weighted parameters, we can see precisely how a stadium performs based on empirical data. Advanced computational techniques background much of this work, with 3D models

“ Sports science has revolutionised how we rate and improve player performance. A parallel approach to stadium design will enable clubs to get the best out of their key asset. ”

Andrew Pottinger, Venue Performance Consultant



Learn more about developing high-performance venues.





SPECIALIST
Q&A

Carolina Florian
Associate Lighting Designer

“BuroHappold really sees the value of having different specialist disciplines to solve very intricate challenges.”

Is light a tricky medium to work with?

It is. You can predict a lot with software modelling and a good technical background, but the reality is that the outcome may still surprise you. There are elements that you can never predict unless you do a mock-up or physical model tests. That's because your eye perceives an environment differently to what photographs or software calculations can show you. An important part of our design process is to get samples from manufacturers to make sure that their products will deliver what we have promised to clients.

Are there any recurring challenges in working as a lighting designer?

The main one is that, because light is such an available material, most people have an opinion about lighting without necessarily understanding it. We often get challenged and have to demonstrate the value that we add.

How would you describe that value?

We have the expertise to bring projects to life for people to experience them. It's not just the architecture, the technical performance and the client aspirations. We need to combine all lighting-related factors, which includes environmental, socioeconomic and physiological aspects.

What are the big projects that your team is involved in?

I'd say Stratford Waterfront is a good example. That's a great project because it combines iconic clients and it's located in a section of London where, since the Olympics, major things are happening. There's a lot of residential development there, too, so our work will complement the experience for everyone who lives in the area. We have the BBC building, the V&A, Sadler's Wells, London College of Fashion and we are doing the lighting in the public realm around those buildings.

Is it accurate to say that good lighting is the lighting that you don't notice?

Yes. I was watching the Coco Chanel film and there is a part where she says something like, "If you remember the woman then the dress is fantastic, but if you remember the dress that's because it wasn't the right one." Lighting is the same. If you notice the light sources, and you can feel annoyed by them, then it didn't work.

Is there anything else about lighting that tends to annoy you?

Glary light sources on street columns. Some of them are extremely bright. A lot of street lighting was quickly changed to LEDs because it was more efficient, but now, after a few years of understanding the effect, you shouldn't have that cooler, whiter light at night. Another one is the coloured lights that are applied to facades. That can be a nightmare, with green and red and purple lighting going on.

How have LEDs affected your work?

That was a massive change. Now we can use efficient light sources that are very powerful in terms of controls, colour range and dynamic effect. So, you go from designing a scheme with static white light to being able to change the room to different colours or even change the colour of the white light, depending on the daylight parameters and mood. Daylight moves from warmer white light in the morning to very crisp around midday; then it goes into warmer, amber shades again at sunset. That's kind of how our bodies work.

The body wants different light at certain times of the day?

Yes. Artificial lighting can be designed to behave in what they call a "human centric" way. Nowadays we understand more about how we respond to light, not just in aesthetic or mood terms but also physiologically.

Circadian rhythms?

Exactly. That's a complicated topic because, although we know that there is an effect, it hasn't been fully proven that artificial light influences the circadian rhythm in the same way that daylight does. There is a push for trustworthy research on this to inform future applications better, especially for health projects – like hospitals – and night shift environments, which could show more substantial results.

It seems that your work requires an even balance of technical expertise and artistic flair...

Yes, I enjoy both. Technology in lighting keeps changing a lot. At the moment we are having a bit of a revolution with controls and how you can integrate the lighting with smart cities. For example, another project I have is Amaala in Saudi Arabia. That's a development on an empty coast comprising three massive resort plots with new infrastructure – so new airport, new roads and everything. The client vision is for an integrated, smart environment that provides the artistic quality and wellness and all the experience of a seven-star resort. If you focus only on the artistic side and don't keep up with technology, then at some point you will feel left out of the conversation. You won't know what's best to propose to the client in terms of what's out there.

What's exciting you about where the specialism is headed?

The most exciting part for me is that BuroHappold really sees the value of having different specialist disciplines to solve very intricate challenges. We bring the confidence to enable client visions. That has a lot to do with working closely with the architects, but without the right type of light the project will never be perceived as envisaged.

Andy Keelin
Commercial Sector Leader



COMMERCIAL

People-focused, performance-driven. This ethos informs every commercial project that we undertake at BuroHappold. Whether we are creating premium office accommodation, thriving residential communities, landmark skyscrapers or busy retail centres, it is our business to deliver high-performance, sustainable developments that enrich the economic and social landscape.

Providing our clients with high-level consultancy, creative engineering and pioneering digital design, we are uniquely placed to realise projects that not only respond to the challenges of modern life but also actively improve it. Key to our success is our ability to bring together experts from across our global offices, in fields such as infrastructure, risk and resilience, asset management, inclusive design, health, wellbeing and productivity. This allows us to develop multifaceted solutions that deliver real value for our clients.

As digital leaders, we embrace emerging technologies to enhance our ability to design environments that are intuitive to use and responsive to the needs of the people within them. Our Workplace Analytics tool, for example, provides us with unique insights into human

behaviour so we can understand how people interact with the spaces we create, and close the gap between intended performance and how they are used in reality.

This means that we are able to see, in real time, how the design decisions we make affect the user experience. By making small adjustments to our design – such as placement of stairwells, internal temperature, amount of daylight, position of desks or access to outdoor space – we can create environments that promote social interaction and collaboration, and actively enhance wellbeing.

By embracing the digital revolution, and combining it with the existing skills and expertise of our international community of experts, we are delivering three-dimensional engineering solutions. In doing so, we promote positive interaction between people, improve the quality of the built environment and leave the lightest footprint on our planet.

KEY PERFORMANCE INDICATORS

Sector turnover	£62.9m
As percentage of company turnover	36%

HERE EAST LONDON, UK

We transformed the giant, 51,000m² open-plan shell of the former International Broadcasting Centre into a bold new base for business and technology. A key part of the London 2012 Olympics legacy plan, Here East represents the very best in industrial regeneration, establishing a vibrant hub of innovation that is attracting high-tech creativity and high-value employment to the local area. It is one aspect of our ongoing legacy and regeneration work across Queen Elizabeth Park and the surrounding area, which on its own is set to add £450m to the UK economy.



Image: HawkinsBrown

BOSTON SEAPORT

BOSTON, MA, USA

BuroHappold is working with Genster architects to deliver a new commercial complex in the heart of Boston's Seaport District. The 18-storey tower will provide 15 floors of modern office accommodation, two levels of retail space and underground parking. Its architecture is highly articulated yet timeless, and behind the stunning facade lies a building that is designed with user wellbeing in mind. Features include outdoor terraces on alternate floors, a vibrant public promenade lined with shops and proximity to the new Harbour Square Park.



Image: Genster

ÜBERSEEUARTIER

HAMBURG, GERMANY

Set to become the commercial heart of HafenCity, this architecturally outstanding development includes a shopping mall, multiplex cinema, office buildings, hotels, a cruise terminal and bus station. We drew on expertise from our teams in Berlin and Warsaw to develop an integrated building services strategy that works across this large-scale, complex project. Our final design includes a centralised cooling energy centre that meets the differing load profiles of the various buildings. We also harnessed waste heat to generate 250kW of energy for the shopping mall, resulting in a construction cost saving of over \$1m.



Image: Moka-Studien/Orw

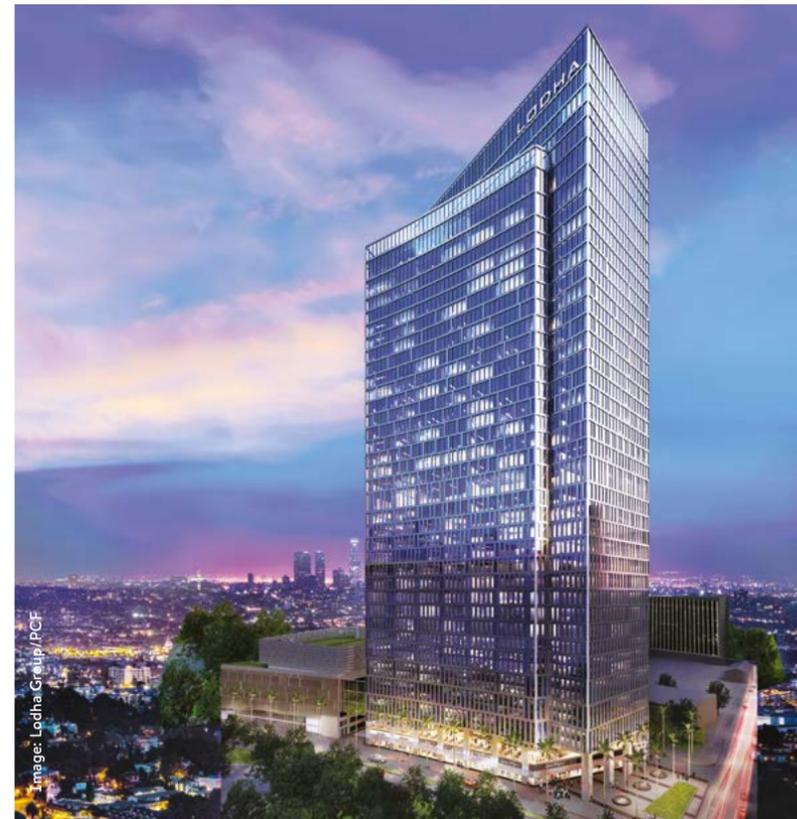


Image: Lodha Group/PCF

ONE LODHA PLACE

MUMBAI, INDIA

This Class A development comprises flexible office accommodation, cutting-edge technology and sustainable building systems. It is intended to attract a diverse mix of businesses, from small start-ups to large companies. Located in Mumbai's busy city centre, the tower had to be constructed on a constrained site to tight timelines. Supporting a low-energy footprint, we developed an intelligent building management system that provides dynamic feedback on performance. We also created MEP solutions with the flexibility to support future growth, ensuring that One Lodha Place will provide a high-quality working environment throughout its lifecycle.

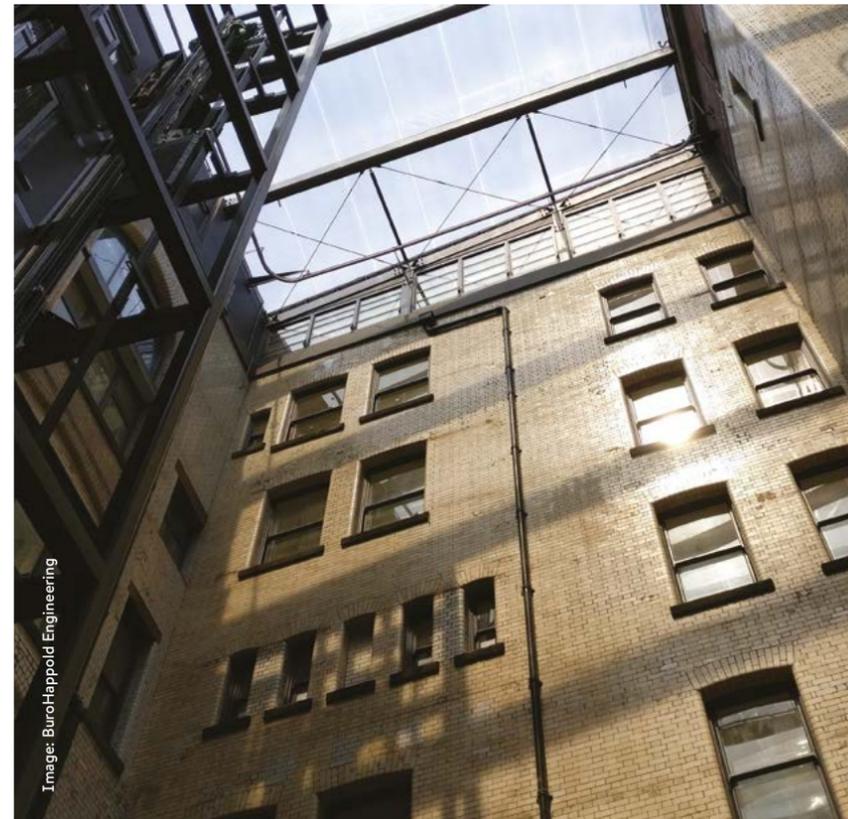


Image: BuroHappold Engineering

HANOVER HOUSE

MANCHESTER, UK

This ambitious refurbishment project unites two of Manchester's architectural jewels to create a prestigious new city centre destination. Revitalising the Grade II listed, Edwardian Baroque Hanover House and adjacent New Drapery Warehouse required a meticulous and sympathetic approach. Our structural and building services engineers undertook detailed analysis work before and during design development. This let us understand how we could reinforce the historic buildings to support striking new features such as the mezzanine floor, the ETFE mansard roof and the dramatic central atrium.

Working capital

Engineering exceptional office space in the heart of London



ALDGATE EAST
LONDON, UK

As a practice that is committed to promoting sustainable design, we are exploring multiple options to find high-performance solutions that are also energy-efficient.



101

Whitechapel High Street is an ambitious, multifaceted development that will provide 50,000m² of high-quality, flexible office space for blue-chip tenants from across the financial, technology and fintech sectors. BuroHappold Engineering was selected to provide a range of services across the project, applying our expertise in creative engineering, complex problem-solving and sustainable design to realise a landmark new development in the heart of London's financial district.

People-centred approach

We understand that the success of any development lies in its ability to meet the needs of the people that will use it every day. That is why our specialist in-house analytics team draws on big data to model and assess the spaces we create. This enables us to optimise our designs for comfort, functionality and revenue generation.

At 101 Whitechapel High Street, our analytics team reviewed the interior of the building – including parameters such as entrance points, lobby space and desire lines to nearest transport links – to provide evidence-based solutions that will improve the user experience. We are also looking beyond the building to inform the design of the public realm and incorporate features that create welcoming, safe and enjoyable surroundings for locals and visitors alike.

Resilient infrastructure

The development's proximity to Aldgate East tube station and two major roads presents the project team with both challenges and opportunities. Initially, it ensures that the new development is well served by existing transport links, which include four nearby Underground entrances and five bus stops.

These assets do, however, make work on an already constrained site increasingly difficult. Our engineers modelled the ground works needed to excavate the basement of 101 Whitechapel High

Street, so that we could present the planning consultants and the London Borough of Tower Hamlets with proof that our work would not impact the existing infrastructure.

Low-carbon design

Large-scale developments such as 101 Whitechapel High Street can have high energy demands. As a practice that is committed to promoting sustainable design, we are exploring multiple options to find high-performance solutions that are also energy-efficient.

Mindful of the London Plan, in which air quality is a key consideration, our building services engineers are assessing various means to condition the interior of this large complex. We are considering using a heat pump system, which is more efficient than traditional, gas-fired provision as it allows heating and cooling to occur at low temperatures. We are developing a highly glazed facade that enables natural light to permeate deep into the building without excessive solar gain. This minimises the need for both artificial lighting and internal conditioning.

Economic vitality

As well as creating an exceptional working environment for a range of businesses – from small start-ups to well-known multinationals – 101 Whitechapel High Street will offer an attractive retail space designed to draw tourists and local residents alike to the area. This will create a more diverse community that flourishes beyond the nine-to-five working day, and ensure the ongoing economic vitality of this vibrant new area. **BHE**

ENGINEERING 4.0

HOW WE ARE USING DIGITAL TECHNOLOGY TO TRANSFORM THE WAY WE WORK

Great design places people at its heart. This has been a guiding principle at BuroHappold since the practice was founded over 40 years ago. We have earned a reputation for creating environments that not only work for people but also actively engage and delight them.

That is why we see the digital revolution as the natural next step in our evolution. Access to big data provides us with greater insight into the way people use and interact with the spaces that we design. New technologies equip us with the tools we need to push the boundaries of possibility and deliver ever more intelligent solutions that can adapt to accommodate myriad user needs for generations to come.

“Digital is about using technology to create human outcomes that were previously unimaginable or impossible,” says Tony Scott, global technology director at BuroHappold. “Already, our adoption of emerging technologies is driving new ways of working across the practice, enabling us to break out of traditional silos and engage in much richer collaboration. As we continue to develop our digital capabilities, there is no limit to the scope of what we can achieve.”

We are always looking for the next challenge to solve. That is why we explore and incorporate the potential of digital technologies at every level. However, with change comes disruption. As we embrace digital methods in place of traditional working practices – and increasingly use virtual reality, augmented reality and artificial intelligence to fulfil functions that were previously carried out by engineers – we are having to reimagine our role.

“We need to review the skillsets we have and adapt them for use in the world of tomorrow,” says Tony. “It takes real courage to see that, but by automating some of the processes we used to carry out ourselves, we can free up the ingenuity and intelligence of our engineers. This allows them to explore emerging technologies and develop new tools that will broaden our offering for clients.”

Having the vision to harness the potential of new technologies to enhance the way we work and design, combined with the agility to transform our practice from within, has positioned BuroHappold as digital leaders in our industry. Our willingness to shed old skillsets in the pursuit of better design is also testimony to our commitment to a better built environment.

“We still need the human skills of empathy, understanding and leadership,” says Tony. “But now, with the onset of the digital revolution, we can augment these and reach beyond our existing capabilities to see, design and shape our world in new and exciting ways.”

The beneficial symbiosis of human experience and digital innovation is exemplified by our pioneering Analytics tool. For over a decade, our Smart Space team, led by group director Shrikant Sharma, has been collating data around human behaviour and the way people interact with spaces. This work has enabled our engineers to visualise the effects of their design decisions so that they can better realise environments that support people’s needs.

Already groundbreaking in its own right, the scope of this work has been pushed even further by our team. By combining the capabilities of

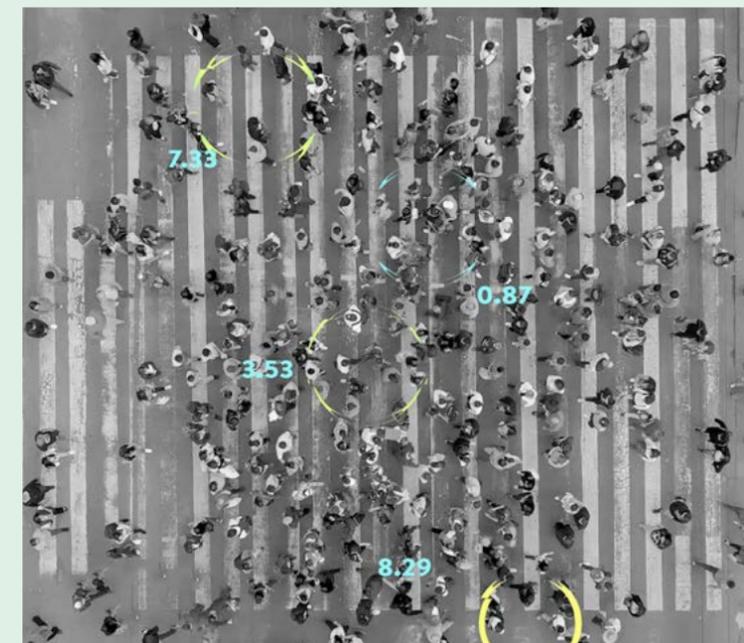
Building Information Modelling (BIM), Geographical Information System (GIS), Internet of Things (IoT) sensors and Agent Based Modelling, they have developed Analytics. This is a powerful data analysis, predictive modelling and optioneering engine that enables us to evaluate the effects of changes and revisions to our designs in real time.

“Analytics is all about bringing technology and humans together,” says Shrikant. “The tool turns data into evidence-based insights so that we can make informed decisions that result in better outcomes.”

“Working in real time, we can interact with the engine, or sketch over it, all while getting live feedback on the effects of our changes. It produces rapid, clear and engaging visualisations. The interface has simple slider bars and 3D walkthroughs that allow people to explore different design options.”

The Analytics engine is rich in data. It contains insights into human behaviour gathered from years of research undertaken by our Smart Space team, together with client data collated on past and present projects. This is bolstered by the continued influx of information from ongoing analysis and access to new sources. Every day, more data is added to the engine; as its wealth of resource grows, so too does its predictive accuracy. This improves our ability to realise environments that are designed around authentic insight into human behaviour and user needs.

Right: The Analytics tool combines several software platforms. This enables us to analyse design decisions in real time and quickly arrive at accurate, evidence-based solutions that benefit our clients.



“Analytics answers what was, for me, the biggest challenge facing the AEC industry,” says Shrikant. “That was the lack of evidence-based design and, as a result, the lack of focus on ultimate outcomes. As engineers, we are responsible for ensuring that the buildings and environments we design work for the people that use them. That’s why we wanted to take the opportunity that the world of data and technology provides to gain a far deeper understanding of the impact our designs have on people along with their wider social and economic consequences.”

This revolutionary tool is being used across our practice to great effect; it informs everything from devising an intuitive passenger journey through an airport to realising office buildings that encourage collaboration and improve employee wellbeing. It is also strengthening our relationships with clients, as it gives us the opportunity to invite them into our design process. This creates more transparency and allows us to work together to arrive at evidence-based decisions that fulfil their requirements.

Analytics provides us with the means to analyse the past, change the present, and predict the future. In doing so, it ensures we deliver the best experiential outcomes for people, the most economic and efficient solutions for our clients, and that we can actively shape a better built environment for us all.

We believe that people work better together. We also appreciate that we can only create environments that truly perform for everyone if a diverse range of experience, knowledge and perspectives has contributed to their design.

We believe that people work better together. We also appreciate that we can only realise environments that truly perform for everyone if a diverse range of experience, knowledge and perspectives has contributed to their design.

It is this premise that underpins another area of digital innovation within our practice – the creation of an open source Buildings and Habitats Object Model (the BHoM). Developed by BuroHappold directors Al Fisher and Rob May, the BHoM is an industry-wide computational project that aims to support greater collaboration between AEC professionals by enabling architects, engineers and contractors to standardise design data and share code.

“The BHoM is our response to the challenge we face as an industry to work together more effectively,” says Al. “Its core purpose is to tackle the problem of interoperability between software, so that we can transfer design models between platforms efficiently without losing information. To achieve this, we needed to establish a common language across the different software that is used to define design objects and features.”

“The process has been a real learning curve,” says Rob. “It revealed that the way we described objects, even within BuroHappold, was different depending on which discipline we worked in. So we had to release a lot of unconscious bias across the practice to collectively agree on simple, basic definitions of objects, and in doing so establish a discipline-agnostic base to work from.”

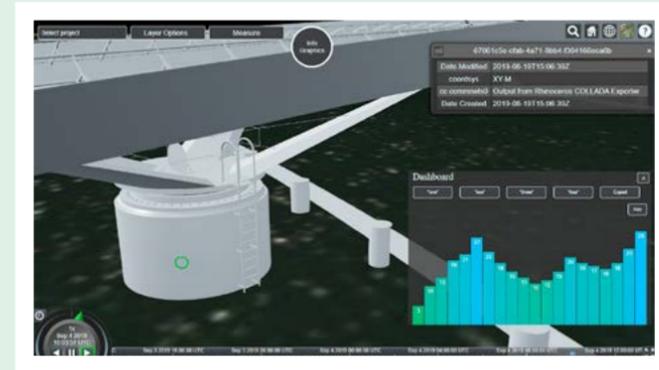
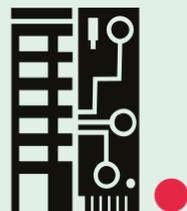
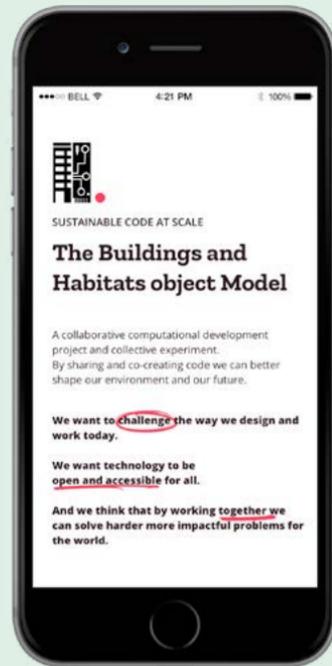
From this point, Al and Rob were able to develop a common language that engineers within BuroHappold can use to pass information between software. They then looked at how to structure the BHoM so that, unlike any other building software, it allows hundreds of people from across the AEC industry to contribute to it. This was key to its success.

“We are not architects, and we are not contractors,” says Rob. “We don’t have the expertise in these subjects to build out that part of the BHoM. That’s why, on 21 December 2018, we open-sourced the code to everyone. Our aim is that, between us all as an industry, we can work towards a common design language.”

The BHoM is still in its infancy, but by establishing a shared design language that is cross-discipline, software-agnostic and location invariant it has sparked a new conversation about the way we work across the AEC industry. Indeed, BuroHappold is part of an industry-wide consortium tackling data exchange through open source frameworks. With a £1m grant from Innovate UK, this project – AEC Delta Mobility – aims to improve productivity, performance and quality.

Below:
The BHoM is our response to the industry challenge of working together more effectively. It establishes a common language across software so that we can design collaboratively.

Facing page:
GIS enables us to create digital twins of real-world assets to capture valuable performance insight and explore it via an interactive dashboard.



As well as creating new tools within our practice, we are looking to transform existing workflows by integrating additional digital capabilities. We have used GIS to explore design options more rapidly, develop integrated solutions across disciplines and ensure the overall design quality. Now, however, we are developing GIS technology for use in a more complex and ambitious format, which will reimagine not only the way we design the urban realm but also the remit of our role within it.

“For the last year, we have been looking at ways to expand our GIS footprint,” says Anthony Tuffour, associate director and GIS lead. “Integrating more information into our models so that we can move beyond creating 2D maps and, instead, build data-rich 3D replicas of assets in the digital world.”

These complex 3D models are called digital twins. Comprising intricate layers of data gathered from an array of sensors and sources, these twins are linked to connected technologies that allow for real-time environmental and system data capture. This information is used to adjust and fine-tune the performance of physical assets – ranging from street lamps and traffic lights, to bridges and buildings, entire cities and even countries.

“The concept that digital twins revolves around is the collection of data, both past and present, and applying it to monitor the performance of physical assets in real time,” explains Anthony.

“Using data in this way enables us to predict future scenarios, identify potential issues and rectify them before they occur. Doing so also improves the efficiency of our designs, minimises downtime, and makes the built environment a more accessible and enjoyable environment for people to exist in.”

“What would normally be done manually and painstakingly over weeks, months or years, can now be done digitally, to advance that process,” adds Irfan Soneji, digital services director. “The use has been somewhat limited, but that has changed now. We’ve expanded our understanding of how we can build different assets — a dustbin, a lamppost, a building, or anything in the public eye. We use the information available for that particular asset, and effectively replicate that into the digital world.”

“Take an example of a building, or a mug, or a pen — wouldn’t it be useful if we could mimic and replicate that in the digital world, to be able to learn from it, do simulations on it, understand how we would want to modify and change it, and then see what effects that has in the real world?”

Whether our findings inform switching streetlights on at the right time to improve safety, adjusting traffic lights according to the density of vehicles on the road, or monitoring the usage of city wide energy grids to understand where resources are being spent and where they can be saved, digital twins are allowing us to develop intelligent, responsive and agile infrastructure across our cities.

“As well as enabling us to monitor our designs more precisely, understand their performance and prevent potential problems, the use of digital twins also allows us to establish an ongoing relationship with our client throughout the lifecycle of our designs,” says Anthony.

“This changes the role we play in shaping the built environment. No longer do we deliver a project over, say, five years, and then step away from it. Rather, we stand by our work, continually assessing the performance of our designs so that we can gather ongoing data to inform our understanding of their efficacy, and rectify any issues we may discover.”

By remaining involved, we are able to adapt and enhance designs to make them increasingly responsive to human need. Digital twinning provides us with the capability and proximity to ensure the spaces that we design are equipped to face multiple challenges.

The decisions we make during the early stages of our design process have a lasting impact on the social, economic and experiential outcomes for generations to come. It is this responsibility that drives us to seize the opportunities that technologies afford to gather greater insight into the effects of our work. This empowers BuroHappold to deliver solutions that make life better for us all. **BHE**

CULTURAL

Museums are no longer receptacles for the past, but places of encounter. Concert halls are no longer the reserve of classical music, but open for the enjoyment of every genre. Art galleries are no longer silent spaces, but dynamic places that spark conversation.

A practice that thrives on a challenge, we are excited by the way in which our consumption of culture is changing. Building on a long tradition of anticipating trends to create venues that delight audiences worldwide, we are now adapting and developing new experiential analysis techniques. This allows our team to reach beyond expectation and defy convention to deliver the extraordinary.

In Dubai, we have harnessed artificial intelligence to disrupt the architectural landscape and create the world's first torus-shaped building with the Museum of the Future. In China, we have transformed the traditional library model by connecting quiet places for reading and reflection with outdoor spaces that ignite the imagination. In the USA, our analytics experts are using bespoke visualisation software to devise a seamless and intuitive visitor experience at the Los Angeles County Museum of Art.

Stephen Jolly
Cultural Sector Leader



As well as realising immersive environments for visitors, these tools allow us to deliver more for our clients by offering unique insight into the way that people use the spaces we create. They allow us to test and analyse a variety of design options, using big data to arrive at evidence-based solutions that we know will improve dwell times in retail areas, while reducing queuing and congestion around other amenities. By working closely with the wider design team, our clients and stakeholders, we are able to arrive at outcomes that are certain to add value across the board.

This vision sets our work apart, creating cultural venues that unite people in the shared experience of truly unforgettable surroundings. It is the creativity of our people that drives these innovations in design and technology. That is why we continually strive for greater collaboration across the practice, drawing expertise from our international network of built environment specialists to assemble the best team for every project we undertake.

This inclusive ethos, coupled with our forward-looking approach to design, allows us to stay one step ahead in the ever-evolving cultural landscape – realising world-class venues that inspire contemporary visitors, deliver real value for our clients, and encourage social and economic growth within the surrounding communities.

KEY PERFORMANCE INDICATORS

Sector turnover	£31.4m
As percentage of company turnover	18%

XIQU CENTRE

WEST KOWLOON
CULTURAL DISTRICT,
HONG KONG

Behind the sinuous curves of the Xiqu Centre's iconic facade lies a cultural sanctuary that blends theatre, art and the public realm. Seven teams from across BuroHappold have been involved in creating this landmark venue, reimagining the role of the cultural centre in society to realise fluid spaces that blur the interface between inside and outside. The result is a venue that invites the public in to experience its sumptuous interior, encouraging them to enjoy and interact with a variety of dynamic spaces, which in turn have the flexibility to adapt to support a diverse international arts programme.



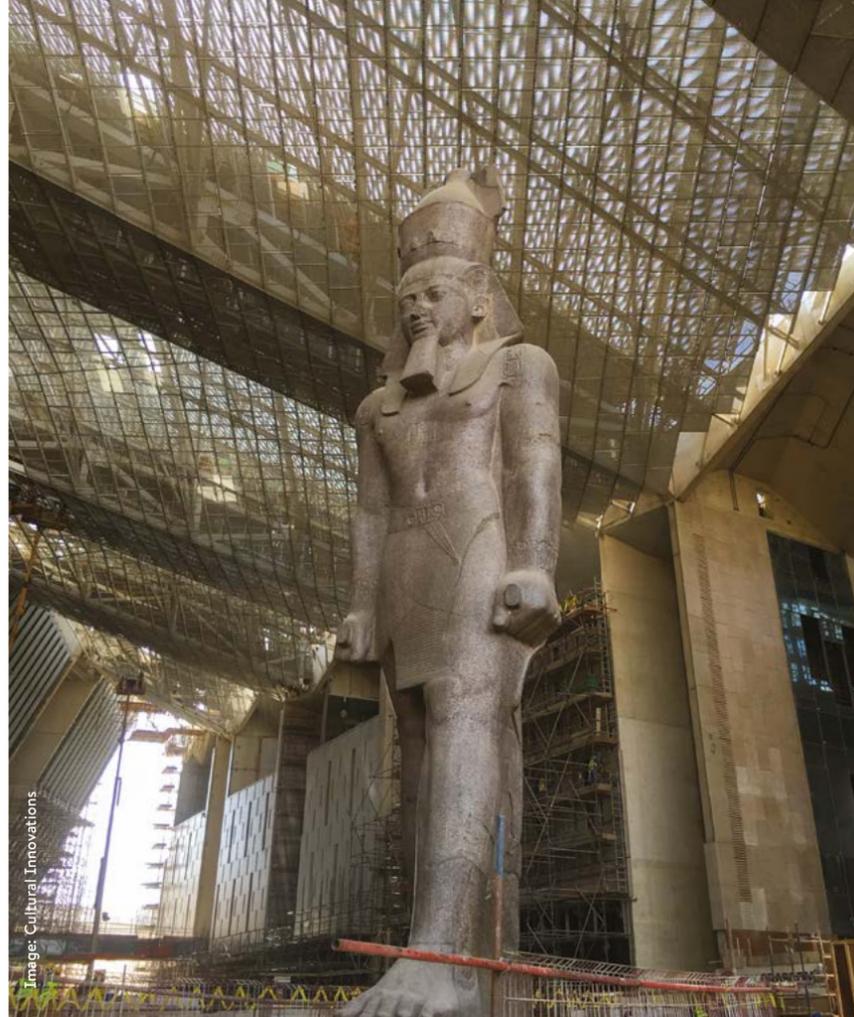


Image: Cultural Innovations

GRAND EGYPTIAN MUSEUM

GIZA, EGYPT

Monumental in scale yet insightful in approach, this remarkable feat of architecture and engineering earns its place beside the pyramids. With a long history of delivering pioneering low-energy solutions in some of the most extreme climates around the world, our building services specialists devised passive strategies that can both preserve the priceless artefacts within the museum and maintain a comfortable environment for visitors all year round.

THE FACTORY

MANCHESTER, UK

Building on the success of the Manchester International Festival, The Factory supports performance, visual art and popular culture with an audience capacity of up to 7,000. The venue stands on the former Granada Studios site – our team engineered the existing character of the area into the new structure by retaining features such as historic rail arches. BuroHappold's structural and building services engineers worked together to realise interconnected performance spaces across the large warehouse building and its adjoining theatre. Equipped with a full technical grid, these spaces have the flexibility to be subdivided or work in tandem to provide a unique spatial and technical backdrop for artists to create and present work.

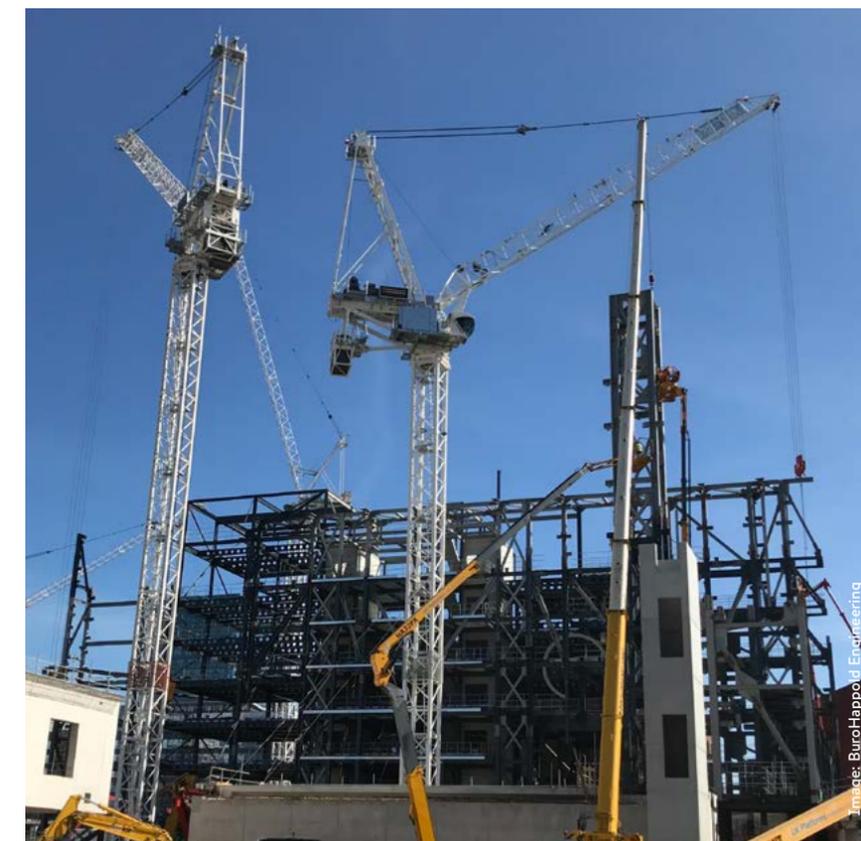


Image: BuroHappold Engineering

NG20 MUSEUM

BERLIN, GERMANY

Envisaged as a place of exploration and encounter, the NG20 is designed to spark interaction and invite dialogue around the 20th-century art collection that it will house. In our role as building services engineers, we have developed an innovative air curtain that will allow the museum to throw open its doors. This removes the barrier between inside spaces and the outside world by creating a buffer to ensure that the internal climate stays comfortable for visitors. On completion, NG20 is set to become a modern masterpiece that can stand alongside existing architectural landmarks the Neue Nationalgalerie and the Philharmonie, which already define Berlin's Kulturforum.



Image: Herzog & de Meuron



Image: Diller, Scofidio + Renfro

CENTRE FOR MUSIC

LONDON, UK

The Centre for Music will bring three leading cultural institutions together within one spectacular venue in the heart of London. Our analytics team are using in-house visualisation software to inform our development of a highly efficient, integrated engineering strategy that responds to both the compact site and the verticality of the scheme. This collaborative approach will ensure that we can realise the porous, multi-layered concept for the centre along with the complex ensemble of public, performance, education and commercial spaces it contains.

**ACADEMY MUSEUM OF
MOTION PICTURES**
LOS ANGELES, USA

Movers and shakers

Structural security to safeguard an icon



THE MEP STORY

Step behind the scenes for an exclusive tour of our design with associate MEP engineer, Joseph Williams.



The three bridges have custom connections that can absorb movement during an earthquake.

If the theatre moves left or right, each bridge rotates on low-friction movement joints.

If the theatre moves backwards or forwards, the bridges can slide along tracks within the building.

Designed by Prizker Prize-winning architect Renzo Piano, the Academy Museum of Motion Pictures will bring the magic of the silver screen to life. We are working across the renovation of the historic Saban Building and the realisation of a glittering new 1,000-seat theatre, providing integrated engineering solutions that will unite the two venues and ensure an unforgettable visitor experience.

Safety in the event of an earthquake was a vital consideration in the design of the new orb-shaped theatre, and our structural engineers were challenged to come up with different yet compatible solutions for the two buildings.

To preserve the character and integrity of the Saban Building, we strengthened its existing steel and concrete structure so it could withstand the force of an earthquake. We were able to flex our creativity when it came to the theatre, undertaking in-depth analysis to develop an innovative base isolation system that allows the entire building to move up to 30 inches in any direction during an earthquake. Such was the elegance of this solution, it has been exposed as a design element in the final building. **BHE**



Image: Renzo Piano Building Workshop



SPECIALIST
Q&A

Davood Liaghat
Head of Bridge
Engineering and
Civil Structures

“A good bridge is one that shows you what it is. It’s about that beautiful structure.”

What’s your role in the bridge team?

I’m the director and I lead the team. It’s a fair-sized team that has built up over the years. There was no bridge group at BuroHappold when I joined – 2019 is our twentieth anniversary.

What makes a good bridge?

A bridge’s structure is all apparent. We don’t generally clad it. You can see how a well-designed and executed bridge works in terms of the flow of forces, how the loads are taken down to the foundations and the best engineering judgement, which means making it slender. A good bridge is one that shows you what it is, so it’s about that beautiful structure.

So what makes a bad bridge?

Poor design. Have you ever been on the M25 going towards Gatwick Airport? There’s a pedestrian bridge, lots of cables. A very clunky mast, necessarily huge structure. The proportions don’t seem right.

Are there recurring challenges for bridge projects?

Bridges tend not to generate income. It’s usually more about providing social need and functionality than financial gain. So the challenge is to give every client that comes to us the most efficient, cost-effective bridge that we can deliver.

Bridges seem to be quite quick to construct. Is that because there aren’t loads of different disciplines involved?

That’s one of the things I absolutely love about bridges! Of course, we use other disciplines as and when we need it, such as support from our ground engineers and lighting experts. Yes, we work as a team – don’t get me wrong, I love working as a team – but the structure, as I explained, is very much what it is.

Do you subscribe to the romantic idea that bridges bring people together?

Absolutely. We did a bridge over the River Tiber in Rome – the Ponte della Musica – which I started in 2000. For various reasons, it took 12 years to do. I developed a great passion for it. Who wouldn’t? It was one of the first bridges over the Tiber for a long, long time. Enthusiasts and friends who go there send us photographs of it being used for concerts and fashion shows. People do yoga on it. Some bridges need to become a place of their own.

Which projects have you found especially rewarding lately?

We’ve recently completed a major piece of infrastructure in Sunderland. That bridge is called the Northern Spire, which crosses the Wear. Last year that was the third biggest bridge being built in the UK. Another great project of ours is a moveable bridge across Copenhagen harbour, known as the Lille Langebro, which has just opened to the public. That one is so popular. In July, people were diving off it to get cool. It’s got a sloping side so the kids slide down it and jump into the water. Wonderful.

I’ve heard something about the “total podium offer” that you’re developing...

Let me explain. “Podium” is a generic term for the platform leading to and surrounding a venue or a development where the building has to overcome some obstruction, whether it’s a road, railway or tunnel. These days, because of lack of space, there’s a lot of pressure to build over those existing assets. To accomplish that, a lot of coordination and technical analysis has to be done. Podiums are places where you get people and traffic going – a perfect example is the Emirates Stadium in north London – so around it you need to have roads and platforms to get people in and out safely. They’re complex structures.

Where does BuroHappold come in?

That kind of project requires many disciplines – not just for the structure, it’s also about things like crowd flow, safety, security, utilities and drainage. If you’re the owner of a venue you have the headache of sourcing and managing each of those specialities. We’ve got the experience to bring that package together and run it for the client.

What interests you about where the bridges specialism is heading?

There are challenges in terms of technology, new materials and delivering efficiently. The future has to be about enabling these three matters to improve. Take the first point of how we can improve our computational work. Software has made the analytical process faster. We’ve got quite a lot of these tools but they don’t necessarily talk to each other. They need to be talking to each other more efficiently.

What is the advantage of that?

Improving communication using a common data format means that we can automate model creation, which saves time and cuts human error. We’re doing code work to facilitate these processes, so something that would have taken two weeks can now be done in a couple of days. That allows us to devote more time to the creative side of our work while improving accuracy and safety. I must emphasise that, because when you mention it to clients they say, “Great, I can pay you less and you can do it in half the time.” It’s not always about getting everything done faster, of course.

What’s the next big project on the horizon for the bridge team?

We’re doing a major bridge over the Danube in Budapest. That’s estimated at 180 million euros, which is a different scale of project for us. I’m looking forward to that. Hopefully, it won’t take 12 years like the one in Rome.

SCIENCE AND TECHNOLOGY

KEY PERFORMANCE INDICATORS

Sector turnover	£13.1m
As percentage of company turnover	8%

What defines a science and technology project? Complexity, and the need for flexibility over time. The complicated nature of laboratory design means providing facilities for different scientists and researchers, who all have specific requirements. The Quadram Institute, which opened this year, houses a hospital, university and a government research institute, all with specific needs. Our role as design engineers was not only to accommodate these needs now, but also to be adaptable enough to evolve our design during the project.

Our recent project wins demonstrate the trend for placing scientific institutions within cities. Scientific centres used to be in secure countryside locations, but increasingly – especially in London, New York and Boston – research companies and universities are building clusters of interconnected institutions to stimulate innovation and increase productivity. This connectivity is appealing to researchers and scientists, many of who prefer to work near amenities, transport links and their peers. The Alexandria Centre for Life Science North Tower reflects this trend, and is also the tallest laboratory building

Andy Parker
Science and Technology Sector Director



that BuroHappold has ever engineered. The 23-storey building on the shores of the Hudson River will complement the high-spec East and West Towers.

A huge part of our work in this sector involves securing and cementing relationships with our clients. We have close links with UCL and The Dyson Institute of Design Engineering at Imperial College in the UK; in the US, we have similarly strong bonds with Brown and Arizona State University. Our impeccable reputation has also allowed us to join the Oxford University Framework, which means that we are guaranteed work on high-budget, high-profile research buildings for years to come.

BuroHappold science and technology engineers demonstrate, again and again, their insight, flexibility, skill and tenacity on every project we do. We design buildings that give scientists the freedom to work in a way that inspires them, giving them the space and tools to make a difference to the world. This makes me very proud, and drives me and the team to design and build better, every year.

QUADRAM INSTITUTE NORWICH, UK

Arranged over five storeys, the Quadram Institute is a interdisciplinary facility dedicated to food science, gut biology and health. The first of its kind in Europe, the £60m facility opened its doors in 2018 to provide a flexible space for three organisations – the Institute of Food Research, the University of East Anglia and departments from the Norfolk & Norwich University Hospital – while providing state-of-the-art facilities for NHS patients. Our work has contributed to the creation of spaces that encourage interaction, offer exceptional laboratories and reduce emissions.



Image: NBBJ Architects and photography by Nick Gutteridge



Image: NBBJ Architects and photography by Luke Hayes



Image: Kennedy & Violich Architecture

WELLESLEY COLLEGE, GLOBAL FLORA COLLECTION AT THE MARGARET FERGUSON GREENHOUSES

WELLESLEY, MA, USA

A research platform for exploring the interface of biology and the physical sciences in the built environment. This 6,200ft² greenhouse enclosure includes desert and Mediterranean-type climates, subtropical wetlands and tropical habitats, plus an exterior cold zone. BuroHappold's goal was to minimise the facility's carbon footprint and use of potable water supply, while maximising sunlight penetration and minimising heat exchange requirements. ETFE pillow technology minimises structural weight and creates maximum transparency for the plants.

ARIZONA STATE UNIVERSITY, INTERDISCIPLINARY SCIENCE AND TECHNOLOGY BUILDING VII

TEMPE, AZ, USA

A 258,000ft² research facility and comprehensive addition to Arizona State University's growing research district on the Tempe campus. BuroHappold is providing integrated engineering services for the facility, and one of the key challenges is striking a balance between creating sufficient daylight at the same time as minimal solar gain. Our facade consultants used both the specific form and material of each facade system in the building, which are informed directly by the sun path, to balance the light and heat.



Image: Architectonics Group



Image: BuroHappold Engineering

SIR MICHAEL UREN BIOMEDICAL ENGINEERING HUB

LONDON, UK

The Michael Uren Biomedical Engineering Hub is a new purpose-built facility on the Imperial West campus at White City, London. The centre houses life-changing research into new and affordable medical technology, helping people affected by a diverse range of conditions. The building comprises a mix of laboratory and office space for interdisciplinary, translational research initiatives at the interface of biomedical sciences and engineering.

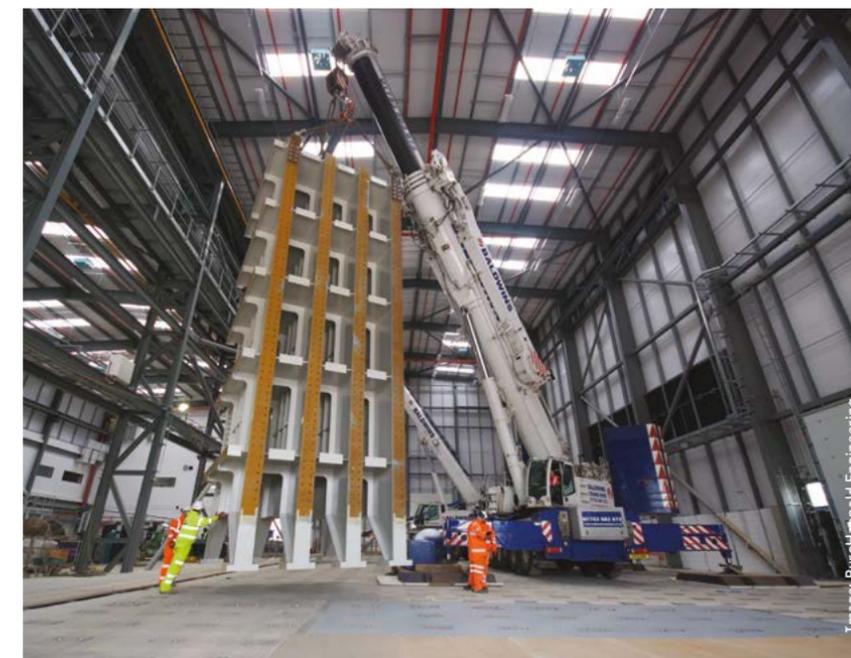


Image: BuroHappold Engineering

AIRBUS WING INTEGRATION CENTRE

BRISTOL, UK

BuroHappold is designing a bespoke strong wall and floor for this flagship aircraft wing testing facility. Both elements needed to be designed to the highest execution class, which is usually reserved for nuclear testing plants. Accordingly, we specified a steel modular reaction wall and a floor that features 663 high-capacity anchors held within tolerance by a system of trusses. A 3D model of the floor reinforcement enabled the contractors to install each element accurately and quickly.

Meeting of minds

Creating spaces for big ideas

Good ideas happen when people interact. In a laboratory, university or research institute, people tend to have chance encounters in corridors, at the coffee point or near meeting rooms. But what if a building could increase that connectivity? What if we could “engineer” those chance meetings, making them not only more likely to happen, but also increase their depth and meaning?

As part of BuroHappold’s analytics service, our science and technology team have developed a tool that does just that. By modelling a day-in-life of your building, we map people flow, behaviours and activities, looking at connections and stopping points. Our new designs then increase the opportunities for these chance interactions, making the environment more appealing to people, and ultimately increasing productivity and quality of outputs.

BuroHappold’s Lab Analytics assessment tool

The effectiveness of research environments is a complex issue and easily overlooked as being too difficult to assess, predict or optimise. Each year, UK organisations invest billions on research. How to use that budget wisely is a key question for every institution. Should it be spent on people, equipment, capital projects for new refurb facilities or investment in small, start-up research firms? We are developing a data-driven approach to facilitate these decisions, which ultimately improves predictability and research success.

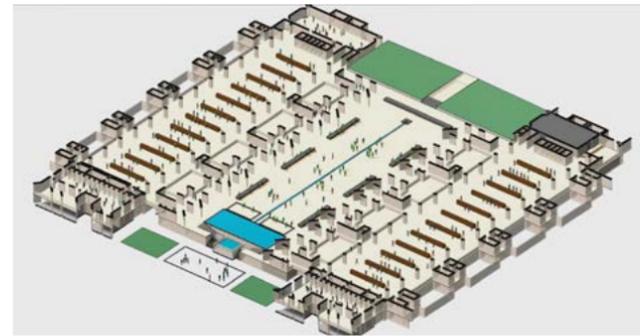
Studies on workplaces and labs have shown that several factors impact the quality and efficiency of working environments. These factors include the quality of the spaces, the organisational structure and culture, communication patterns, types and diversity of people employed and operational processes.

Combining these factors and studying them provides a powerful, holistic assessment of the effectiveness of the research environment. When incorporated into an interactive assessment tool benchmarked by big data, we analyse a diverse range of options and refine strategic, design and operational decisions that maximise outcomes for every client.

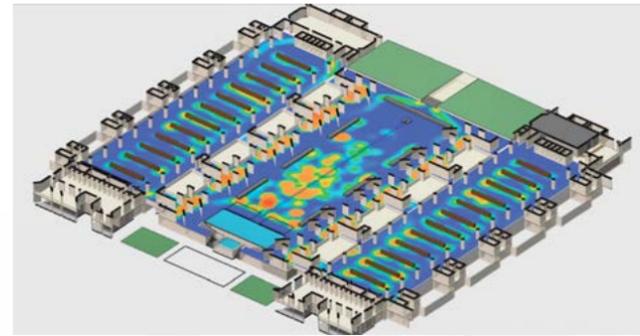
Our strategic assessment tool helps research organisations to understand where they stand and which parameters can be leveraged to efficiently maximise research effectiveness. **BHE**

Productivity in a research environment means generating good ideas and acting on them. We want to increase that productivity by modelling and then adjusting the environment to optimise it for every person who works there.

Andy Parker, Science and Technology Sector Director



The Lab Analytics tool being used to model movement and areas of congregation within a scientific research institute.



LAB ANALYTICS

What factors affect productivity in a science or technology environment?



ENVIRONMENT

- Temperature
- Humidity
- CO₂
- Noise
- Light



PEOPLE

- People location
- Footfall
- Level of interaction
- Dwell time
- Productivity
- Movements
- Diversity
- Culture



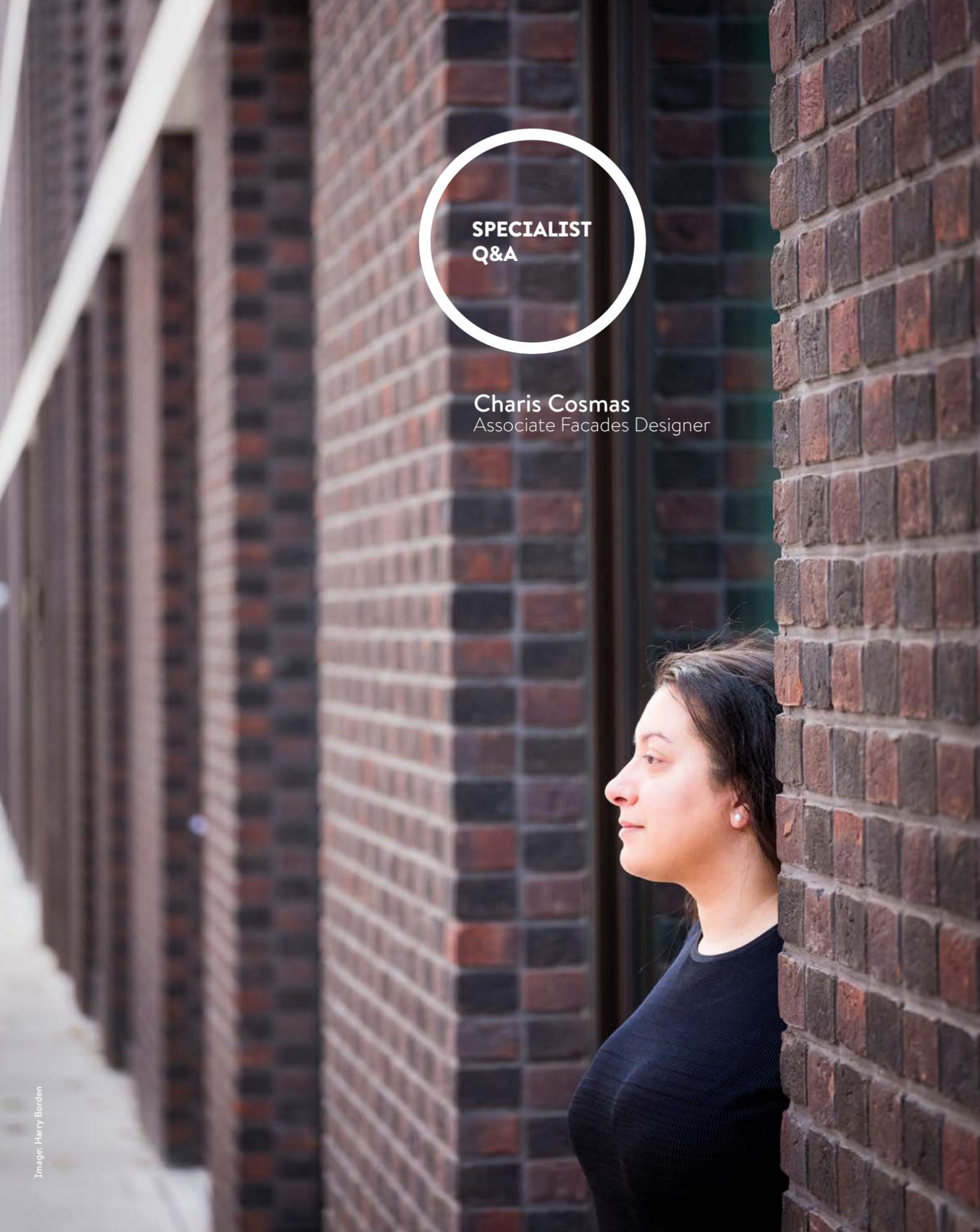
SPACE

- Space utilisation
- Meeting room utilisation
- Desk utilisation
- Elevator vs. stair usage
- Visibility



Learn more about Lab Analytics.





SPECIALIST
Q&A

Charis Cosmas
Associate Facades Designer

“Taking an advisory role and developing relationships lets us help clients in the best possible way.”

When you tell people that you're a facades engineer, what tends to be their next question?

What's that? I'll usually explain that I take what an architect has dreamt up and make it feasible. Also, there's typically a variety of requirements that the client wants, whether it's residential or commercial, and all of them have a slightly different emphasis. Cost is often a large factor, but always balanced by the performance and technical requirements. It's considering all of these various things.

I guess a common assumption might be that facade engineering is all about how the building looks...

It is important, how it looks, but the facade is a complex part of the building. We collaborate with most disciplines – a big one is acoustics, especially on urban residential projects. When a building is surrounded by traffic and railway lines there are strict noise requirements, but you also want to have a delicate facade that can be ventilated and looks good with lots of light coming in. The more open you make something, the more noise ingress you're going to have, so it's about looking for the magic space where that tension comes together and we can create something great.

Where does the facade begin and end? Does the front door count?

Yes. When you look at a building, everything you see on the outside to the internal – what you touch on the inside – is a facade. The full wall build-up and the insulation all count. The glazing. The frame holding the glazing. The solid wall. You're layering on components that overlap and affect each other. Something that benefits you in one area might negatively affect another. It's that marriage of the different components and performances that you're trying to find.

How important is technology in getting the best results?

We've been using computational analysis and scripting to enable what we do for a long time. More and more now, we're collaborating with architects on this. If we have a script, then we share that with architects or we link the two together. Once you start and get into a rhythm with it, that can be really powerful.

Can the simplest facade sometimes be the most challenging to realise?

Definitely. Whiteleys is my big project at the moment, which is a £1 billion development of an iconic heritage building in west London. There's a retained facade and then there's a whole masterplan of new buildings and facade elements. Even though it looks simple and crisp, the facade is actually very complex. It's a steel window system on a large scale. That's rare, but we've learnt a lot from similar work that we've done on Battersea Power Station, which has proved beneficial in making this project a success. Assisting the client in understanding the procurement routes and which contractors could deliver it was one piece of the puzzle. There's a lot more complexity to it than meets the eye... which has been fun!

Is it accurate to say that facades are subject to trends?

Yes. At the moment precast concrete is in. There was a time when terracotta was fashionable. Glass is always popular. What's becoming a trend – well, not a trend, more of an impactor – are energy performance and sustainability requirements, which are getting more stringent as climate change becomes a dominant global issue. Meeting those while maintaining the visual is becoming increasingly challenging. Finding ways to make all that work and really deliver the best value is the new frontier of how to push things forward.

What would you say is a facade crime?

I'd say a facade that is not created holistically with the building, which is when the design is crowbarred in later and achieves less elegant and efficient results. Also, glass quality. It's got better over the years, but getting that glass quality can be difficult to achieve or hard to control without the right specification. That's something we really hone in on – we have a very strong specification. Another thing about glass is that it's supposed to be transparent, so if it's not – or it has weird reflections – that tends to stand out, I find.

Are there common challenges for facade engineering wherever you are in the world?

We're a global team. I lived and worked in Hong Kong and Beijing for three years. It doesn't matter where you are in the world, each client has a different story and something central that really matters to them. It's about listening and responding to that. One client might just want the building done really quickly. For another, it's all about getting the quality but keeping costs down. Then you're looking at repetition, how you can get the most out of materials and the best reduction in the depth of the facade. More internal area usually means more value.

So the odd centimetre here and there adds up across an entire building?

Exactly.

What do you think is special about what the facades team offers our clients?

Obviously, we are technically on top of our game. We also work within the wider specialists group so we can draw upon other expertise. Most importantly, we develop close relationships with our clients by listening to their needs. Understanding what they want lets us deliver the best possible advisory role.



Karl Lyndon
Aviation Sector Director



Justin Phillips
Rail Sector Director

AIR AND RAIL

Airports and rail stations are places of possibility. They connect people across cities, countries and continents, and open up vital gateways for commercial exchange. For over 40 years, we have been aligning the aspirations of our clients with the changing expectations of international travellers and increasingly complex market needs. By shaping projects at the earliest stage, we can realise high-performance, world-class transit hubs.

As leaders in the digital built environment, we are embracing new and emerging technologies to enhance all aspects of our practice. Within the Air and Rail sector, we are developing pioneering computational programmes that enable us to design and deliver exceptional facilities that have the lightest impact on our planet.

Take, for example, Beijing Daxing International Airport. This landmark facility is set to become the largest terminal in the world, serving 45 million passengers upon opening with the capacity to expand to 75 million. Our engineers were able to weave passive and sustainable practices throughout its design, resulting in a 50% reduction in energy consumption.

We are also drawing on big data to generate multidimensional virtual models that allow us to fully explore the consequences of our designs and deliver evidence-based engineering solutions. Our unique Passenger Analytics tool uses data to generate real-time models that map people movement through a space, so we can rapidly test scenarios and design options to reduce risk, optimise financial return and ensure an unrivalled passenger experience.

By marrying modern technology with our knowledge and expertise gained over years working in this sector, we continue to deliver projects that amaze and delight. Across the world, airports such as Oslo Gardermoen and New Heydar Aliyev – and rail stations such as West Kowloon Terminus and Anaheim Regional Transportation Intermodal Center – will remain in the memories of travellers for years to come.

KEY PERFORMANCE INDICATORS

Sector turnover	£9.1m
As percentage of company turnover	5%

BEIJING DAXING INTERNATIONAL AIRPORT BEIJING, CHINA

User-focused, energy-efficient, and built with the flexibility to sustain growth, Beijing Daxing International delivers a unique passenger experience. Environmental drivers, adaptability and intuitive ease of navigability were key in the development of our concept. We worked extremely closely with Zaha Hadid Architects to integrate the engineering design into the form, allowing us to render the spacious areas desired by our client. Highly functional and aesthetically impressive, the result is an iconic terminal that sets a high bar for the future of sustainable aviation.



Image: Getty Images/ansoniiao



Image: BueroHappold Engineering

WEST KOWLOON TERMINUS STATION

WEST KOWLOON CULTURAL DISTRICT, HONG KONG

West Kowloon Terminus Station is one of the most technically demanding projects that we have worked on in recent years. We drew on expertise from 11 of our offices around the world to push the boundaries of structural engineering in realising the unique free-form shape of the vast, 200m-wide terminus roof. Our bridge engineers designed the seven walkways that radiate out from the main station, creating a cohesive route through the main complex and a striking visual addition to this spectacular gateway to Hong Kong.



Image: Gerber Architekten/bloomington

OLAYA METRO STATION

RIYADH, KINGDOM OF SAUDI ARABIA

Olaya is one of three architecturally significant stations among the 85 that comprise the Riyadh Metro system. It is also one of the largest and busiest. Our analytics experts mapped the movement of people through the station to ensure it provides a seamless and coherent passenger experience, advising on everything from the placement of stairs, lifts and escalators, to the planning of the retail concourse. Our work also showed that the internal floor area and number of ticket gates could be reduced without impacting passenger flow, which saved overall building costs.

PITTSBURGH AIRPORT TERMINAL MODERNISATION

PITTSBURGH, PA, USA

As Pittsburgh continues to establish itself on the world stage, the modernisation of its airport will provide the city with a high-performance, cost-efficient facility that attracts more flights, more tourists and more businesses to the region. Addition of a new terminal with 51 departure gates will consolidate check-in, ticketing, and security and baggage operations while creating attractive indoor and outdoor plazas. On completion, this project is expected to extend the life of the airport by 40 years and generate approximately \$1.66 billion in economic activity for the region.

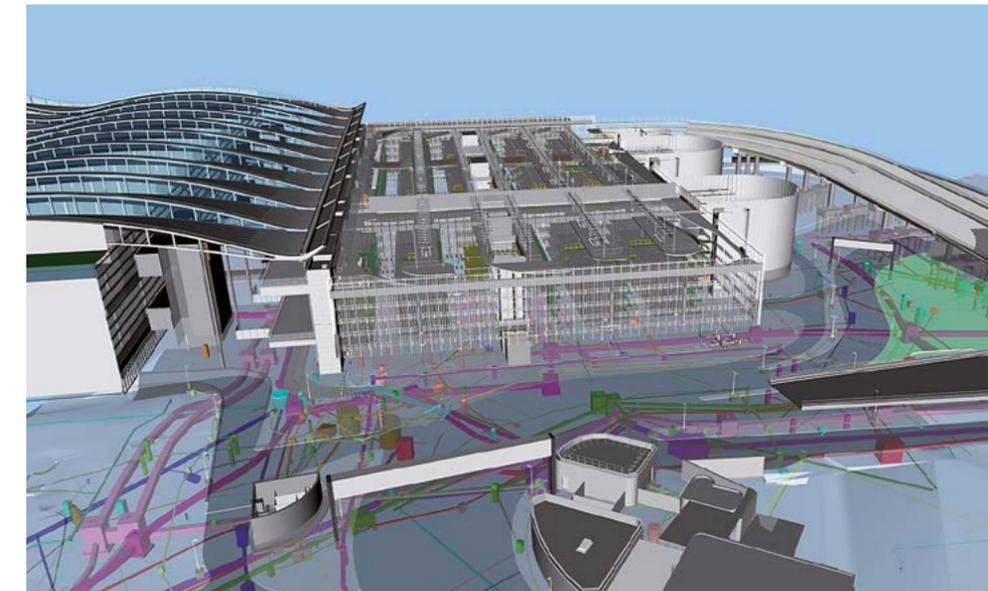


Image: Gensler + HDR in association with Luis Vidal + architects

HEATHROW AIRPORT

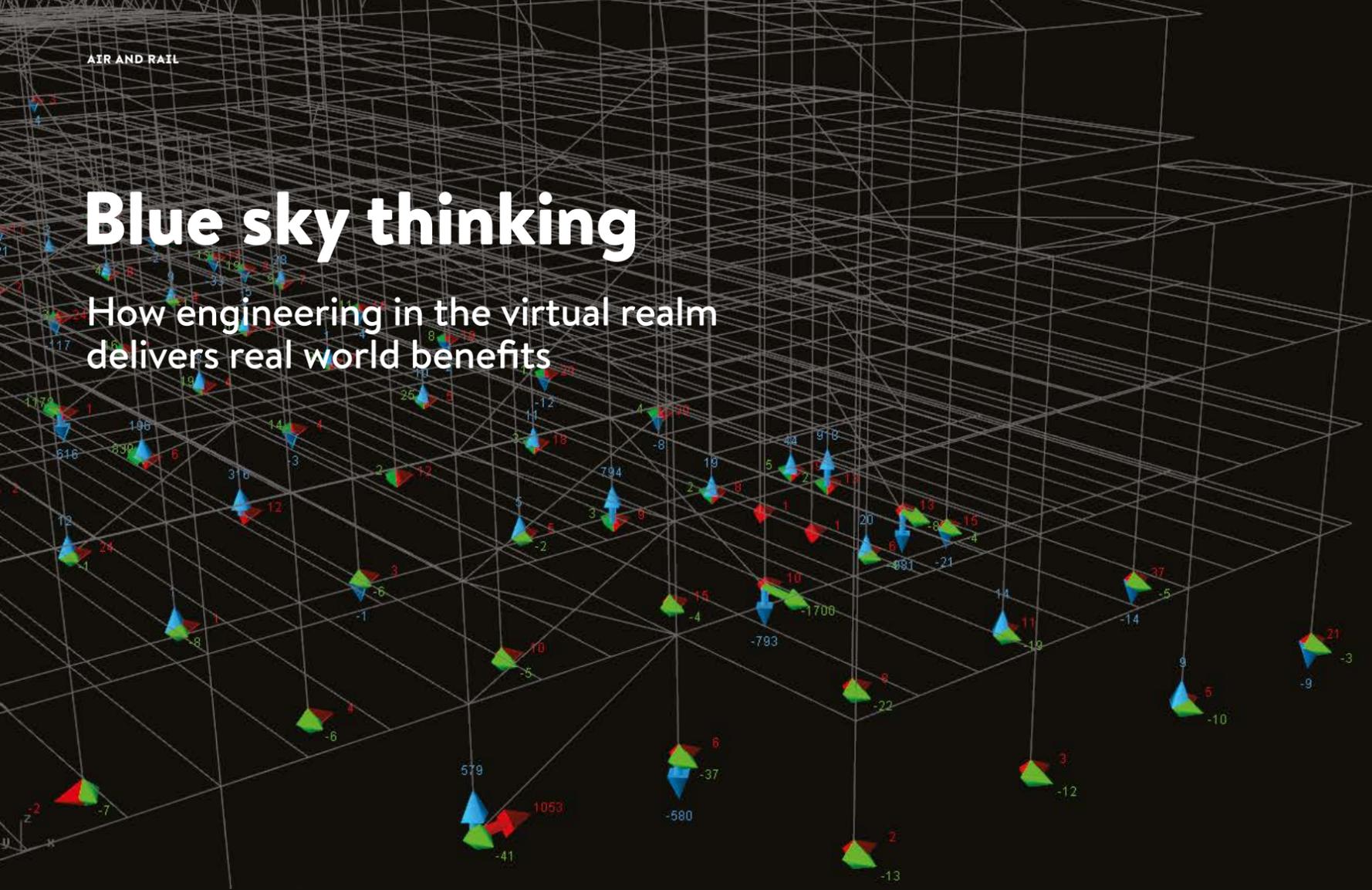
LONDON, UK

Our relationship with Heathrow Airport has spanned 25 years, and seen us complete over 300 projects – ranging from the complete redevelopment of Terminals 3 and 4, to the realisation of a new transport interchange and satellite pier at Terminal 2. We have been selected to continue our journey with the UK's busiest airport, working as part of an integrated team to design and deliver an ambitious expansion programme that aims to establish Heathrow as the best-connected, most efficient and most sustainable airport in the world.



Blue sky thinking

How engineering in the virtual realm delivers real world benefits



This £1bn transformation programme will increase the existing runway capacity of the UK's third busiest airport from 28 million to 55 million people a year. To accommodate this rise in passenger numbers, new piers and a multi-storey car park are being created, and Terminal 2 is being extended and reconfigured over 80,000m² to deliver high-performance facilities and an intuitive passenger experience.

As civil, structural and facade engineers, BuroHappold worked closely with the client, stakeholders and wider project team to challenge and refine the initial brief. In this way, we could deliver elegant, cost-effective solutions according to a demanding programme and within a live airport environment.

MANCHESTER AIRPORT
MANCHESTER, UK



We developed innovative computational programmes that allowed us to analyse and test our structural design for the Terminal 2 extension within one coherent model. Creating and maintaining a highly accurate model of the evolving airport in BIM enabled us to be agile with our designs and work alongside the contractor in the virtual world to identify and rectify problems before work started on site.

This bold and intelligent use of the very latest technologies ensured that we were able to drive benefits across the project. We have achieved considerable time and cost savings, reduced risk on site and provided valuable support to the on-site team. This has created a succession of outcome-driven solutions that have allowed us to deliver our client's vision without compromise. **BHE**

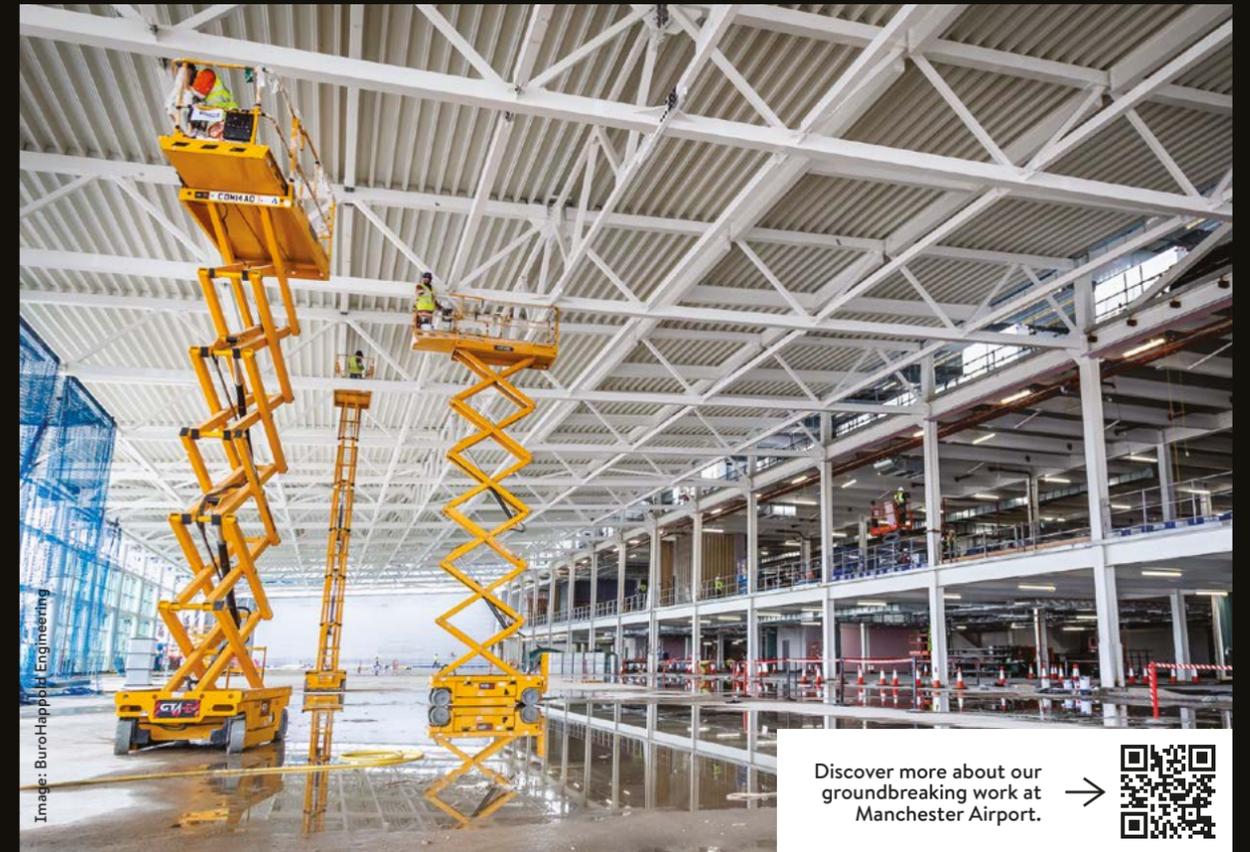


Image: BuroHappold Engineering

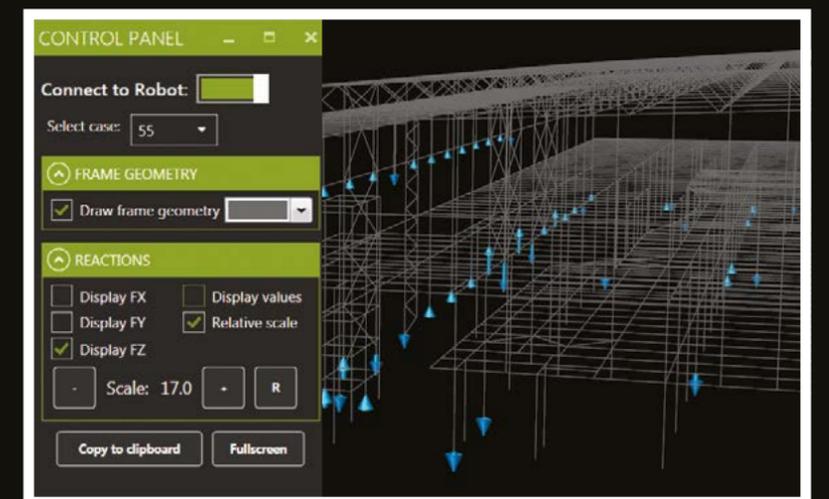
Discover more about our groundbreaking work at Manchester Airport.



This bold and intelligent use of the very latest technologies ensured that we were able to drive benefits across the project.

Facing page and right.

To realise the complex structure of the extension, we used Grasshopper to write a new computer programme that pulled together multiple analysis tools to create a combined, coordinated model in which to develop our design. This software enabled us to rapidly process large amounts of data. In this way, we could analyse the 8,000 tonnes of steelwork required to deliver a structure capable of withstanding immense blast, gravitational and lateral forces.



THE LINKS EFFECT

HOW A NEW COMPUTATIONAL APPROACH CALLED WECHSELWIRKUNGEN CAN ANALYSE MASS HOUSING'S INTERCONNECTED DESIGN ASPECTS TO IMPROVE QUALITY OF LIFE FOR RESIDENTS

Image: Getty Images/BuroHappold Engineering

Thousands of Hong Kong citizens live in “coffin apartments” half the size of a parking space. Over 500,000 people are on the growing waiting list for rented accommodation in Stockholm – many of those hoping to be centrally located will not move in before 2040. A 2016 survey by the Royal College of Nursing claimed that 40% of London nurses plan to leave the capital within five years solely due to the cost of housing. Spiralling unaffordability is a quandary faced by booming cities the world over. The answer is to build lots more homes as quickly as possible, right? Not entirely.

“Successful metropolitan areas suffer from the same problems,” says Wolf Mangelsdorf, group director for structures based in BuroHappold’s New York office. “Too little housing, enormous price increases and rents that price people out of living there. All these places that are doing well economically have a housing shortage and a house price problem.” The answer to these woes is typically expressed as a numerical target attached to a deadline. However, quantity and speed of construction are, Wolf explains, only part of a viable long-term solution. “Target numbers carry the risk of being the only focus,” he says. “We must not neglect the quality of the urban neighbourhoods that we are going to build or radically alter, nor can we afford to disregard those who live there.” Quality of life for residents, then, also needs to be evaluated as part of the mass housing design process. Defining, measuring and demonstrating this potentially nebulous concept is a complex procedure made possible by a computational modelling approach that Wolf calls Wechselwirkungen.

The seeds of this notion were sown in 2014, when Wolf was asked to mentor one of the teams participating in a workshop convened to rethink modular design. This week-long exercise took place at Domaine de Boisbuchet, a leafy French estate with minimal distractions. The result was a parametric design tool for modular architecture. This system can create unique buildings tailored to site conditions, aesthetic demands or environmental performance criteria; maximised off-site prefabrication keeps costs low while maintaining quality. “That led, somehow, to more in-depth thinking

around what mass housing means to the built environment,” says Wolf. “The urban form is not the goal. It’s an outcome, yes, but the goal is the performance.”

The broad objective of Wechselwirkungen is to create mass housing with a sense of place. Pleasant public spaces and the bustle of street life are central to achieving this goal. In accomplishing this via parametric modelling, Wolf proposes breaking down blanket quality of life parameters, such as “Safety and Security”, into their defining components. In the case of “Safety and Security”, this might include visibility, lighting, policing, walkability, mix of use, hours of activity and so on. “All of them, to a greater or lesser extent, have an influence on how safe and secure a place is,” Wolf explains. “But none of them solve the problem individually.” The same process is applied to desired outputs, for example a “Lively Street Space”. Among the integral elements here are mix of use, hours of activity, lighting, visibility, public transport, density, street level retail and walkability. Evidently, there is overlap between the constituent parts of “Lively Street Space” and “Safety and Security”. The model takes this into account, linking all of the individual parameters to objectives and outputs before using data to analyse overall performance as adjustments are made to the design. The net effect is that every consequence of any change, however small or improbable, is captured and communicated.

“We connect everything to everything,” says Wolf. “I explained this to a friend of mine in Germany who was very much into this sort of placemaking. He said, ‘Yes, it’s all about the Wechselwirkungen’. It’s a German word that doesn’t really translate into English. The interrelation of seemingly unconnected things, that’s the connotation. Once you look at all these interconnections – or the reciprocal effects between different things – then you start grasping the bigger picture.”

Aided by a meticulously assembled PowerPoint presentation, Wolf provides a comprehensive rundown of the Wechselwirkungen modelling process. “There’s this idea that you make it very utilitarian, this almost mechanistic view of the world,” he says. “Then these ideas of place come in.” On his laptop, Wolf calls up images of deserted communal gardens embellished with sharp hedges



“Successful metropolitan areas suffer from the same problems. Too little housing, enormous price increases and rents that price people out of living there.”

Wolf Mangelsdorf
Group Director, Structures

and desultory water features. “No one would ever go there. This is not a place for people. You go somewhere like Soho, New York, or Kreuzberg in Berlin and you feel that they work. They’re not pretty, necessarily, but they have a good mix of people living there and using the street. Some buzz. Where life spills out on the street, where you have people feeling safe and secure, you create liveable spaces. I kind of linked that back to Jane Jacobs and eventually got to this.”

Jane Jacobs was a writer and activist who strongly believed in a community-based style of urban development. In her 1961 book, *The Death and Life of Great American Cities*, she identified four conditions that are indispensable for a city’s streets and districts to “generate exuberant diversity”: mixed primary uses, short blocks to make neighbourhoods more walkable, buildings that vary in age and condition, and sufficient population density. As a resident of New York, Jacobs was reacting to the wilfully top-down urban renewal of the city’s master builder Robert Moses. An unelected but hugely powerful public official from the 1920s to the late 1960s, Moses shaped NYC through ambitious works including bridges, parks, highways and landmark construction projects such as Shea Stadium. Jacobs, who lived in Greenwich Village, first came up against Moses in 1955 when she involved herself in a planning battle over a proposed four-lane road through Washington Square Park. One notable subsequent clash helped to shelve plans for the Lower Manhattan Expressway,

which would have necessitated bulldozing 14 blocks and displacing over 2,000 families. A similarly strong desire to maintain and nurture a vibrant connection between building and street is what underpins Wechselwirkungen.

Subjectively speaking, the basics of Wechselwirkungen are easy to grasp but – for a non-technical audience – the fine detail is slightly trickier to glean. “Yes, it is a reasonably complex sort of approach,” Wolf agrees. “I have presented this at numerous conferences and the response has always been very positive. People get the basic idea but really looking at what’s under the bonnet can be rather difficult.” What is clear, however, is that this method allows a sensible degree of stakeholder input without detriment to delivery. Urban planning tends to follow a traditional top-down process, whereby a single design is presented as all but the finished article. Subsequent discussion really only countenances minor modifications. This can disenfranchise the community, though the lack of deliberation does keep the project under control and moving forward. Conversely, widespread consultation via a pure bottom-up process, while democratic, is not only difficult to manage but also risks glacial progress that could stall investment. Wechselwirkungen offers a practical compromise.

“Through this model that we’re proposing, we offer a middle way where you get the security of the top-down planning because everything is predictable, electronically,” says Wolf. “At the same

time, there’s transparency that allows us to open the process to stakeholders and start meaningfully engaging them in shaping their own built environment.” This allows consensus to be reached on the objectives and aspirations of the stakeholders, from which quality of life parameters can be weighted. From there, the environment and existing urban context – such as the climate and the landscape – set the project’s immovable boundary conditions and calibrate the model. This is where the design process begins; buildings, infrastructure and space configurations can be trialled and the effects on performance, as shown by the quality of life parameters, evidenced. For residents, the information could not be more straightforward – this is what any given scenario will look like, and this is how it will affect your life.

“Theoretically, I can model an infinite number of different versions of the same thing but I can only build one,” Wolf continues. “That’s the key piece. I have to choose one. The more that I can engage the community in that selection process, the more likely it is that I arrive at that decision with as broad a buy-in as possible.

“It’s also about leaving enough room to grow, which is quite important, I think. Not everything must be designed and predetermined. A sociologist at LSE, Richard Sennett, calls it loose fit cities. If you look at somewhere like the Heygate Estate [vast neo-brutalist development in south London], every route has been predetermined and all the rest of

Wechselwirkungen is a computational modelling approach that emphasises street interaction and quality of life in urban mass housing design.

“We’re delivering the necessary transparency and allowing decisions to be tested while the process of design remains firmly in the space it should occupy, which is between science, art and intuition.”



The Stuyvesant Town-Peter Cooper Village development in New York City exemplifies the modernist “towers in the park” style that isolates housing from the street.

it, but the whole thing is sterile. It fell into social disrepair. That was built in 1974 and, 40 years later, it’s torn down. This is not a sustainable model”.

Indeed, Sennett’s 2009 essay, *The Public Realm*, touches on how over-determined visual forms and social functions prevent city structures from adapting when conditions change. He refers to such rigidity as giving rise to a “dinosaur effect”, whereby buildings are either torn down or – in extreme cases – simply abandoned because they cannot be repurposed as the city evolves. Born in Chicago in 1943, Sennett saw a promising career as a cellist ended by a hand injury before becoming a leading social thinker. As a boy, he lived in the Cabrini-Green public housing project. This estate would eventually deteriorate into one of the most notorious, crime-ridden slums in the entire United States before being systematically demolished between 1995 and 2011.

Cabrini-Green was an archetypal example of the modernist “towers in the park” style as conceived by Swiss-born French architect Le Corbusier. It is precisely this type of development that Wechselwirkungen has been devised to counteract. Under Le Corbusier’s

doctrine, clusters of tall, single-use blocks stand isolated from the street; the vertical plane is claimed for living space while the horizontal is given over to car usage, and lots of it. The most famous example of this scheme is Le Corbusier’s provocative 1925 Plan Voisin, an unrealised proposal that recommended levelling two square miles of central Paris to make way for eighteen cruciform high-rise buildings. Symmetrical and standardised, this ascetic blueprint has proved extremely influential upon city planning. In his aforementioned essay, Richard Sennett prefaces his thoughts on the Plan Voisin by saying that he does not wish to engage in “the critic’s pleasurable exercise of architect-bashing.” Nonetheless, Sennett subsequently makes it plain that he is no fan of Le Corbusier’s disdain for the impurity of disordered street life as expressed by over-determined buildings that sacrifice adaptive capacity for purity of form.

In addressing the past and present problems of mass housing via highly sophisticated means, it might appear that Wechselwirkungen smudges the line between architect and engineer. Not so, says Wolf. “Architects might feel that we are sort of encroaching into their territory with this, but we can evidence some of the more intuitive decision-making

that normally happens so it’s totally compatible,” he explains. “What we’re lacking as engineers, very often, is the wilfulness of the designer, the thinking around just making a decision because we like something. I don’t think we should be trying to occupy that intuition and wilfulness kind of area – I’ve seen stuff that was designed purely by engineers. It is often aesthetically horrendous.”

Rather, by offering Wechselwirkungen as a collaborative tool, we have a vital role to play in the timely creation of sustainable mass housing where people actually want to live. “We’re delivering the necessary transparency and allowing decisions to be tested while the process of design remains firmly in the space it should occupy, which is between science, art and intuition,” says Wolf. “Designing is very much about making choices. By enabling architects to make more informed choices, what we can accomplish together only becomes stronger.” **BHE**

URBAN DEVELOPMENT

KEY PERFORMANCE INDICATORS

Sector turnover	£33.2m
As percentage of company turnover	19%

According to the UN, the world's urban population is growing by 60 million people a year. By 2030, nearly five billion of the world's 8.1 billion people will live in cities. The demand for high-quality, sustainable urban development and regeneration has never been greater. BuroHappold is focused on fulfilling that demand.

How we build cities is changing. The demand for "Smart Cities" technology is forecast to grow to between £250 billion and £663 billion per annum over the next five years. Our work on "giga projects" such as Neom, Amaala and the Al-Ula cultural masterplan is ground-breaking in terms of how tech and data is being used to plan, design and build. This creates efficiencies in infrastructure, accelerates economic growth and improves quality of life.

Every team at BuroHappold is committed to tackling the climate emergency. Urban Development projects include the Gartenfeld development in Germany, an ambitious residential masterplan with an emphasis on car-free and digital and sustainable principles. Our work in New York on the 80x50 plan is setting the agenda for tackling climate change in American cities; we are also working with LA County on their action plan. In Asia, we are developing Jakarta's transport network and continuing our 100RC

Alan Harbinson
Managing Director – Cities



work in Melaka. Meanwhile, in India, we are working on a new township project, Embassy Knowledge Park, and the multimodal interchange at Bangalore Airport.

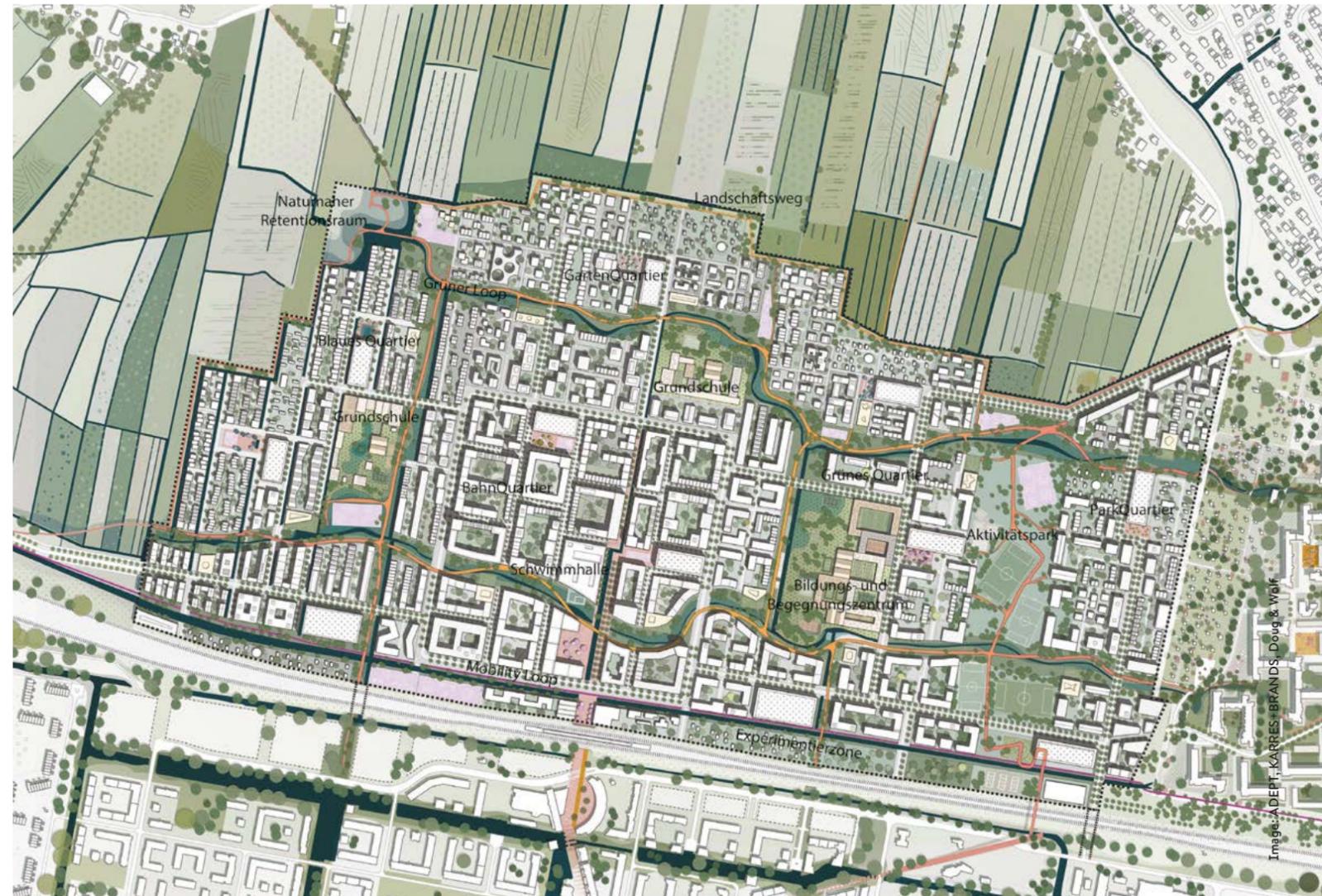
Urban regeneration has been particularly important in our Asian, Indian, American and Middle East markets. One example in the US is our work in reconfiguring Detroit, testing alternative land-use scenarios from both technical and financial perspectives.

Elsewhere, the new double-opening swing bridge in Copenhagen, Lille Langbro, has opened. Similarly, the Providence River Pedestrian Bridge in Arkansas has been successfully delivered. Looking ahead, design work on a new bridge spanning the Danube in Budapest has begun

We want all of BuroHappold's buildings and cities to be smart, sustainable and offer a high quality of life for those who use them. By continuing to deepen and widen our knowledge and embrace technology, our engineering designs consistently exceed expectations.

OBERBILLWERDER HAMBURG, GERMANY

This is a large-scale masterplan for a 124-hectare development close to Hamburg city centre. BuroHappold aims to meet the 30 strict DGNB sustainability criteria for district certification, which are usually applied to much smaller developments. As well as 7,000 residential units there will be shopping areas, public buildings, a swimming pool and 28 acres of green space. This "connected city" will offer a high standard of living for all budgets at every stage of life.



CORDOVA MASTERPLAN

CEBU, THE PHILIPPINES

Combining the skills and experience of our Cities team and Hong Kong team, the Cordova masterplan consists of 1,500 hectares of four reclaimed islands off the northern coast of Mactan island. The area is earmarked for mixed-use development, to create an investor-friendly, sustainable and resilient city. This work is just one of the many major masterplans BuroHappold is delivering across South East Asia. Particular technical challenges include building in resilience to typhoon conditions, providing infrastructure to serve an eventual residential population of up to one million people, and creating phased and flexible infrastructure to allow for long project construction and probable future changes to masterplan. Our plan also conserves the existing mangrove outcrops and promotes waterfront edge treatment that enables new mangrove habitat to be created.



Image: Arquitectonica



RED SEA PROJECT

KINGDOM OF SAUDI ARABIA

BuroHappold worked alongside WATG Architects, Irvine, USA to complete an overall and a Phase One masterplan for this unique luxury tourism development. Phase One of the project, due to complete in 2022, will see the construction of 14 hotels across five islands and two inland resorts, as well as an airport, a yacht marina, leisure and lifestyle facilities, and supporting infrastructure. BuroHappold is committed to enhancing the ecological balance of this unique area. Where technical solutions do not yet exist to address some of the sustainability opportunities and challenges, we have identified pioneering technologies that may be adopted in future project phases.

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LILLE LANGEBRO

COPENHAGEN, DENMARK

Following an international design competition, Realdania appointed BuroHappold, WilkinsonEyre and Eadon Consulting to design a new movable bridge across Copenhagen Harbour. The concept was for an elegant, low-lying crossing that incorporates two swinging spans to provide a navigable watercourse for shipping. The bridge's sweeping form demanded precise standards of design detailing and fabrication. An engineering innovation incorporated a moment connection between the movable spans, which helped minimise the bridge's primary structural depth.

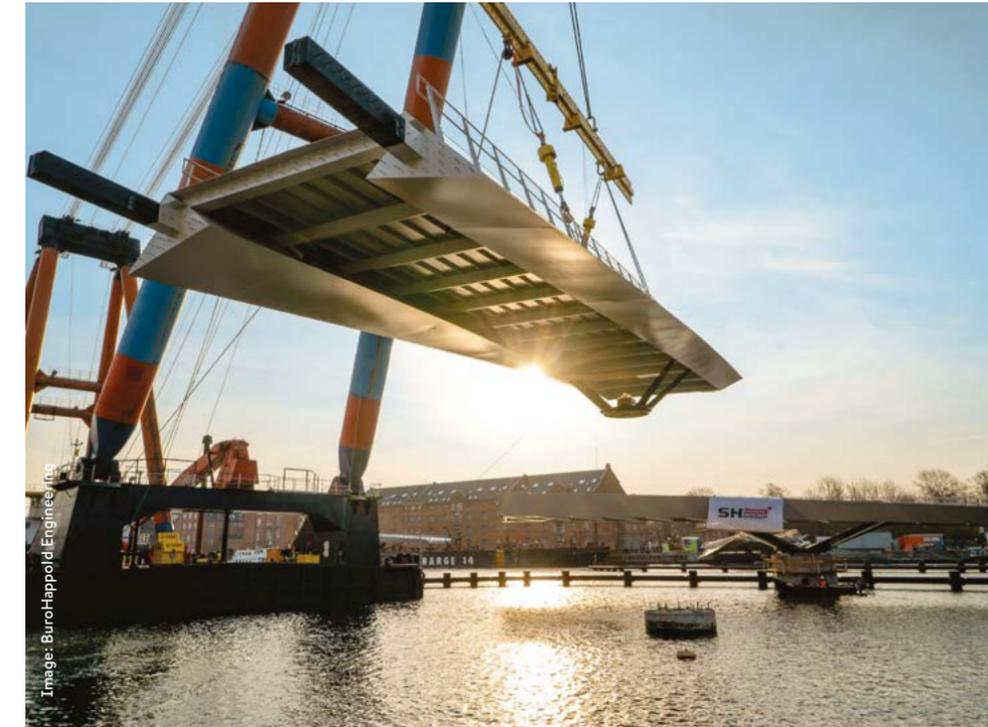


Image: BuroHappold Engineering



Image: BuroHappold Engineering

THAMESIDE WEST

LONDON, UK

Thameside West is a 40-acre, mixed-use development on the north bank of the Thames. BuroHappold has been working with Keystone London and GLA Land and Property Ltd (GLAP) to submit a planning application for 5,000 homes, 200,000ft² of industrial/workspace and 75,000ft² of shops, restaurants and bars. The masterplan includes a primary school, river walkway, two riverside parks and a DLR station. It will make a key strategic link between the Lea Valley regeneration area and the wider Royal Docks.

What's the big idea?

BuroHappold's pioneering Urban C:Lab programme is championing collective working to challenge convention and tackle some of society's most complex issues

BuroHappold is a progressive practice that has been at the forefront of shaping our built environment for over 40 years. Standing on sustainable foundations and fuelled by a commitment to design positive urban environments for the communities that use them, we thrive on finding solutions to the seemingly intractable problems facing society.

We know that we are stronger when we work together. That is why we pool experience and knowledge across our global community of experts, and seek co-creation with partners outside our practice, to stretch the boundaries of possibility and deliver real change.

Never have these principles felt more relevant or important than in today's turbulent times. The need to declare a climate emergency, increasing urbanisation and unstable governance are making our existence feel more precarious than ever. Collectively, we need to disrupt the old order and find new ways to tackle the complex challenges that we face together.

A catalyst for change

Urban C:Lab, our pioneering research and development initiative, is dedicated to this cause. As a practice that strives to recruit, retain and develop the brightest minds in the industry, we selected 20 talented individuals from

across BuroHappold to embark on this intensive programme. Over the course of two years, they are working with our experts and engaging with external partners to question the status quo, smash through silos and hurdle over hierarchies to influence meaningful change as the consultants of tomorrow.

"The 20 participants represent a diverse range of disciplines from within our practice," says Partner and founder of Urban C:Lab, Gavin Thompson. "This supports our aim of removing any barriers to collaborative working by uniting individuals from across our global offices and our external network. We all share a commitment to working together to push the boundaries of strategic planning and design, so that we can find ways to address emerging urban challenges."

Exploring the big issues

Within this overarching aim, the Urban C:Lab group is investigating a series of guiding key themes. These include the climate emergency, urbanisation, commercialisation, design, scarcity of resource, regeneration, natural capital and governance. Each member is encouraged to choose a focus area of interest within these themes and to develop it into a proposition or project that will deliver positive change.

Already, some interesting areas of exploration are emerging. These range from creating tools to evaluate the development potential of stranded assets, to finding ways of predicting occupation rates to allow for better economic forecasting, to exploring the unconscious bias of urban planners on the safety of women in cities around the globe.

A collective approach

This big thinking around ways to trigger meaningful and beneficial change in the built environment is underpinned by exploring and implementing ideas within an agile and supportive agenda. This includes working with external collaborators and clients within an enriched environment that is deliberately unconstrained by routine organisational procedures.

Urban C:Lab seeks to promote co-working beyond the practice by developing partnerships and relationships that encourage interdisciplinary approaches to urban development. These include the engagement of acclaimed architect Reinier de Graaf, and Hugh Montgomery, Professor of Intensive Care Medicine at UCL, as external strategic advisors to the programme, and a partnership agreement with the Academy of Urbanism.

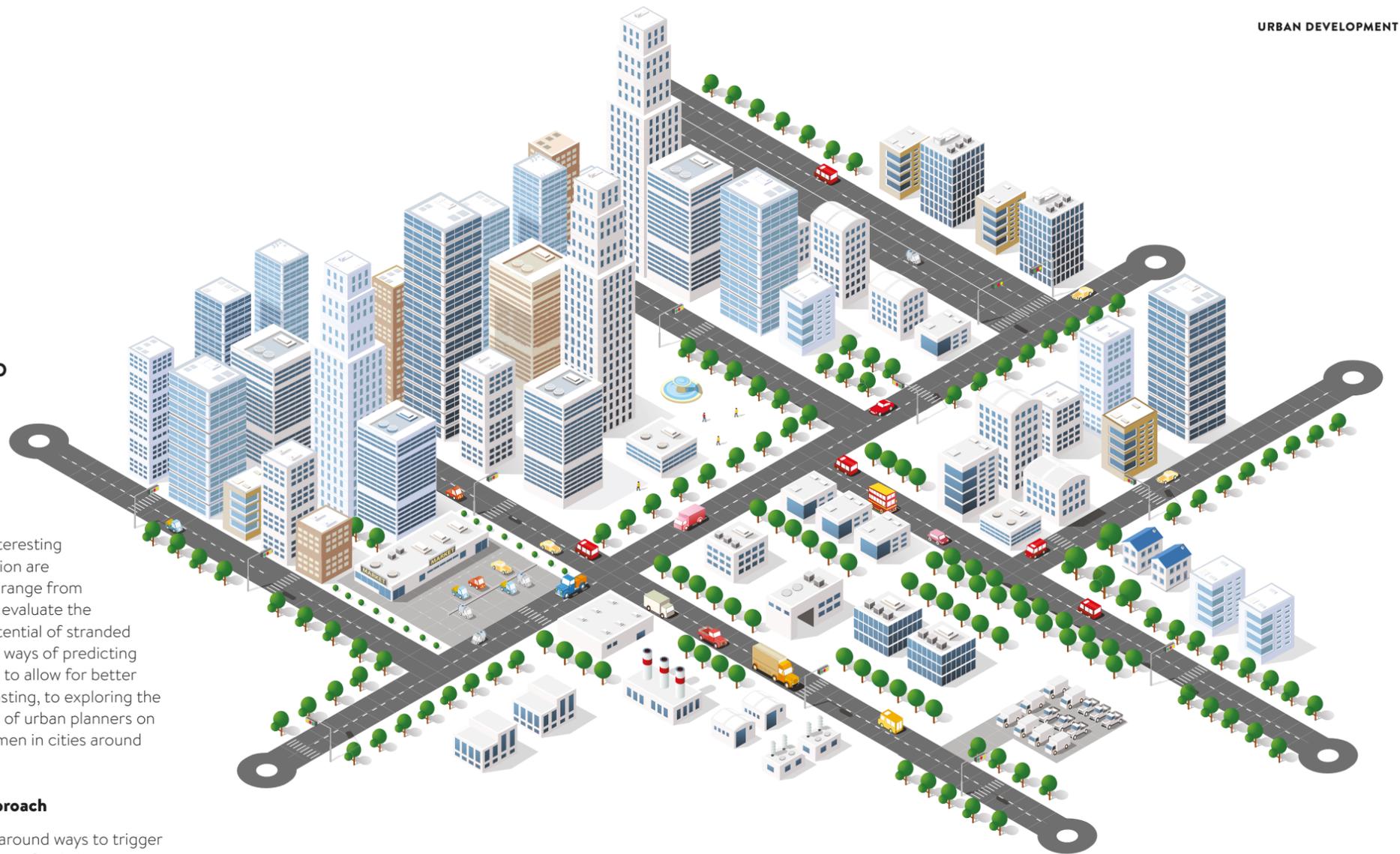


Image: Getty Images/alexangel21

“We all share a commitment to work together to push the boundaries of strategic planning and design, so that we can find ways to address emerging urban challenges.”

Gavin Thompson, Partner and founder of Urban C:Lab

Challenging preconceptions

To spark debate throughout our practice and among our external partners, Urban C:Lab has initiated a series of events at which guest speakers are invited to share their opinions on a range of important and provocative issues.

Reinier de Graaf delivered our first lecture on the future of architecture; award-winning structural engineer Himanshu Parikh spoke to us about his groundbreaking work around using water and environmental sanitation infrastructure to alleviate poverty in low-income urban and rural areas.

Another recent talk was given by Hugh Montgomery, whose lecture entitled *Engineering the Climate Change Emergency* had a profound effect on those in attendance.

"It was the most impactful lecture I've ever heard on climate change," says Mohamed Gaafar, infrastructure engineer and Urban C:Lab member. "I think Hugh found a way to make climate change relatable, and for a long time it hasn't been. We should all be striving and creating new paradigms, new ideas, and new solutions to the problem."

Only by changing the way we think can we transform the way we work and deliver tangible solutions. Urban C:Lab is committed to making change happen, so that we can truly improve life for people across the world and safeguard the future of our planet. **BHE**

Find out more about Urban C:Lab activities here



What makes a great engineering firm? It used to be enough to create exceptional buildings and cities. Now, however, increased competition, higher global building standards and increasing urbanisation means that firms have to offer their clients much more than a standard design service in order to succeed. A deep understanding of each client's needs, truly sustainable solutions, and specialist knowledge and experience are all expected, at every level.

Misti Melville is confident that BuroHappold Engineering fulfils that expectation. She believes that this is due to our people – the practice employs hundreds of extraordinary, talented professionals who bring transformative change to every one of our clients' businesses.

Where do you see the future of work progressing?

A recent report from Capita detailed the risk businesses are facing with skills shortages. At BuroHappold, we are not alone and are facing this very issue head-on. To future-proof the business, we need to embrace technology to ensure we can keep at pace with our changing external environment. According to Capita's Digital Opportunity Report, 57% of jobs are vulnerable to automation. Embracing technology such as artificial intelligence (AI) and robotic process automation (RPA) can help to free up our time to really focus on the more interesting and insightful areas of everyone's roles. We are already utilising a hybrid workforce combining human and digital labour in the BHoM (Buildings and Habitats object Model). I am certain we can push this further and much faster than we have ever seen before, which is exciting.

How has BuroHappold evolved in recent years?

BuroHappold has changed a lot in the time I have been with the practice. We have made great strides across all our regions in adapting and growing our business. One of our key changes has been to introduce neuroscience and neuroleadership factors into the business and how we do things, which you can see in the My Career Plan and Objectives (My CPO) portal. We also focus on a growth mindset in our Career and Development and Key Objectives programme; by owning your own career you will have the desire and confidence to learn new skills.

Digitalisation is a key focus in our strategy for the business; we are committed to continually improving and streamlining our current processes. In order to be ready for changes in our markets, we need to adapt, to future-proof the business. We have a number of initiatives including Project Digital 360°, headed by Irfan Soneji, to kick-start BuroHappold's digital journey, as well as the appointment of Tony Scott, global technology director, to turbocharge and refine the implementation of our digital strategy.

BuroHappold is committed to providing multiple opportunities and channels for our people, whatever their role, location or grade. We want everyone to have the opportunity to be heard, gain feedback on how we can improve and feel free to suggest creative or innovative ideas. One way we do this is through Rungway, an online platform that enables knowledge sharing across the business. It's a great way to encourage debate and discussion on issues people feel strongly about, or when they want advice on any number of matters.

Tell me about neuroleadership. Why is it so important?

The neuroscience of leadership, neuroleadership, is the study of leadership and development from the perspective of what happens in the brain. It focuses on neuroscientific research and knowledge in the areas of leadership development, management training, change management, education, consulting and training. Dr. David Rock first coined the term "neuroleadership" in 2006 in his research on looking at leadership from a biological perspective.

Understanding neuroscience and neuroleadership can really help people to develop their full potential. Once we understand what happens in the brain, it can help us to deal with people in a more effective manner. The greater the understanding of the brain and how it operates, the more effective we will become at leading change, communicating, managing relationships and achieving our business strategy.

Other benefits gained from a better understanding include improved engagement, greater productivity, change effectiveness, improved retention rates and a reduction in the costs associated with employee turnover, learning to lead and manage yourself and others. This understanding is imperative during highly stressful situations such as periods of change.

INSPIRATION AT WORK

WHAT WE DO AND HOW WE DELIVER IS EVOLVING. MISTI MELVILLE, GLOBAL HR DIRECTOR, DISCUSSES THE APPLICATION OF NEUROSCIENCE, THE IMPACT OF TECHNOLOGY AND HOW BUROHAPPOLD'S CLIENTS BENEFIT FROM OUR MULTIFACETED SKILLS BASE



What expertise and skills should we be growing across the business?

Our core business has always been engineering. However, we need to grow on this fantastic foundation to provide additional value to our clients with a more multifaceted skills base. As Sarah Rettker, vice president of investor engagement at the Georgia Chamber of Commerce, says: “We are moving into an unprecedented and unpredictable future where you must challenge yourself to continue to gain new skills... embrace positive discomfort in order to evolve and to advance your career.”

So, we must develop our offering in engineering, technology and consultancy, but also look to grow in areas such as relationship skills, knowledge networking, digital and consulting, project management, negotiation, commercial acumen, collaboration and leadership.

I always encourage our people to keep looking at all the Opportunities pages on My Career (internal development tool). A secondment or transfer opportunity might be the best way for someone to broaden their skills and learning and we are always keen to assist with this.

How can employees own their careers and continue their professional and career development now?

CEO Neil Squibbs says, “Learning is a priority”. We are so fortunate to have a CEO who is genuinely invested in people’s development and a continuous learning culture. Our I&D team has been working hard to make learning more accessible, including a rollout globally of virtual courses. The My Career portal allows anyone, graduate to Partner, to view all learning opportunities, with programmes such as Early Careers Development (first three years of graduates’ professional careers, offering business and technical skills development), Learning to Lead (support people management and leadership skills for senior and associate grades) and our Leadership Development Programme (fast track development for selected directors or principals). Line



“We are a pearl in the engineering world and sometimes underestimate how good we are. I want to help our organisation and our people to reach and exceed their potential, enhance thought leadership, help shape exciting and personally satisfying careers, and ensure that BuroHappold continues to lead at the cutting edge of our industry.”

Misti Melville, Global HR Director

managers will always provide hands-on guidance and support. Ultimately though, we all need to own our own careers, but at BuroHappold, we want to provide a doorway to the opportunities available.

How is tech changing our work?

Research company Insight Avenue has found that I&D leaders are already deploying digital extensively within their learning environments, with an emerging focus on artificial intelligence, virtual reality and wearable technology. I believe technology is great. However, I do not see it superseding human interaction. Our people need to continue to develop strong relationship skills so that we not only understand our clients’ needs but also elevate our services by offering valuable, far-reaching business insight.

What is our strategy in terms of growth?

Gone are the days when companies held complete control and employees would remain with the same company for their entire career. These days it is far more about the employee experience. We know, as a business, recruitment of new talent and retention of our employees are difficult and is a continuous journey.

For recruitment, the phrase often quoted is finding the right people with the right skills at the right time. Retention also presents a fine balance with recruitment, and there are many reasons why people choose to stay or go, so we simply cannot neglect the existing teams. In a way, we should be re-recruiting them every day by empowering them to develop skills not just for now, but for a fast-changing future, providing access to interesting work and projects, balancing work with family and personal needs, providing agile or flexibility of work and making sure our culture and values resonate with our people. We are taking steps to enhance our brand to attract new recruits in our growth areas as well as improving our employee experience to retain our top talent. We are pleased that 80% of our hires are recruited by our in-house team.

How does that strategy affect our people?

Our aim is to always remain sustainable and provide roles for people in the tough times. We must remain attuned to our markets and continue doing what we are doing, not by reducing our project work but by growing where there is capacity and the right opportunities.

Start-ups are true disruptors in the market, and continue to shake up the traditional nine-to-five job market. McKinsey found that about 30% of the working-age population in Europe and the United States engage in some form of gig work, and, according to Intuit, by 2020 approximately 43% of the workforce in the US will be freelancing.

We acknowledge that we will have to adapt our strategy and working practices to reflect external market factors; we are currently trialling new agile working policies across various parts of the firm.

What do people say about life at BuroHappold?

Following the results from our 2019 Culture Survey, we have taken on board the feedback and are strengthening a few areas including management and leadership, communication, and career and development. Our people are our business. Our culture and sense of collaboration is why people like working at BuroHappold, an opinion that is clearly supported by comments in the survey. Employees highly rate our breadth of expertise and knowledge, our projects, the freedom to get on with work, the overall culture, attention to diversity and our commitment to move forward.

So, what’s your final piece of advice?

Never stop learning. Put your hand up to grab opportunities even if you are not sure if you are ready. Take your continuing education and learning into your own hands. **BHE**

A LEARNING CULTURE

Five initiatives that help BuroHappold’s people to excel

EARLY CAREERS DEVELOPMENT

A framework that provides a clear path from onboarding through to the first three years of graduates’ professional careers. Offering business and technical skills development, this includes a blended mix of virtual education, on-demand digital learning and on-the-job experience supported by regular one-to-one review meetings. It incorporates our existing ICE- and CIBSE-accredited training schemes.

LEARNING TO LEAD

An accelerated six-month blended learning programme for senior and associate staff who are direct line managers. The course requires significant personal commitment in terms of time, energy and practice. It is aimed at those who are about to be – or who have recently become – line managers and want to develop a long-term career in this direction.

LEADERSHIP DEVELOPMENT PROGRAMME

Designed to develop and support the next generation of senior leaders of BuroHappold. The programme aims to fast-track the development of selected Directors (Principals) who have demonstrated they have the potential to become a senior leader in the near future.

URBAN C:LAB

Urban C:Lab, a two-year research and development programme that bypasses routine organisational procedures at BuroHappold. The aim is to equip each “C:Labber” with the knowledge and skills required to influence real change in the communities we live and work in each day.

HACKADEMIES

A series of global events, getting under the skin of visual programming, and other activities that are bringing our computational engineering activities alive. With the explosion of data being generated with BIM technologies and engineers being challenged with some of the biggest global mega trends ever like climate change and population growth, has there ever been a more exciting and important time to be an engineer?

EDUCATION

With over a hundred universities, and even more schools, in our global portfolio, Education is a key sector for BuroHappold Engineering. We know that where people learn is a key factor in how effective their learning is. Good buildings can transform educational life, stimulate minds and help students to achieve their full potential.

Over the last decade, higher education has become a particular focus for us. This has coincided with many universities becoming increasingly business driven. The emphasis has shifted towards the quality of “the student experience” to attract undergraduates and enhance learning and personal outcomes; for many of our clients this is paralleled by the need to recruit world-class researchers.

With universities and students facing increasing financial and academic pressures, the need for student-centred spaces providing excellent value for money becomes ever greater. BuroHappold understands that budgets are often tight, so we work with our clients to deliver solutions that meet the needs and expectations of every stakeholder. Our projects cover all required building types, so we can bring in expertise from other sectors to support specialist facilities such as sport, science, vocational studies and performing arts.

The “basics” are always our starting point: high-quality ventilation, daylight, and simple controls. From there we work with our collaborators and clients to meet the specific needs of each project, whether that is striking design, flexible building use, low carbon usage or minimal running costs. Wherever the campus, our global team can help to create a building that works within its environment.

As ever, we have delivered a fantastic range of projects this year. Award wins include recognition from the Chartered Institution of Building Services Engineers, the Judges Award of Excellence at the Scottish Property Awards and an AEC Excellence Award in Building Design for the Brown School of Engineering. Schemes in this diverse sector range from new timber buildings set in woodland for Kingswood Preparatory School and Nursery in Bath to the magnificent high-rise research facilities of Chicago’s Louis A. Simpson and Kimberly K. Querrey Biomedical Research Center. Whatever the scale, BuroHappold persists in solving challenges for some of the world’s most revered institutions.

We continue to investigate how the physical environment can assist with student mental wellbeing. BuroHappold has developed a number of tools for studying, analysing, and predicting many of the issues that can help with a productive and happy student lifestyle. Our data-fuelled and outcome-driven methods can help to optimise and direct investment while taking a “what if?” view of the future within this rapidly developing sector. While the built environment is a key factor contributing to mental health, this does not seem to be receiving the attention that it deserves. Optimising the environment can benefit all students, staff and visitors. This improves outcomes for everyone while helping to establish a strong and caring community.

Mike Entwisle
Education Sector
Global Lead



KEY PERFORMANCE INDICATORS

Sector turnover	£12.8m
As percentage of company turnover	8%

HITCHCOCK CENTER FOR THE ENVIRONMENT

AMHERST, MA, USA

Hitchcock Center for the Environment, a 9,000ft² environmental education centre in Massachusetts, recently achieved the ambitious Living Building Challenge™ certification. This is the fourth such certified project in Massachusetts and the 23rd in the world. Net zero water and energy have been achieved through innovative interventions by the team led by designLAB architects, with BuroHappold providing MEP engineering, energy modelling and sustainability consulting.

The structure has been designed and built to embody the centre’s ethos by harmonising with the natural environment; a high measure of sustainability is achieved by not only

working with nature but also working like nature. Net zero water and energy solutions include the collection of rainwater – the building’s only source of water – and natural ventilation with the use of environmentally friendly, locally sourced materials. Energy derived from solar surpasses energy gained from traditional sources and waste is significantly mitigated through composting.

The new building offers improved classroom spaces, a resource centre filled with live exhibits and interactive learning tools, and an open studio for an environmental education programmes open to all ages.

Designed to be a teaching tool focused on sustainable solutions through the study of natural systems, the project includes two signature courtyards – the “nest” space and the “den” space – along with various demonstration gardens, teaching pavilions, and trail systems to emphasize a connection with the natural surroundings.

In accordance with the Living Building Challenge™, the Hitchcock Center is committed to dedicating an equal amount of the land that their new facility occupies to permanent conservation easement.



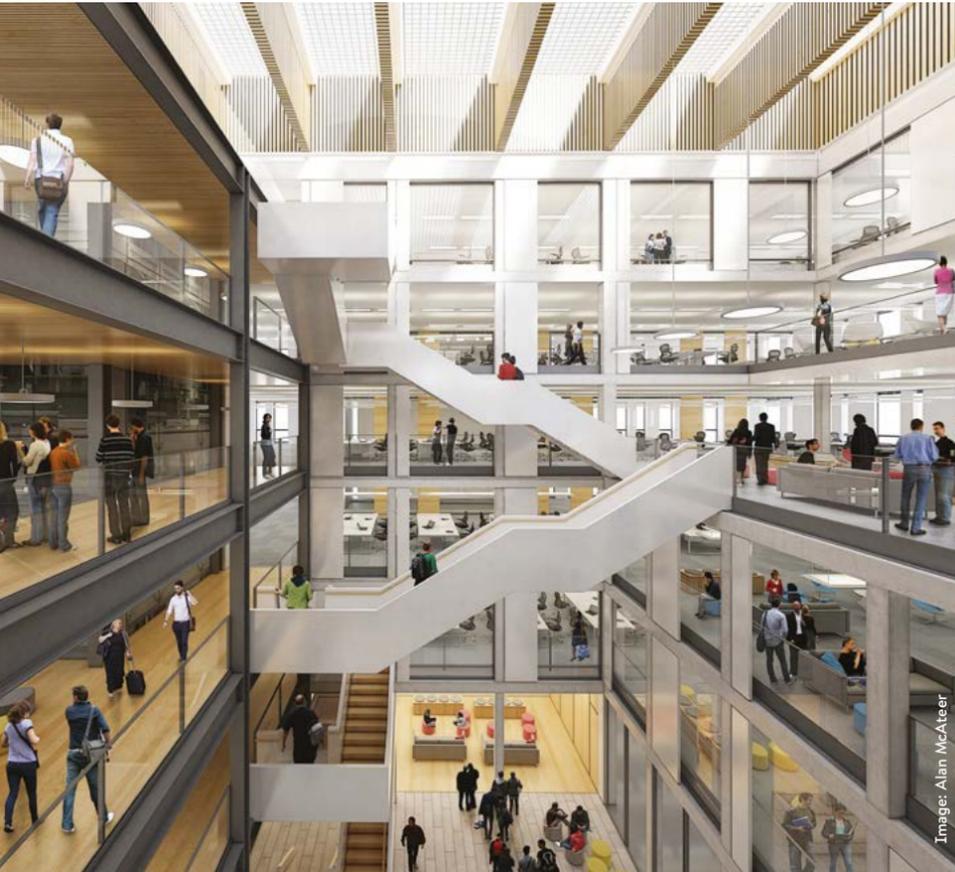


Image: Alan McAteer

BAYES CENTRE, UNIVERSITY OF EDINBURGH
EDINBURGH, UK

The third and final phase of the Potterrow development – which has replaced a car park with a mix of buildings, courtyards and streetscape – provides an impressive home for the Bayes Centre, housing a range of IT and informatics disciplines, and affirming the University of Edinburgh’s position as a global leader in data and technological excellence. The challenge for BuroHappold was to create somewhere suitable for start-ups, major multinationals, business development staff and researchers. This space needed to promote interaction while making use of natural light and ventilation.

Our team provided innovative technical solutions to achieve robust, safe construction appropriate to the architectural form.

After the successful completion of two phases, the university chose to stay with BuroHappold for this concluding stage despite strong competition from local consultants. The design of the Bayes Centre benefits from lessons learnt earlier in the project, continuing to set exceptional standards for the university.



Image: Design Engine Architects

THE MURRAY CENTRE, DOWNE HOUSE SCHOOL
BERKSHIRE, UK

The Murray Centre is the most significant new building project that Downe House – one of the UK’s top girls’ schools – has undertaken in recent years. This three-storey structure includes a library, galleries, a modern auditorium, teaching spaces and a cafe.

The building has a dramatic glass facade that wraps around the front elevation, for which our team devised an integrated solution involving the building structure as the mullion for the glazing. With environmental considerations a central factor, we proposed a passive design approach that uses natural ventilation and high-performance materials to reduce energy consumption. Through our innovative structural work and building services design, we helped to create an educational hub to inspire students for years to come.

UC SANTA BARBARA, SAN JOAQUIN VILLAGES, PORTOLA DINING COMMONS
SANTA BARBARA, CA, USA

The Portola Dining Commons is part of the larger San Joaquin development. This provides UC Santa Barbara with new on-campus accommodation for 1,000 students along with additional student amenities and housing for faculty and staff. The 25,000ft² building includes an 800-seat dining hall with the capacity to serve 2,500 people a day.

The high performance design includes passive measures, cutting-edge active systems, and renewable energy. Our team worked with the university’s facilities and maintenance team to select Energy Star rated appliances and lighting, ensuring that the project achieves high energy savings throughout its extended lifetime.



Image: Patrick W. Price Photographer

BOLDREWOOD CAMPUS, UNIVERSITY OF SOUTHAMPTON
SOUTHAMPTON, UK

The client vision for Southampton University and Lloyd’s Register of Shipping was to create an outstanding Maritime Centre of Excellence for innovation, business and education. This is set within the Solent maritime cluster, on a revitalised campus remote from the main university.

This project encompassed a number of specialist structures involving long spans, and includes a 140m-long towing tank for cutting-edge research into maritime design. Our civil and structural engineering team engaged with the architect, MEP consultant and faculty stakeholders to refine the project’s key requirements, ensuring a cost-effective buildable solution.



Image: Grimshaw Architects



Image: Getty/Deagrez

Making the connection

BuroHappold continues to research how the built environment affects student mental health

The physical environment plays a crucial role in how first year students establish friendships that may last a lifetime. Conversely, if poorly designed, these buildings can contribute to social isolation, in turn triggering academic and wellbeing issues.

For children heading off to university and making their way in the world, moving away from familiar support structures such as family and school friends can leave students isolated, lonely and afraid. Mix in the financial burden of university fees along with living expense loans and life – as they knew it – quickly feels alien to them.

Over the last few years, BuroHappold has been researching and exploring how the physical environment can affect the mental health of students; whether for good or bad. Our findings are that connectivity is key: connectivity within and between buildings, across

campuses and through the cities in which universities are located. This speaks clearly to a need for community and identifies what is often lost when moving away and beginning student life in another part of the country – or, in some cases, another part of the world.

There are no quick fixes – however, it is clear that we should take the time needed to equip students with the necessary skills to thrive before, during and after university. Helping teenagers understand how to connect with the university community feels like a good start. Part of the preparation for student life needs to include improving the awareness of support and the ability to seek it. The universities themselves must also clearly communicate and support initiatives to tackle loneliness, and promote a sense of belonging.

From our research, it is clear that universities are taking student wellbeing

extremely seriously, with many of them investing in specialist support structures and interventions. Universities are also thinking critically on the best ways to reconfigure their estates and campuses to enrich student wellbeing.

Through the recent series of design sprints led by BuroHappold, options have been explored for city-based university masterplans to include elements such as the availability and route of public transit between the university and student accommodation and developing accommodation that promotes both interaction and the choice of when and where to interact.

Each intervention may feel insignificant; however, they all contribute to the bigger picture – which is that university students and staff need to be encouraged to understand the role of the environment and community in protecting mental health. **BHE**

University students and staff need to be encouraged to understand the role of the environment and community in protecting mental health.



BuroHappold's design sprints enable a broad range of disciplines to address specific challenges around student mental health.

Beyond engineering

Stories from around the practice

LGBTQ+

Our LGBTQ+ employee network groups are active in supporting underrepresented people. They are global in reach and open to all employees. They provide an inclusive and safe environment for employees to share ideas and offer support. We marked Pride 2019 by confronting bystander culture. Our LGBTQ+ community Allies support equal civil rights, gender equality and LGBTQ+ social movements, as well as challenge non-inclusive behaviour.

“I believe that we must actively challenge any form of discrimination that we encounter in order to progress successfully.”

Neil Squibbs, CEO

“When it comes to creativity, people need a work environment where they can be themselves. We want diversity of perspective – and anything that stands as a barrier to that, I stand against.”

Gavin Thompson, Director

“I really want to create a business that feels happy, that is supportive, and where people can thrive and fulfil their potential. We need to step up and make it happen.”

Duncan Price, Partner

“I want to come to work somewhere where everyone brings their whole self into the office, and they are comfortable doing that.”

Emily McDonald, Partner

**BUROHAPPOLD
ENGINEERING**



INCLUSION AND DIVERSITY

BuroHappold is determined to continuously improve as an organisation. We are a diverse and inclusive practice, which reflects the varied cultures of the communities and clients that we serve. Ours is a culture wherein each person – irrespective of gender identity, ethnic or national origin, sexual orientation, marital or civil partner status, pregnancy, race, age, religious belief or disability – has the support and opportunities to reach and exceed their potential.

By looking at our business activities through a diversity lens, we will continue to address bias while supporting the development and visibility of underrepresented employees. We aim to further promote the rich diversity of our employees’ experiences, talent and ideas. Through our diverse teams, we provide innovative and relevant solutions to our work and culture. In doing so we create a sense of belonging for every one of our people.

GENDER EQUALITY



We have made considerable progress in recruiting and retaining female employees, hiring over industry standards in many of the countries in which we operate.

Our UK Gender Pay Gap Report (soon to become a global report) provides a useful benchmark as well as showing us the need for further measures to help improve female representation at our senior grades. This, along with positive role modelling through the work of our Women’s Business Network, continually reviewing our promotion processes and accessibility of career development activities and working with our senior leaders on inclusive behaviours, helps ensure equality of opportunity for all.

Improvements to our maternity returner process and family leave policies, coupled with flexible working arrangements allows all our employees to manage their work and family responsibilities.



SHARE OUR SKILLS

BuroHappold’s Share Our Skills programme provides employees with the opportunity and support to apply their talents to causes they are passionate about. To date, we have awarded 925 days of our people’s time for 50 projects across the globe. In 2019, we celebrated five years of Share Our Skills. Here are five milestone projects that really exemplify the enormous beneficial impact that our teams can make upon communities all around the world.

2014: St. Mary’s C of E School, Manchester, UK

BuroHappold worked with the children, families and teachers of this primary school to deliver a new Key Stage One playground. Our aim was to create a space that not only promotes the happiness and wellbeing of the children but also enriches creative learning. By collaborating with pupils throughout the design development stage, we were able to base our design around their needs, while also contributing to a shared understanding of making and shaping places.

2015: Homeboy Industries, Los Angeles, USA

Statistics show that young offenders are highly likely to be rearrested within a few years of their first offence. Homeboy Industries is changing this by enabling ex-gang members to learn skills that help them find employment. The social enterprise purchased a plot of land and buildings under renovation, with the long-term objective of creating a new campus. BuroHappold initially focused on transforming an outdated building into The Annex – a welcoming

and functional short-term space for use while the wider complex is designed and successfully completed.

2016: Kibera Flood Risk Reduction, Kenya

Suffering from biannual floods, Kibera is the largest informal settlement and slum in Nairobi. The poorest residents have no choice but to live in areas with the lowest rent, which are those most prone to flooding. BuroHappold’s water group worked in close collaboration with local non-profit Kounkuey Design Initiative (KDI) to deliver a hydraulic model that simulates a range of rainfall events. This can be used to assess the current risks to local residents, how these are likely to change with the effects of urbanisation and climate change, and how they can be addressed.

2017: Build It International Centre for Excellence, Zambia

Build It International (BII) is a non-governmental organisation (NGO) working in underdeveloped areas of Zambia to improve skills and deliver essential education and

healthcare facilities. To date, the scale of BII’s training facilities has meant they can only instruct young men and women from three or four localised communities each year. A new Centre for Excellence will allow BII to offer a greater range of training modules for a larger number of people. The BuroHappold team provided masterplanning, structural and sustainability guidance, as well as technical and on-site support throughout the construction process.

2018: Agri-Tech Centre, Samraong, Cambodia

This sustainable agricultural training school created jobs for local farmers and builders while students learn efficient, low-cost farming methods and technological practices. The Samraong economy is heavily dependent on agriculture, with many people migrating to nearby Thailand for work. The Agri-Tech school teaches new skills, such as learning to grow different crops and raise animals to sell at nearby markets. This allows people to continue living near their homes and families.



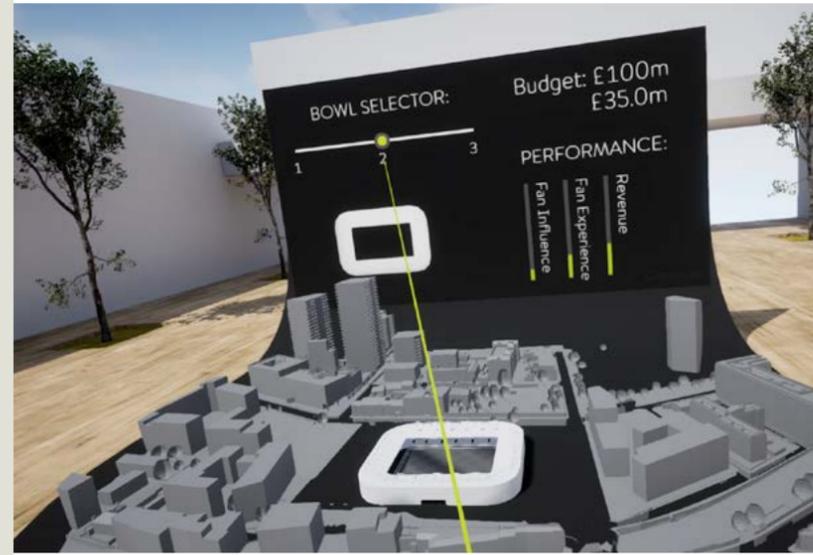
Read the Happold Foundation's *Our Impact in 2018* report. 

THE HAPPOLD FOUNDATION

The Happold Foundation is dedicated to using engineering skills and experience to make a positive impact on people's lives. The organisation works with young people, educators and researchers to shape a community that wants to improve the built environment. The charity's story began in 1995, when Ted Happold, along with BuroHappold Engineering's founding partners, started a charity that would support engineers in understanding the needs of our global society. The Foundation provides financial and practical help across four focus areas: futures, education, thinking and human development.

"The next 12 months will see us evolving, with our intention to bring the foundation to the forefront of the thoughts of engineering professionals," says Ian Maddocks, Partner and current Chair. "By making the path to a career in our sector more accessible, we can show how engineering directly links to everyday life. This will help us to make a greater impact on projects across the globe and make even more of a difference to people's lives. I am looking forward to continuing to create a solid basis from which the charity can develop and flourish."

VISUALISATION



Visualisation is the next best thing to standing in the building. Our experts can deliver highly immersive experiences that are not only visually engaging but also technically useful in understanding how a building will look and feel before a single brick is laid.

Interactive, augmented, and virtual reality enables BuroHappold to bring unbuilt environments to life. While these devices are just part of our engineers' technological "toolbox", they are increasingly useful in displaying projects in an engaging way and communicating complex design issues to colleagues and clients. AR and VR allow a deeper level of refinement and adjustment, which enables our clients to achieve truly visionary, transformative outcomes.

Above left: "Gamification" expanding stadium design options.

Above: Augmented reality development.

See how our 360° Tottenham Hotspur new stadium tour brought the venue to life.



CHRISTMAS PRESENCE

The giant advent calendar that lit up our Bath head office in December was the brainchild of office director Claire Smith, "It has always struck me that our beautiful building, that sits in the heart of Bath Quays, looks like an advent calendar," she recalls. "When I counted the windows and there were 24, the decision was made!"

Claire's vision was brought to life by Senior Designer Steve Jennings, with the professional expertise of Senior Lighting Designer Amy Rennie and the practical support of architectural LED lighting specialists acdc. This festive gesture triumphed in the Innovation category at 2019's Creative Bath Awards.



ESSENCE OF BUROHAPPOLD

The Essence Awards celebrate the very best of BuroHappold by recognising those who really reflect our culture of collaboration and excellence. Senior Revit MEP Coordinator **Laia Carpena** was our individual winner – she was praised for her commitment to upskilling her team in computational

design, and generating a buzz around the subject with patience, enthusiasm and passion. The **Stratford Waterfront team** won the outstanding team prize. Consisting of 19 different disciplines from four different offices, the team was described as “amazing” by Partner Emily McDonald.



Above: Laia Carpena, winner of the individual Essence of BuroHappold Award.

Above left: Some of the Stratford Waterfront team, thrilled at winning their award.

2018/19 AWARDS

Here is a selection of the accolades that BuroHappold’s projects and people have collected this year.

CEO Magazine, India
Company of the Year, 2018
BuroHappold Engineering

WELL Certified™ Gold status
Los Angeles and Warsaw offices

NCE100 Impact in Climate Resilience Award, 2019
BuroHappold Engineering

NCE100 Top 10 Companies, 2019
BuroHappold Engineering

Deltek Insight Most Valuable Projects Awards 2018 – Architecture, Engineering & Construction
BuroHappold Engineering

Big Project ME Awards 2018 Project of the Year
The Louvre Abu Dhabi, UAE

Building Awards 2018 International Project of the Year
Msheireb Museums, Doha, Qatar

Pascal Award 2019
Spark C office building, Warsaw, Poland

Lighting magazine
40under40 Award 2019
Carolina Florian

Hong Kong Institution of Engineers Structural Excellence Award 2019
Passenger Clearance Building, Hong Kong

Construction Compliance Award 2019 Gold Category
Dubai Development Authority, Museum of the Future

Yorkshire Property Awards 2019 Game Changer Award
Thorpe Park, Leeds, UK

RICS Awards, North West – Building Conservation Project of the Year 2019
Manchester structures team for Hanover House, Manchester, UK

Women in Construction and Engineering Awards 2019 Best Woman Structural Engineer,
Sallyanne Lewis

ICE Publishing Awards 2019 Coopers Hill War Memorial Prize
Robert Cooke, ICE Journal Paper: *Urban and landscape design in the Arabian Gulf region: a new paradigm for sustainability*

ACEI Design Excellence Awards 2019 Overseas category
Northern Spire Bridge, Sunderland, UK

CIBSE Building Performance Awards 2019 – Building Performance Consultancy (over 1,000 employees)
BuroHappold Engineering

CIBSE Building Performance Awards 2019 – Project of the Year – Public Use
Newcastle University Urban Sciences Building, Newcastle, UK

ArchDaily Building of the Year 2019
Morpheus Hotel, Macau, China

CLIMATE EMERGENCY



BuroHappold is fully committed to tackling the twin crises of climate breakdown and biodiversity loss. We have declared a climate emergency and will take decisive action:

- Produce a more radical action plan to reduce our own emissions that we can truly deliver against. This will help us lead by example and help us test solutions that we can offer to our clients.
- Place the climate emergency as a key pillar of all our project work. For example, through placing this in all project kick off/execution plans and creating a structured approach to realising appropriate outcomes aligned to this.
- Providing funding to develop a service offering and marketing material for a climate change strategic consulting service for the built environment.

MSHEIREB HERITAGE MUSEUM

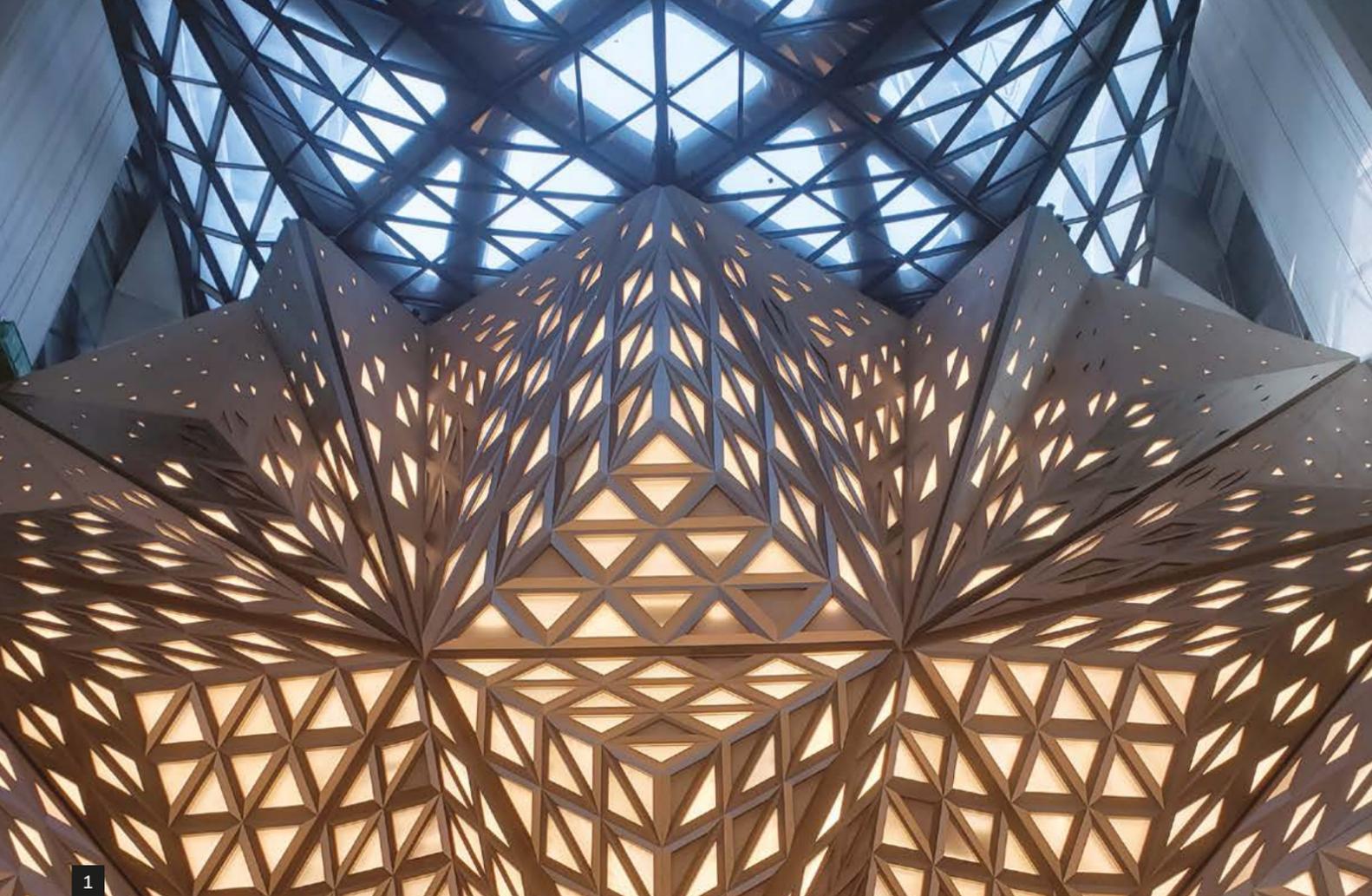
International Project of the Year, Building Magazine. Our team was enlisted to help transform four historic buildings into modern-day museums that will showcase key elements of Qatari history and culture.



SALLYANNE LEWIS

Best Woman Structural Engineer, Women in Construction and Engineering Awards.



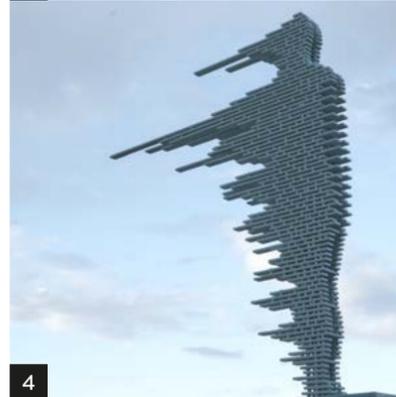


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OPENINGS

Here are just a few of the many BuroHappold projects that opened this year:

- Morpheus, China. [1]
- The Kensington billboard, UK.
- The David A. Tepper Quadrangle, USA.
- Xiqu Centre, Hong Kong.
- Zalando Headquarters, Germany.
- Tottenham Hotspur new stadium, UK. [2]
- Kingston Station Footbridge, UK.
- Coca-Cola Arena, UAE. [3]
- Maid of the Bridge, UK. [4]
- The Providence River Pedestrian Bridge, USA.
- The House at Cornell Tech, USA.
- Pacific Visions Aquarium, USA. [5]



YOUNG ENGINEERS

The Young Engineers' Forum encourages and promotes the growth of staff across all of our offices. It is an inclusive community, open to all, that connects junior members of BuroHappold through their shared interests, deepening bonds and new friendships.

2018 was the Year of Engineering in the UK. YEF UK hosted children from local schools through Enabling Enterprise and held workshops with some of London's brightest 16-year-olds from the Arkwright Foundation. This has led to the formation of a STEM Coalition Group, which allows BuroHappold to have a cohesive and integrated approach to outreach activities. Many members of the YEF have now become STEM Ambassadors. Other global YEF activities this year included TED talks, expert discussions, site visits, the formation of Skype Call a School, hack nights and a series of events surrounding Diversity Week. The YEF also enjoyed a ski trip to Slovakia and a surfing excursion to Devon.

CLIENT FEEDBACK

We take the care of our clients and collaborators very seriously and believe it is important to continually improve the services that we offer. As part of our commitment to those we work for, we appoint independent consultants to survey our clients and measure various aspects of service delivery. This ensures that we meet the specific needs and expectations of the people we help.

Across the practice, we gather feedback formally through our Customer Survey Programme, and informally through our day-to-day working relationships. By monitoring how our performance is judged, we are able to draw out common themes and make any necessary improvements. Our executive board regularly reviews this feedback and implements changes accordingly.

“Their ability to see the broader issues and link them across technical disciplines truly sets them apart and makes them an essential asset to our design team.”

Tomas Rossant
Partner, Ennead Architects

“I like their cultural style. There's an ease of working that means you can overcome any performance issues that arise as the relationship is good.”

Ian Williamson
Chief Project Delivery Officer, The Red Sea Development Company

“BuroHappold has lots of really talented individuals. When you work with them, you feel like you are tapping into people that are interested in – and are specialists in – their fields. You get the sense that they invest in research and innovation and so have lots to draw upon.

When designing, they are forward-looking and explore the options. This gives you confidence.”

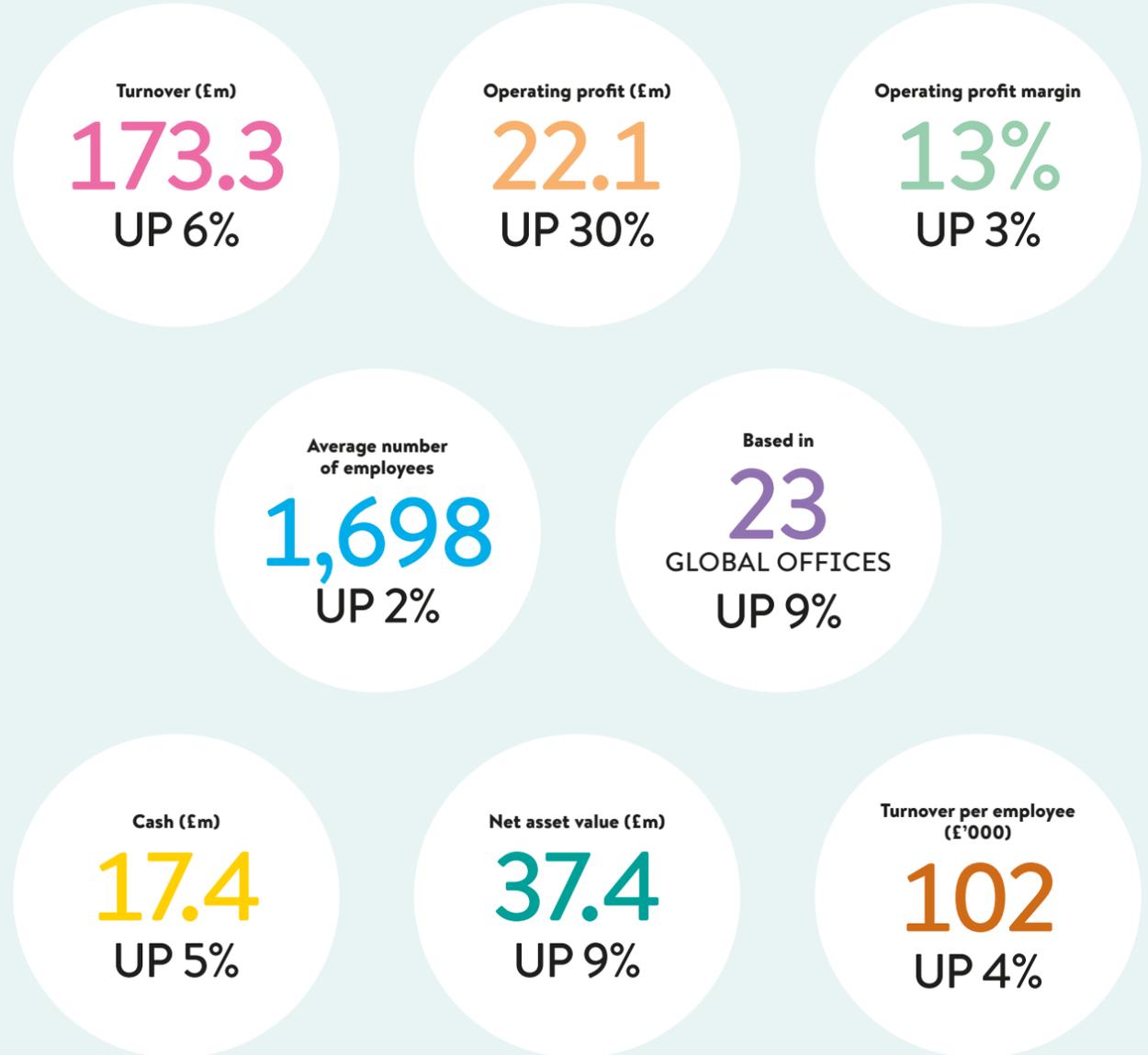
Carol Lelliott
Partner, Nicholas Hare Architects

FINANCIAL OVERVIEW



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 BuroHappold has had a successful year with a 30% increase in operating profit. This fantastic achievement is down to the skills and commitment of our exceptional people.

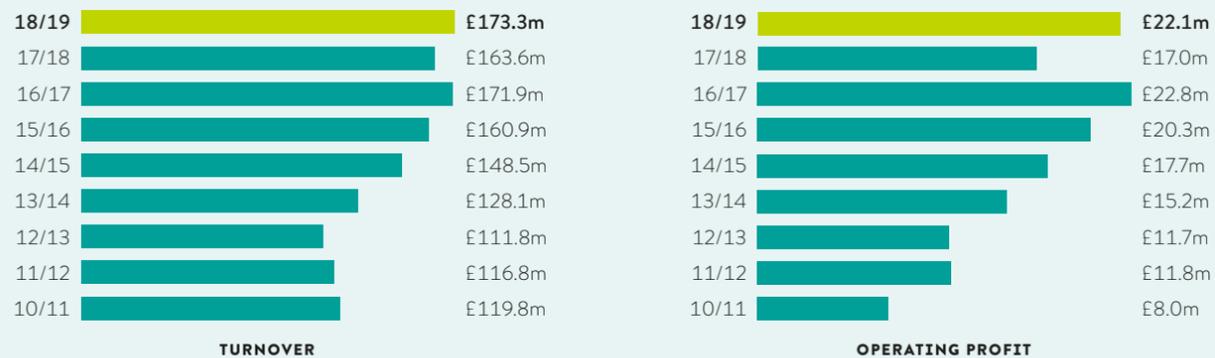
//
 James Bruce Chief Operating and Financial Officer



PERFORMANCE

The group experienced a successful year, generating turnover of £173.3m (2018: £163.6m) and an operating profit of £22.1m. This is an increase of 30% on the prior year.

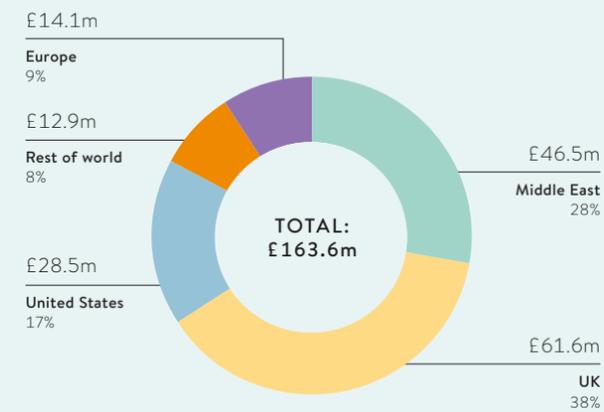
The increase in the group's turnover was driven by market conditions in the United States (+21%) and European business units (+38%), partially offset by decreases in the Middle East (-18%) and Asia (-36%).



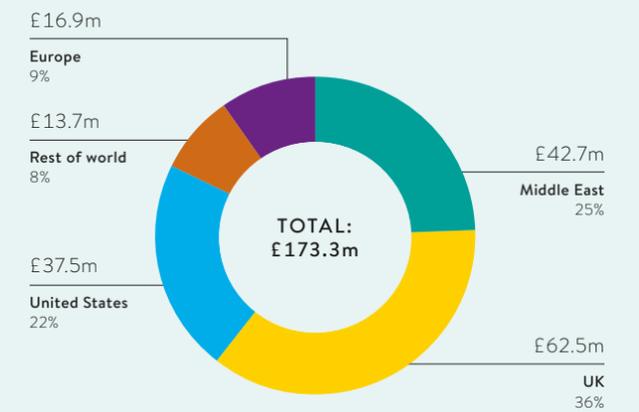
GEOGRAPHICAL ANALYSIS

The group has a significant international presence, continuing to generate turnover in over 70 countries during 2018/19.

The most significant proportion of turnover was generated from projects located in the UK (36%). Turnover from projects located in the United States increased to 22% (2018: 17%) as a result of growth in the market, while turnover from the Middle Eastern market fell from 28% to 25%.



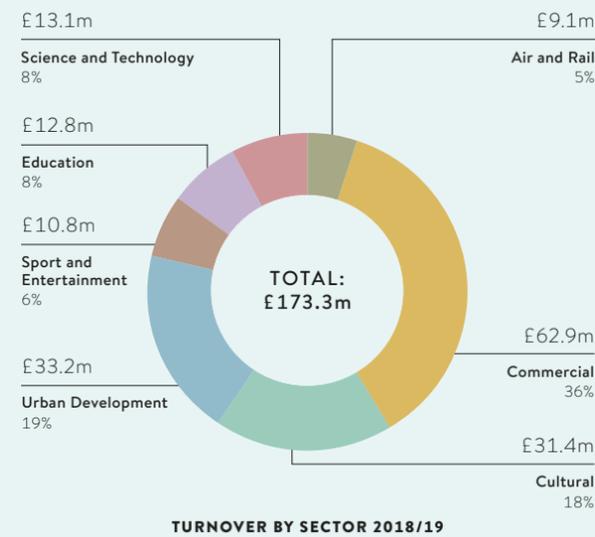
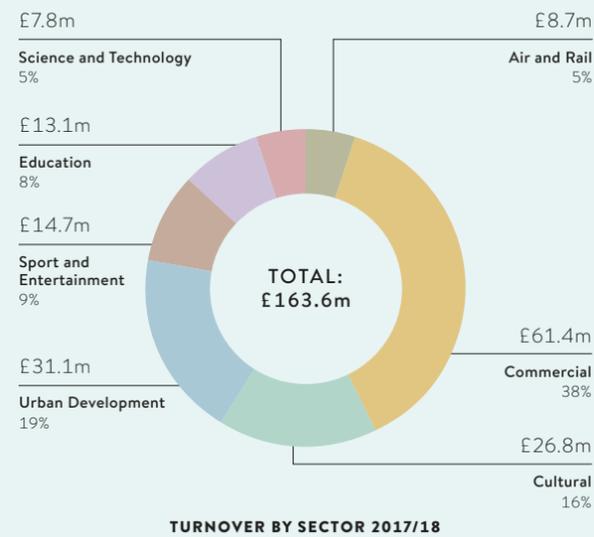
TURNOVER BY REGION 2017/18



TURNOVER BY REGION 2018/19

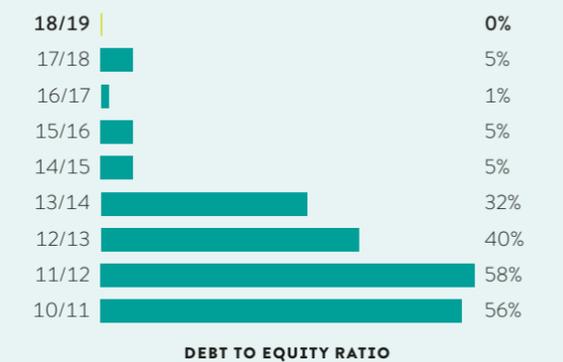
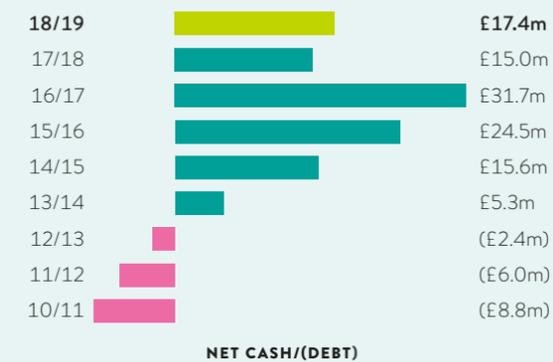
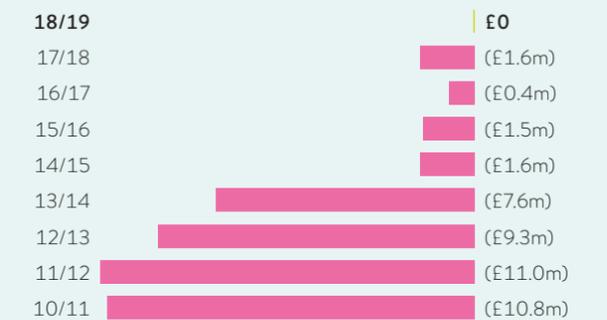
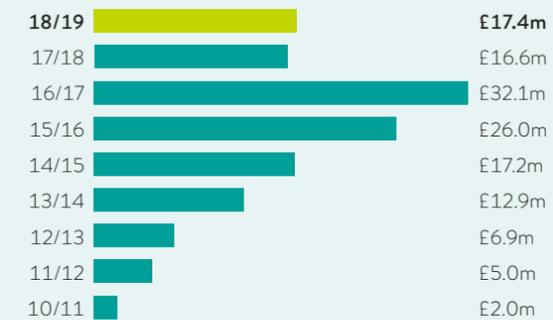
SECTOR ANALYSIS

Our routes to market through our client sectors of Culture, Commercial and Urban Development remain as strong and balanced as ever. Clients are increasingly calling for our expertise, experience and insight to be applied in the Science and Technology sector. Holding a multi-sector portfolio is of strategic importance as it allows us to understand a targeted selection of clients and their core business needs, while simultaneously allowing those experiences, insights and innovation gains to be cross-fertilised. This enriches our contribution to each and every sector.



LIQUIDITY

The group's liquidity position strengthened during the year, with a 16% improvement in net cash and the bank overdraft being fully repaid. This was largely driven by the group's ability to convert the improved profitability to cash, rather than it being required for ongoing working capital.



WORKING CAPITAL

Working capital management remains a key focus for the group, as evidenced by the 10% reduction in trade debtors and 16% reduction in DSO from 120 to 103 days. This has contributed to the increase in cash held by the group from £16.6m to £17.4m.

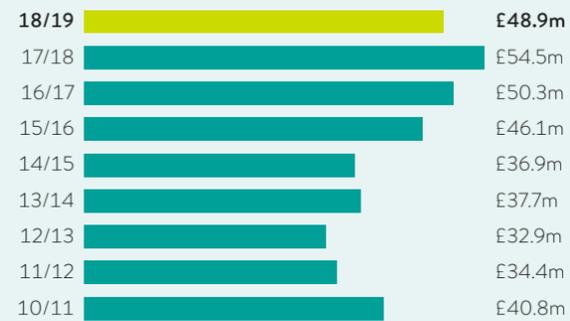
PEOPLE

We are dependent on the skills and commitment of our people. Throughout the year, we have been extremely proud to be able to attract and nurture exceptional talent at all levels. Through development, succession planning and strategic recruitment we aim to ensure our leadership capabilities are focused where they are most needed, facilitating sustainable growth throughout the business. We engage employees through our Young Engineers Forum, Share our Skills and other programmes, which help to inspire the next generation of engineers and professionals.

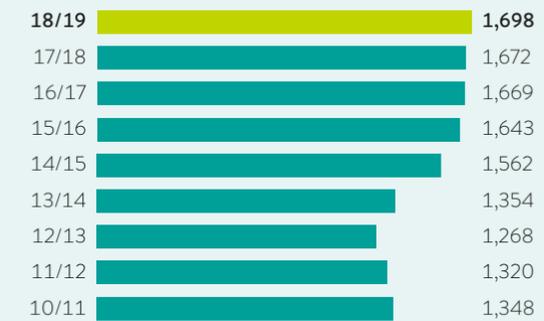


DSO DAYS

Days Sales Outstanding (DSO) represents the average number of days in which trade debtors are paid.



TRADE DEBTORS



AVERAGE NUMBER OF EMPLOYEES



What I know about engineering is that it has to be a group activity. The best work is done by the most diverse group of talents who can still live together.



Sir Ted Happold 20 October 1992

ACKNOWLEDGEMENT

We are grateful to all those who have contributed to this snapshot of our work over the last year and beyond. We always work as part of a larger collaborative network, both internally and with our external collaborators. It would have been impossible to produce this without their enthusiasm, knowledge and experience.

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