

# Reimagining property in a digital world



## **Arup Digital**

Arup Digital combines innovative digital solutions and processes with our domain expertise across the built environment. From digital strategy to design to operations and beyond, we help clients exceed their goals by leveraging the breadth of our global organisation and our world-class depth in digital and the disciplines needed to deliver successful projects in the built environment. We call our approach Total Design in a digital world, in which we believe it is important to consider the physical, human and digital dimensions to a project when proposing solutions. This results in better decisions, better engineering and better outcomes.

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## **Arup Foresight, Research + Innovation (FR+I)**

Foresight + Research + Innovation is Arup's internal think-tank and consultancy which focuses on the future of the built environment and society at large. We help organisations understand trends, explore new ideas, and radically rethink the future of their businesses. We developed the concept of 'foresight by design', which uses innovative design tools and techniques in order to bring new ideas to life, and to engage all stakeholders in meaningful conversations about change.

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*“As a manager and developer of commercial, retail and industrial property, a clear vision about the role and benefits of digitisation across our whole business is critically important in the short to medium term to ensure our assets meet the needs of key stakeholders including customers, tenants, service and utility providers. Our goal is to develop a digital strategy that enables operational and user experience consistency across the assets we manage, in turn seamlessly connecting people to the unique places we create for them.*

*In this way AMP Capital, and its key stakeholders, benefit from economies of scale, leveraging the potential for enhanced user experience through data and digital technology. We recognise that achieving this objective requires a strong focus on governance, procurement, roles and responsibilities and communication, which are key to ensuring we efficiently and effectively meet the future needs of key stakeholders.”*

**Louise Mason**

Chief Operating Officer, Real Estate

AMP Capital

**Digital technology continues to disrupt and remake our world, and the property sector is beginning to experience the transformation.** In this report we look at how digital technology and big data is changing the way leading property managers are making key decisions and improving the value of their portfolios.

### **Better decisions, better engineering, better outcomes**

Digital design tools save time and money and ensure consistency with critical design standards. Intelligent building management means owners can anticipate the needs of tenants or employees before they become apparent, and provide real time information to end users. And a combination of sensors and data analytics offer improvements to operational performance of buildings across every metric.

The report highlights examples of every one of these opportunities, but makes clear that the property sector has not yet fully committed to operating digital property portfolios. Individual initiatives are often isolated, and as a result the full benefits are not realised. The message for developers and corporate real estate executives is that every business will need its own digital strategy if it wants to improve operational performance, the end user experience and produce higher long term valuations.

### **How to become a digital property leader**

Our Run/Grow/Transform strategic framework for digital property management shows how clients can deliver real changes at the asset level now, but also progress towards a more connected strategy across their portfolios.

The report explains how...

- Digital brings together physical data about a building with awareness of the changing requirements of the people who work, shop or live in the buildings to produce better

building performance

- Virtual and augmented reality technologies are enabling smarter property planning and design
- Digital can boost rental yields and improve employee retention
- Live, sensor-based analytics can significantly reduce operational costs
- Digital brings increased control to end user experiences, which drives up everything from wellbeing metrics to productivity.

We also draw inspiration from organisations showing digital leadership, including:

- The White Collar Factory in London, which has integrated digital technologies into its design, providing tenants with greater control over every aspect of their working environment
- The University of British Columbia which is using data to make strategic decisions about its entire buildings portfolio
- A digital sustainability performance tool that Arup developed for a major international hotel group, resulting in operational savings as high as 25% at some properties

In this new era every business must become a knowledge business. Arup believes it is now critical to consider the physical, human and digital dimensions simultaneously to achieve better outcomes. Digital challenges everyone in the property sector to rethink both the nature of our goals and the means to achieve them. Reimagining property in a digital world charts the course forward.

# Executive summary

## The property sector is on the verge of a huge leap forward in how it uses data-driven, digital products and services to make better decisions, construct better projects, and achieve better outcomes.

Ubiquitous sensors, flexible and open IT systems and powerful cloud computing are creating more seamless and integrated experiences in many sectors. But property development often hasn't kept pace. For example, traditional project budgeting isn't yet aligned with the needs of a more integrated world. Costing processes fail to deliver the digital experiences that tenants or employees increasingly expect. And the balance of CAPEX and OPEX is changing as some previously fixed products become services with recurring costs and revenues. New thinking is needed.

There are three stages to reimagining property in a digital world. We call the first stage of digital adoption the **Run** phase. Many firms are at this point, using digital tools and approaches for specific, tactical projects, gaining some tangible benefits as a result. We'll explore some of these projects in greater detail throughout this report.

### Digital Benefits across the asset lifecycle



#### Portfolio strategy

A data-driven investment strategy improves decision making and returns  
Portfolio-level performance analysis creates operational cost savings



#### Construction + fit-out

Faster, more cost-effective, and accurate project delivery  
Process virtualisation enables more efficient transition between design/engineering and construction  
Safer, smarter construction



#### Project planning

New forms of stakeholder engagement make better project delivery & outcomes  
Better site selection using data-driven analysis and visualisation  
Using digital to differentiate



#### Asset operations

Transforming asset operations through digital infrastructure and processes  
Understanding the occupant experience  
Increasing flexibility and integration through open building systems  
New value-added service propositions result from digital / data infrastructure



#### Design + engineering

Faster, cheaper, and more accurate existing conditions modelling  
Digital design simulations improve the future user experience

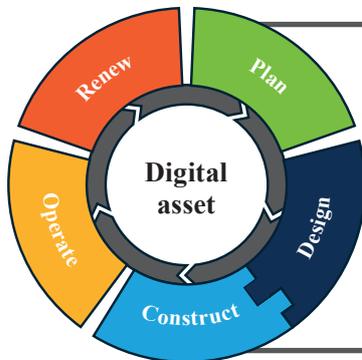


#### Asset renewal

Portfolio-wide intelligence means smarter asset renewal  
Online platforms enable the sharing, sale or reuse of valuable materials at their end of life  
Digital knowledge platforms streamline renewal projects

The **Grow** phase occurs when leading-edge firms begin to move beyond using isolated tactical digital solutions to solve distinct problems in the lifecycle of their assets. Grow businesses widen their focus to see how the entire asset lifecycle can be improved using digital tools and approaches. In this phase of the digital journey additional emphasis is placed on the transitions and hand-offs between phases.

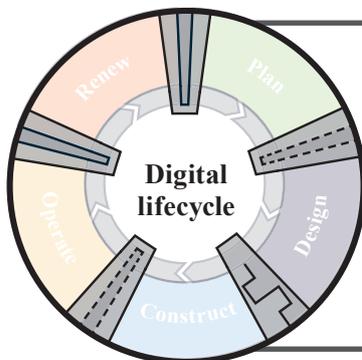
The third and final phase of digital maturity is **Transform**. Clients now benefit from a single, integrated, digital master plan that adds value not only across all phases of the lifecycle of any single asset, but also across the entire portfolio of assets, whether local, regional or global. This leads to increased long term valuations, improved end user experiences, and better operational asset performance.



### Run

Tactical digital implementations improve outcomes at each distinct phase of the individual asset lifecycle.

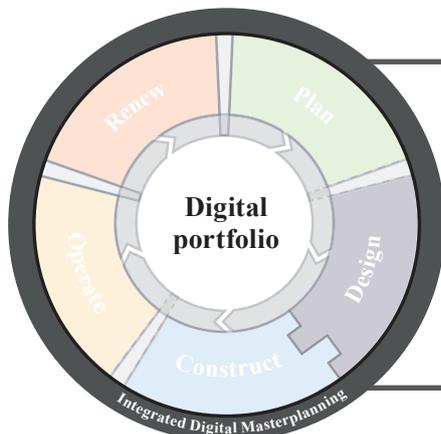
- From planning to design/engineering to construction to operations and to eventual asset renewal/sale, many developers and corporate property executives tactically use digital tools and approaches to improve performance



### Grow

Digital tools and approaches create new value during transitional phases across the individual asset lifecycle.

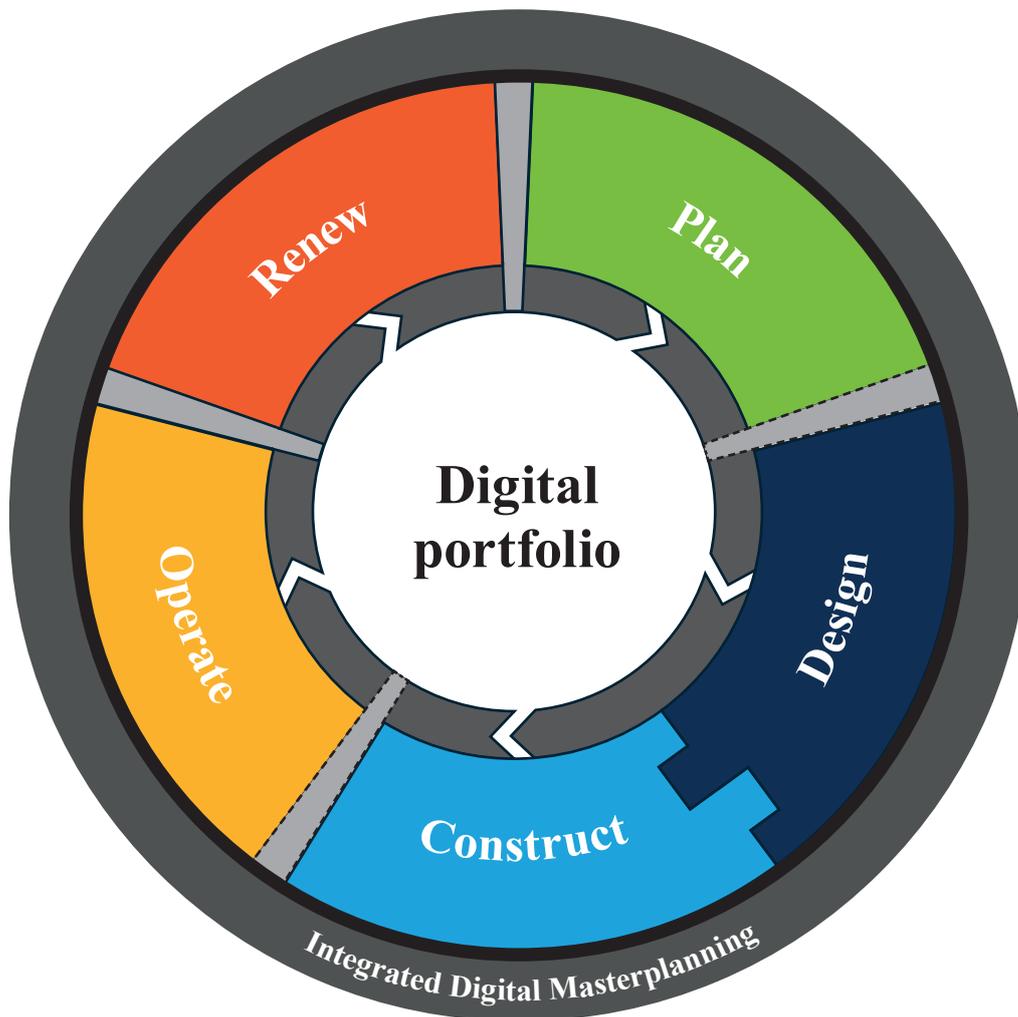
- Digital's role in design and construction is well established and continuing to evolve and strengthen
- Significant opportunities exist for digital to create value between planning > design and construction > operations



### Transform

Integrated digital masterplanning adds value across the entire asset lifecycle and across the portfolio.

- In the future, the availability of data coupled with new computational/analytical power and open, flexible digital systems will create the possibility of fully integrated digital masterplanning at both the asset and portfolio scale.



### Transformed at every level

Digital transformation improves portfolio *efficiency* by increasing integration and automation of building operations. It makes the facilities manager's role far more strategic, and maximises use of the building and its assets. It also drives up tenants and occupants' expectations about the experience produced, both functionally and emotionally. Users benefit from a range of integrated services that support individual needs and preferences. And given buildings' long lifecycles, digital transformation represents increased *agility* by giving property owners and managers new abilities to adapt to changing user needs over the lifecycle of the building.

These buildings provide a wealth of actionable data that allow far better portfolio management and planning for the future. For property decision makers, these new cloud-based data systems, powered by artificial intelligence, will make it possible to store, process and visualise data that create portfolio-wide insights.

# Drivers of digital change: Forces fuelling the shift

1. A digital society wants digitally enabled spaces
2. Experience and place are increasingly important differentiators
3. The falling price of technology is changing the digital business case
4. The Internet of Things (IoT) is enabling ubiquitous digital integration
5. Open protocols enable new forms of integration and control
6. Cloud-based computing and storage enables faster set-up and scaling
7. Digital and physical environments are merging to form hybrid spaces
8. Environmental regulation will drive demand for improved asset performance
9. The sharing economy is disrupting the economics of ownership and usage

## **Digital technology is remaking property in many different ways at once.**

From retail to mobility, hospitality to education, technology is changing the way whole sectors function. Sometimes this unlocks previously unknown opportunities, but as often it poses new potential threats. For property, perhaps the biggest single change is the user – whether working, travelling, shopping or enjoying themselves, every building user is a digital native now. Understanding how to respond to the needs of these always-connected users is central to property’s next chapter.

### **A digital society wants digital spaces**

Digital lifestyles are behind much of the growth of digital’s role in the property sector. For many – particularly those who have come of age with the internet – it is second nature to expect a digital interface to be the ‘command centre’ of our lives. Predictions are that in 2022 there will be 8.9 billion mobile subscriptions globally - up from 2.6 billion in 2015 (Mobility Report, Ericsson).<sup>1</sup> In a very short span of time, smartphones have already become the de-facto tools for many – personal and professional – and result in a hybrid work/life that is both seamless and on-demand. *Increasingly we all expect everything to offer a personalised experience. What does this mean for property development?*

### **Experience and place are increasingly important differentiators**

As firms increasingly compete for the best talent and districts compete to attract new business, the importance of creating places that appeal to people has never been greater. According to the recently published report *Creating 21st Century Communities*, “mixed-use, walkable developments generate 10 times as much tax revenue per acre, save almost 40 percent on up-front infrastructure costs, and result in about 10 percent lower service delivery costs than sprawl development.”<sup>2</sup> *Digital platforms can be a key value driver for property stakeholders when it comes to place and experience. Defining the right strategy and infrastructure enables*

*a fast and flexible system upon which to layer a range of paid and free services that tenants and visitors alike can enjoy. Elements like reliable, high-speed public Wi-Fi or digitally interactive public art, are becoming the features of successful spaces.*

### **The falling price of technology is changing the digital business case**

Unlocking the true potential for digital property requires real-time awareness of system operations, asset performance, and human experience in order to glean powerful insights. All of this, in turn, requires remote sensing, efficient data flows, and powerful processing. The diminishing costs and expanding performance of sensors are now making this possible. The average sensor cost in 2020 will be close to \$0.38, down almost 70% from an average unit cost of \$1.30 in 2004 (Goldman Sachs BI Intelligence estimates).<sup>3</sup>

### **The Internet of Things (IoT) is enabling ubiquitous digital integration**

The Internet of Things (IoT) is a rapidly-expanding network of objects and devices, all of which are outfitted with sensors and embedded connectivity. In the building context this could be anything from desk lights to thermostats, HVAC systems to power outlets, even individual smartphones. *By linking all of these sensors via a network with real-time data processing,*

**CASE STUDY:** A digital society wants digitally enabled spaces

## *The meteoric rise of the digital personal assistant*

Global sales of Digital Voice Assistant Devices such as Alexa and Amazon Echo are growing rapidly, from 1.1 million units in 2015 to a projected 15.1 million units in 2020.<sup>4</sup> Consumer technology now drives expectations at work. As people grow accustomed to taking action and activating home services as easily as having a conversation with a neighbour, how should the workplace respond?



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Paul Hudson CC BY 2.0

**CASE STUDY:** Experience and place as important differentiators

## *King's Cross: interactive and creative place-making*

Once a thriving industrial hub, by the mid-1980's King's Cross had become the lowest-rent area for offices in central London. Now regenerated, the 67 acre site has become a global exemplar of high-impact creative place-making through public space and amenity design, "with...26 acres (10.5 ha) of open space to form a new public realm for the area." It's also "London's largest outdoor, free public Wi-Fi zone – creating an 'always on' experience throughout the public areas." As a result, King's Cross has attracted some key tenants like Google and University of the Arts London and breathed new life into the area.<sup>5</sup>

**CASE STUDY:** Open protocols for new forms of technology integration

## *IoT desk gives more control to the user and more data to the owner*

Currently, the majority of office spaces are fitted out with inflexible systems that offer few customisation options. What if we could hand control to an individual desk's occupant, enabling them to be more comfortable and productive by providing a more personalised and intelligent workspace, at low cost, whilst also reducing energy consumption? The innovative 'All about the Desk' research project is exploring how technology and occupant interaction within buildings could be radically changed by drivers ranging from mobile technology to pervasive networks, sensors, low voltage direct current and rapid manufacturing.<sup>6</sup>



*the IoT enables powerful analytics and new automation opportunities. This paves the way for optimisation and customisation of everything from the system scale down to the individual's experience.*

### **Open protocols enable new forms of integration and control**

Buildings have multiple data systems (IT, HVAC, Lighting, Security, Fire, AV) which often have limited interoperability due to a lack of common, well-structured languages and protocols. Providing an open controls approach based on scalable web technologies enables simplified, adaptable, horizontal integration of sensing and actuating systems at lower cost. *Making data accessible using open standardised APIs and intuitive interfaces will help create a building-wide Internet of Things usable in a joined up way to create more value for occupants and operators.*

### **Cloud-based computing and storage enables faster set-up and scaling**

The Cloud enables “ubiquitous, on-demand access to a shared pool of configurable computing resources (e.g., computer networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort.” *Cloud-based computing helps shift digital resourcing and investment from a capital expense to an operating expense, creating a fertile ground for a proliferation of digital services that can create value for developers, tenants and owner/occupiers.*

### **Digital and physical environments are merging to form hybrid spaces**

Building Information Modelling (BIM) is making it possible to coordinate complex, interdependent systems in a data-rich virtual environment to improve design, engineering and construction, and in the near future, building

operations and maintenance. According to the 2016 National BIM Report – the most comprehensive analysis of the state of BIM in the UK construction sector – of the over 1000 construction professionals surveyed, 86% expect to be using BIM on their projects within the next year, and 97% expect to be doing so within the next 5 years.<sup>7</sup> *Additionally, virtual reality and mixed/augmented reality are making it possible for design teams, engineers, and owners to explore possible solutions early in their development processes, and allowing tenants to experience spaces before they're built.*

### **Environmental regulation will drive demand for improved asset performance**

According to a 2016 report by the World Economic Forum, the real estate sector annually consumes over 40% of global energy, emits 20% of total global greenhouse gasses (expected to grow an additional 7% by 2030), and uses 40% of global raw materials (3 billion tonnes per annum).<sup>8</sup> *Required public disclosure of energy use in commercial buildings is rising globally. Property owners and managers will need smart infrastructure to enable cost effective and timely monitoring of resource usage and performance.*

### **The sharing economy is disrupting the economics of ownership and usage**

Location has always been a major determinant of property value. But now work can be more mobile, will location become less of a factor? A 2015 report by PwC claims that 57% of Americans see “access as the new ownership” with 86% saying that sharing makes life more affordable and 83% saying it adds convenience and efficiency.<sup>9</sup> *Technology companies like AirBnB, Zillow and Uber are building services that enable employees, tenants and residents to access what they want, when they want it, wherever they are. In a digital world, will valuations based on location be affected by hypermobility and virtual access to everything everywhere?*

**DATA:** Cloud-based computing and storage

## *The cloud grows... in use and cost*

**USAGE:** Cisco's Global Cloud Index estimates that, by 2019, 2 billion Internet users (or 55 percent of all consumer Internet users) will use personal cloud storage, up from 1.1 billion users in 2014. Globally, consumer cloud storage traffic per user will be 1.6 gigabytes per month by 2019, compared to 992 megabytes per month in 2014.<sup>10</sup>

**COSTS:** IDC predicts cloud IT infrastructure spending will grow at CAGR of 15.1% from 2014 to 2019, reaching \$53.1B billion by 2019. By 2019, IDC predicts cloud IT infrastructure spending will be 46% of total expenditures on enterprise IT infrastructure.<sup>11</sup>



**ZO.**

Dave Doe CC BY 2.0

**CASE STUDY:** The sharing economy vs the economics of ownership

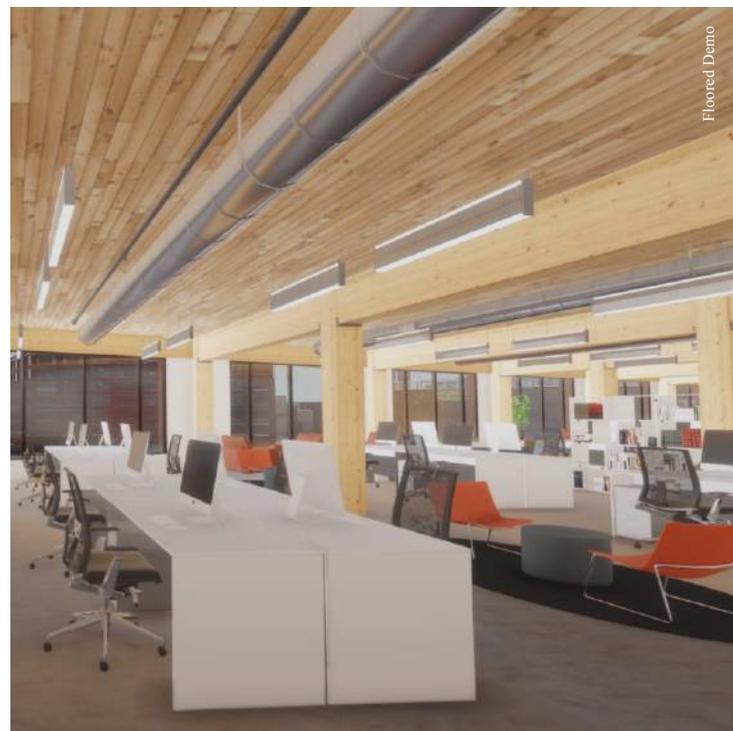
## *Tishman Speyer 'Zo' brings shared services to building occupants*

Developer Tishman Speyer has responded to the digital lifestyle preferences of today's users by partnering with leading digital and physical service providers. Their Zo platform offers a range of services focused largely on work-life balance for its tenants (companies both big and small). Services include wellness, on-demand child care, on-site medical, travel, personal grooming, ridesharing, HR services, and food and catering. Zo has been rolled out at Rockefeller Center in New York City, and the company aims to expand its use to their entire global portfolio.<sup>12</sup>

**CASE STUDY:** Digital and physical environments are merging

## *Floored: 3D visualisation for better decision making in CRE*

Floored is a New York City-based real estate technology company that uses 3D camera technology to scan apartments, offices, and houses to develop customisable 3D models. The platform allows users to create interactive, immersive environments that can be manipulated by architects, developers, brokers and even potential tenants. This interactivity allows future tenants to quickly evaluate a space, test virtual furniture options, adjust lighting conditions, and view the space from any angle.



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*“Our most important job is to serve the 250,000 people who work in our buildings each and every day. Instead of defining ourselves by the square feet we own, we will define ourselves by the quarter million people who use the square feet and how well we tend to them.”*

**Rob Speyer**  
CEO, Tishman Speyer

# The digital property revolution:

Driving improvement at every phase of the property cycle

**Across every phase of the property development process, digital is unlocking new value for the entire stakeholder ecosystem.** As the tools get better, faster, smarter and more powerful and the sector adapts its ways of thinking and working to fully leverage them, new opportunities will continue to emerge.

Digital tools and platforms mean:

- **Better design, engineering and construction performance**
  - e.g., faster delivery, fewer mistakes, comprehensive coordination, more data-driven decisions.
- **Better performance of assets**
  - e.g., higher asset utilisation, lower energy and water use, lower cost of operations
- **Better end-user experiences**
  - e.g., higher degrees of control, greater flexibility, more efficient feedback loops, more seamlessness
- **Better potential long-term valuations**
  - e.g., brand lift, higher awareness, increased demand for space, flexible, future-proofed assets



Portfolio strategy



Project planning



Design + engineering



Construction + fit-out



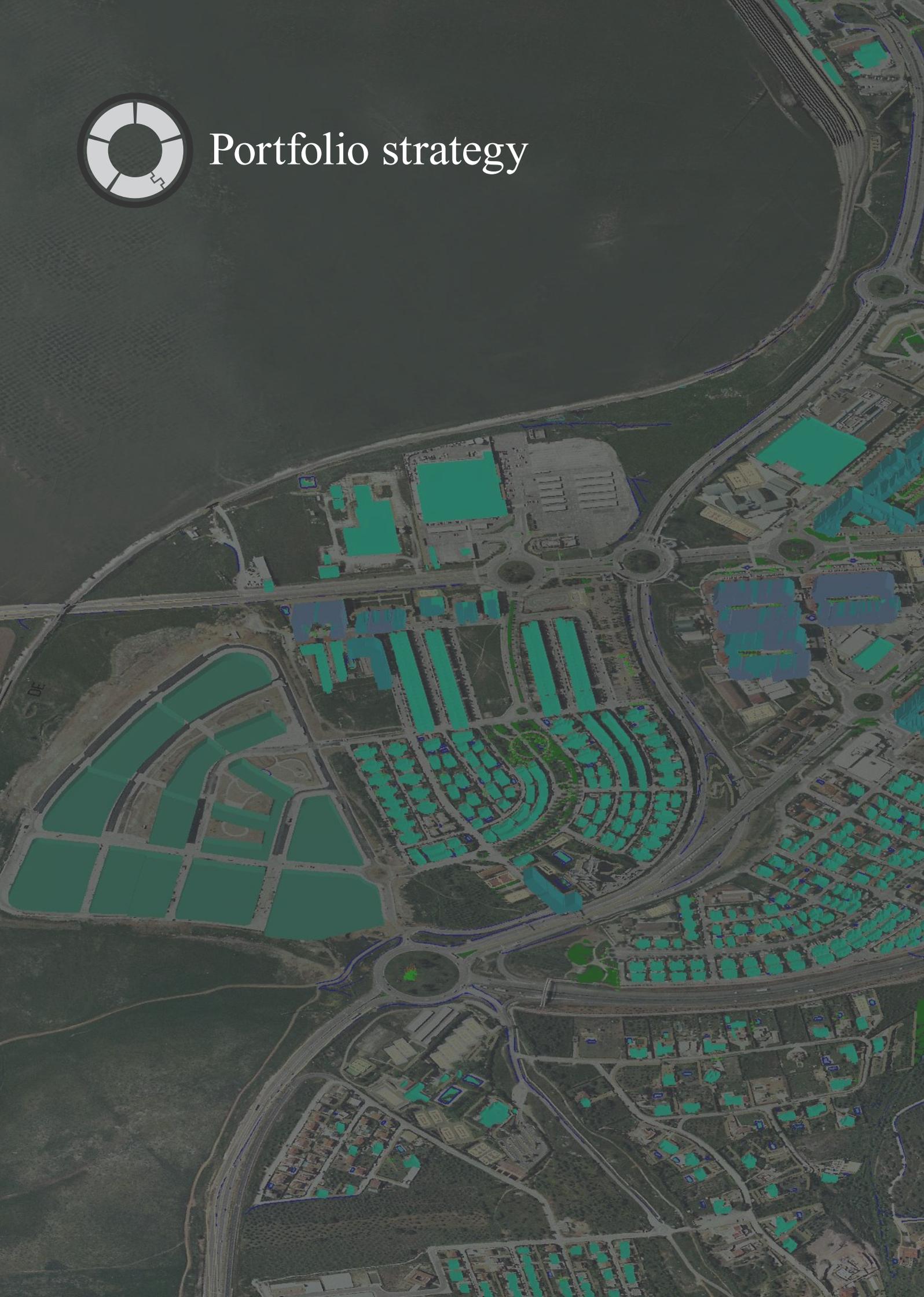
Asset operations



Asset renewal



# Portfolio strategy





## A data-driven investment strategy improves decision making and returns

At the strategy level the digital world is creating both opportunities for better decision making and uncertainties about how to effectively respond. Access to, and coordination of, information are critical. According to the JLL Global Data and Analytics in CRE Survey “75 percent of respondents report they see portfolio information as a core part of their corporate data and analytics strategy, yet less than 28 percent of corporate leaders regard themselves as data-centric.”<sup>13</sup>

*Data supports better investment decisions but requires strategic investments in workforce development and/or hiring in new skills. It also requires appropriate and strategic technology investment across the assets in the portfolio.*

## Portfolio-level performance analysis creates operational cost savings

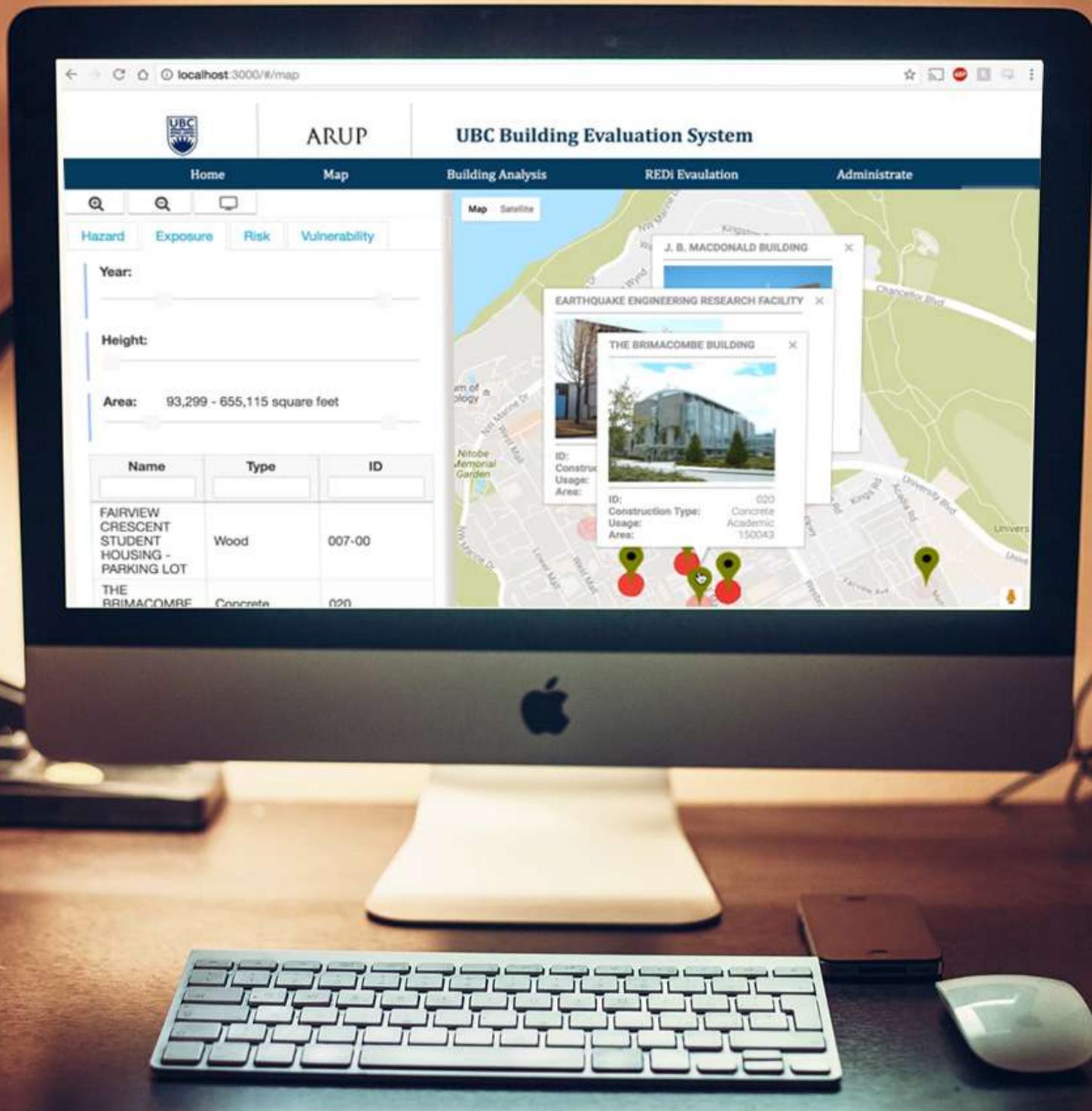
Since assets across a portfolio can span a range of ages and contain many legacy systems and technologies, deciding how best to allocate resources for improvement projects can be a struggle. Adopting a strategic and integrated approach to asset performance monitoring will establish a single source of truth. Bringing large amounts of data together will uncover trends and allow predictive analysis across the mix of assets. Taken together these enable better refurbishment decision-making, whether focused on efficiencies and cost savings, or meeting organisational and stewardship goals.



### CASE STUDY

## *Digital Globe is creating a national GIS database of all building assets across Australia*

**If you had data about every building in your market, how would you use it?** Using artificial intelligence, high-res satellite imagery, and a range of data sets, the technology firm Digital Globe is able to generate actionable, high-value insights by training computers to process large visual data sets and look for patterns, changes and anomalies. Using their Geospatial Big Data Platform (GBDX), they are helping a consortium of Australian federal, state, and territorial agencies, to build a new tool called Geoscape. This high-definition map and database of the built environment provides easy access to the physical attributes of more than 15 million structures across Australia. The tool comprises high-value location and structural data on buildings, including features like footprint and height, rooftop material, and solar panel coverage. “Geoscape will support evidence-based decision making across a wide range of business scenarios,” including planning, risk estimation, site selection, transport analysis, and emergency response.<sup>14</sup>



## CASE STUDY

### *Using digital tools to dramatically improve a university's property investment strategy*

**The University of British Columbia, Vancouver, has used data analytics to help make key property decisions and mitigate risk across their campus of 333 buildings.** The University used an Arup-developed digital insights tool which combines detailed information about every building in a portfolio, including its occupancy, contents, operations, seismic vulnerability, suggested retrofits and corresponding costs. This enables sophisticated risk assessment and cost-benefit analysis. For the University of British Columbia it also supported an integrated resilience strategy to protect students and staff wellbeing and ensure the continuity of campus operations. By digitally simulating thousands of earthquake scenarios, Arup was able to identify high-risk buildings, assess how long buildings would be unusable, which buildings would be suitable for retrofitting and which suited decommissioning. The tool is enabling the University to improve management of their budgets and space-planning for the future.



#### CASE STUDY

### *Powerful environmental performance tools for one of the world's largest hotel portfolios*

IHG (InterContinental Hotels Group) approached Arup in 2008 to help determine how to best measure and improve the environmental impact of its portfolio of hotels around the world, which now stands at 5,100 properties. As a result, the company launched IHG Green Engage, a two-pronged online sustainability tool, designed by Arup. IHG Green Engage enables hotels to set and track property-specific reduction goals for carbon, energy, water and waste. Based on these figures, Arup has developed an energy benchmarking tool that compares the usage patterns of all hotels using the system and recommends strategies for hotels to achieve their targets. **The approach has helped IHG clearly assess the performance of its hotels on an individual and portfolio level, increasing efficiency and helping hotels avoid operational costs of as much as 25% at some properties.**



# Project planning



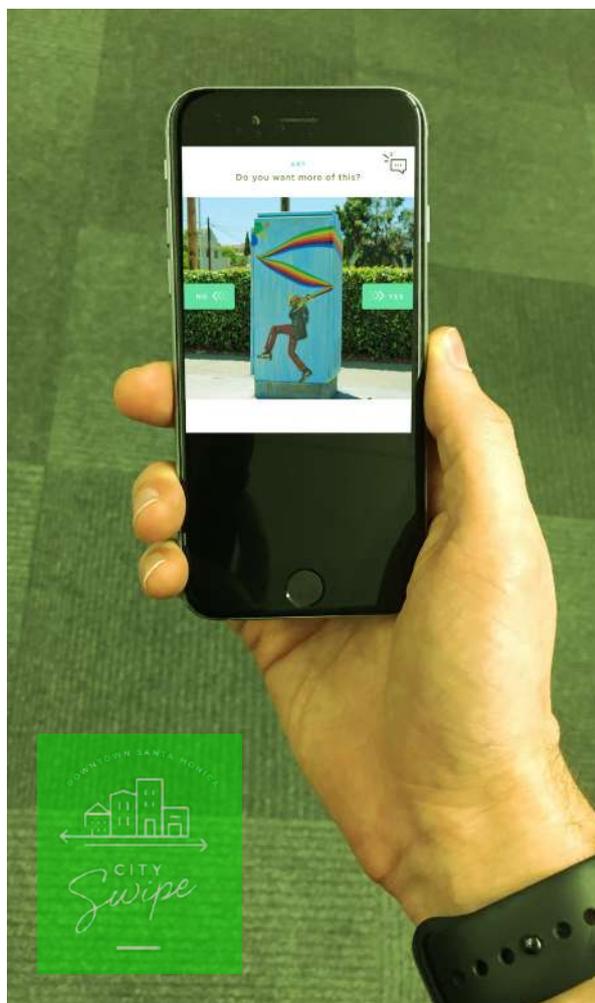


## New forms of stakeholder engagement make better project delivery & outcomes

In many property projects, effective community engagement is central to success. Failure to do so can lead to public opposition and costly delays. It can also carry significant reputational risks. According to Aon's 2015 Global Risk Management Risk Ranking, a survey of 1,400 risk-management professionals in 60 countries,

“Online reputation damage now heads the list of top 10 business risks.”<sup>15</sup> Traditional, face-to-face community engagement mustn't be overlooked, but digital tools expand the ways to engage.

*New digital visualisation and engagement tools help involve stakeholders in the decision-making process early on, giving them a greater sense of ownership and better insight on the impact of the project, ultimately reducing project risk.*



### CASE STUDY

## *CitySwipe: the Tinder of stakeholder engagement*

**How can you gauge what your tenants might want from a place?** The City of Santa Monica (CA) is attempting to gain public feedback for their new urban plan, on every aspect from benches and parking to lighting and public art. They're using a smartphone app which borrows from Tinder's swipe-to-choose functionality. CitySwipe allows Santa Monica residents to quickly view images of different scenarios and answer brief yes/no questions. For the time being, it's fairly basic: a photo of some street art appears with a caption asking: 'Do you want more of this?' But by engaging public stakeholders in this familiar way, it's hoped the planning process will better represent the preferences of the target audience, resulting in better urban experiences and greater local support.



## CASE STUDY

### *Immersive stakeholder tools smooth the planning of HS2*

Unlike architects and urban designers, ordinary people understandably find picturing proposed infrastructure design elements in real life settings somewhat difficult. This is where simulation tools have a vital role to play, particularly on large, potentially disruptive transport infrastructure projects like high speed rail. On the UK's HS2, Arup used custom-made, data-driven, visualisation and auralisation tools – VR simulations and the Arup SoundLab – to help affected communities to experience and understand the likely impacts the new service would produce. These virtual experiences enabled a grounded and reasoned conversation that helped build support for this new major rail line.

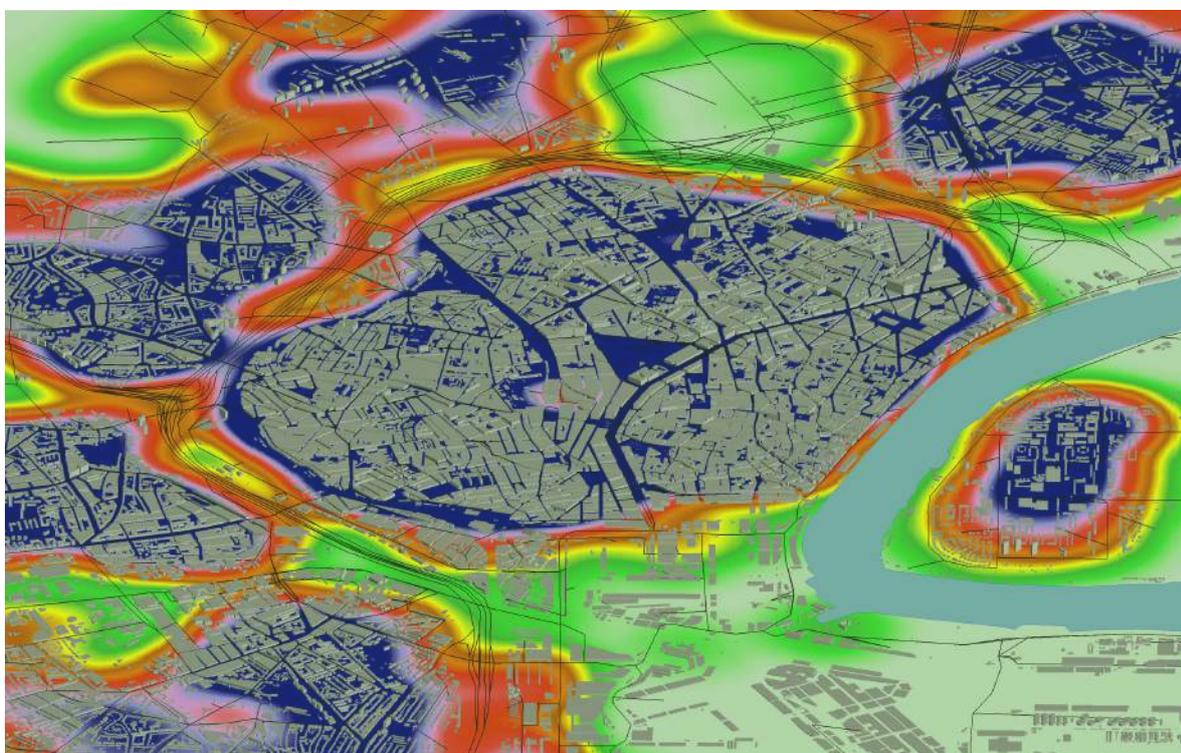


## Better site selection using data-driven analysis and visualisation

Choosing the right location for a project and understanding the constraints of that site are essential to any new development. New visualisation technology and digital analytics approaches are improving the process. Asian property portal iProperty.com gets 50 million page views and 3 million unique visitors per month.<sup>16</sup> This wealth of data enables them to generate meaningful insights about the types

of properties customers search for and the most high-interest locations. They've used this data to offer real estate professionals a dedicated site selection and intelligence tool called iPropertyIQ.

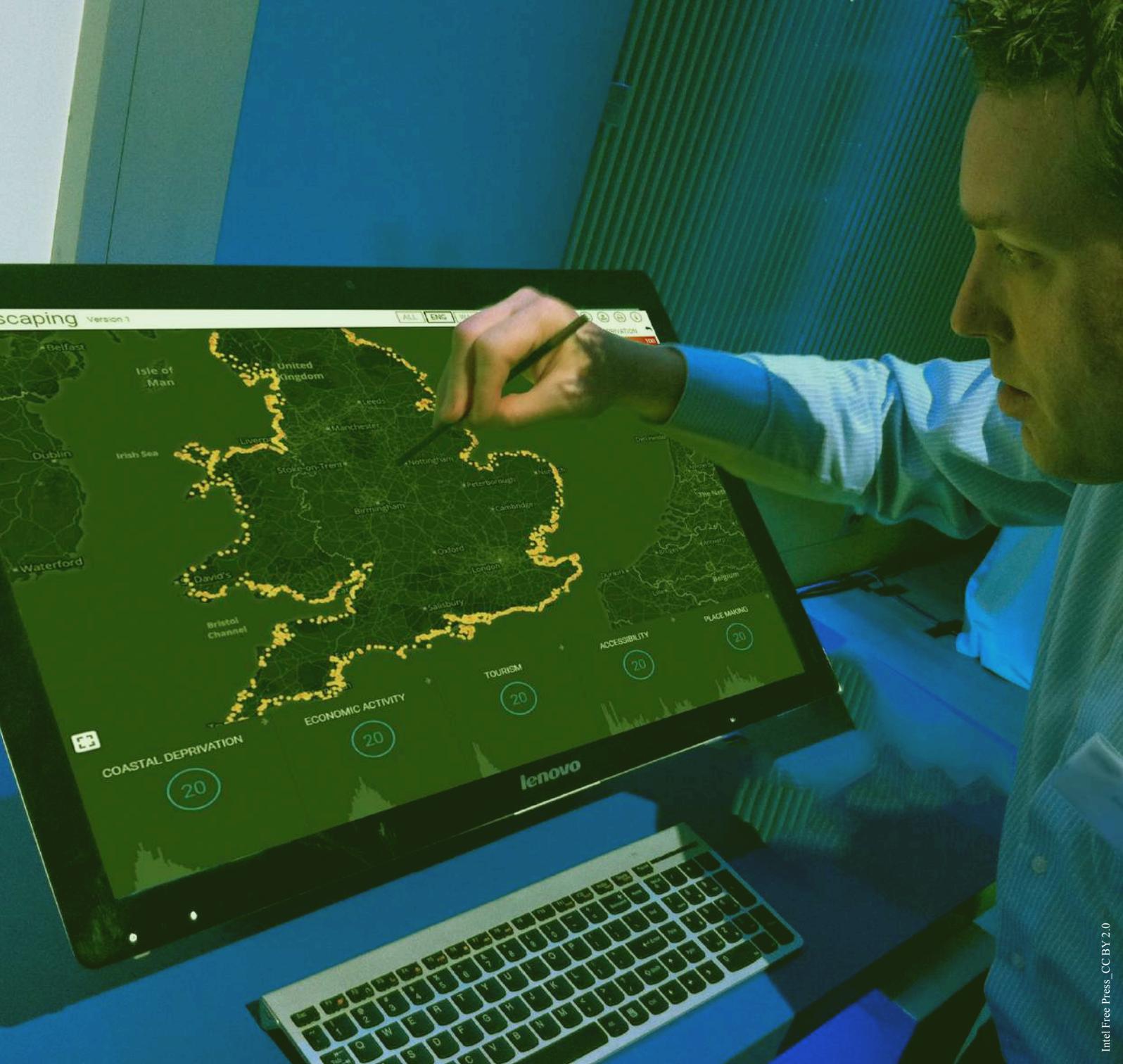
*Increasing the ease and speed of selecting the best site, as well as better understanding that location's strengths and challenges, is a critical success factor for the property sector.*



### CASE STUDY

## *ZoneSavvy: using data-driven site selection to increase retail performance*

ZoneSavvy is a web-based platform that empowers small businesses to make data-driven decisions when scouting and selecting retail locations. The platform classifies every neighbourhood in the US based on a range of characteristics and demographics, such as population density, median age, and average income, alongside existing businesses in the area. The system then compares the neighbourhood in question with similar ones, determining the optimum number of businesses the area can support as well as revealing potential commercial opportunities. For landlords or owners with properties to lease or sell, ZoneSavvy can help determine the types of businesses that would be most in-demand in that location.



## CASE STUDY

### *The Crown Estate: a data-driven approach redevelopment*

Sandscaping uses natural, near shore processes to nourish beaches and create new usable land along a given coastline. In an effort to reduce coastal flooding and, more importantly, to provide maximum socio-economic benefits to the public, the Crown Estate asked Arup to help them select, out of a possible 3000, the optimal sites for sandscaping along the British coast. Arup's digital insights team created a flexible, visual analysis tool to rapidly shortlist potential sites by prioritising and weighing a set of key criteria. The dashboard allowed the Crown Estate and their affiliated planning partners to make rapid, data-driven decisions about where to invest.



## Using digital to differentiate

In many competitive global real estate markets, digital can be a key differentiator. In functional terms this means high-speed, reliable internet and seamless connectivity make a place more desirable to live or work. A recent study by the London School of Economics showed that “home owners in London are willing to pay up to 8 per cent above the market price for properties in areas offering very fast internet speeds.”<sup>17</sup> On the experience side, digitally enabled platforms,

tools and services can dramatically improve the user experience of places and as a result, capture the imagination and create enthusiasm and interest.

*Whether you’re a developer or owner/occupier, the digital performance of an asset is pivotal to both its long-term value and your competitiveness.*

### CASE STUDY

## *Seamless and secure Wi-Fi enables a mobile corporate workforce*

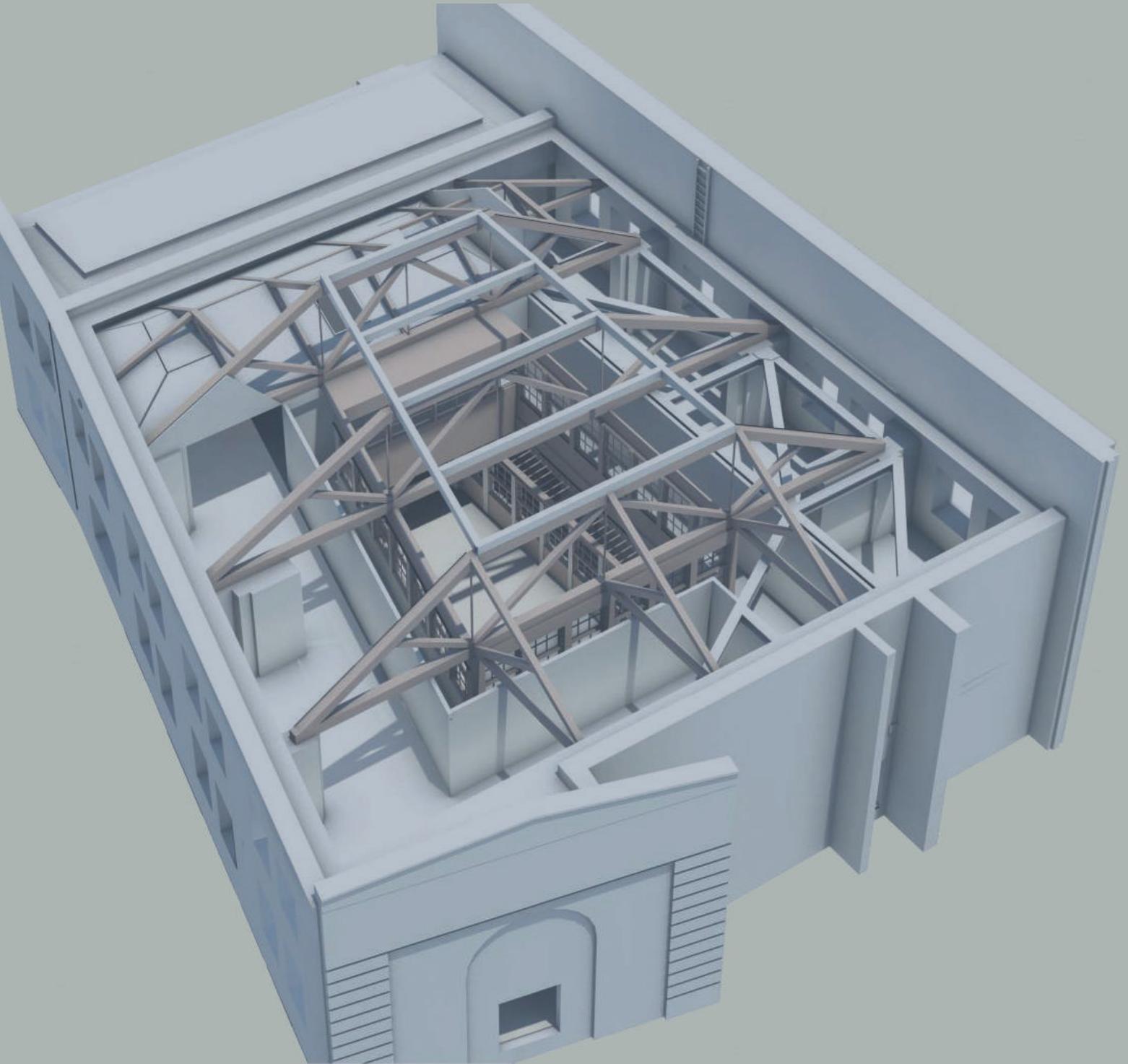
Traditionally, tenant staff can only access the internet and limited corporate computing resources via guest or public Wi-Fi accounts in the common areas of buildings. The resulting restrictions on accessing networked storage and services behind the corporate firewall limit opportunities for fully flexible working. Converged networks and software-defined platforms are enabling seamless connectivity between public and private networks without compromising security. In recent years, many hardware providers, such as Cisco and Aruba, have commercialised these integrations.



*“The rise of mobile technology and an on-demand economy are driving employees across all ages to expect... experiences in their personal lives and at work. This is becoming such a priority among HR leaders... Airbnb CHRO Mark Levy changed his job title to Chief Employee Experience Officer, signaling the importance of this to Airbnb employees.”<sup>18</sup>*



# Design + engineering





## Faster, cheaper, and more accurate existing conditions modelling

High quality retrofits and renovations require a detailed and accurate understanding of as-built assets. Traditional site survey and existing conditions techniques are laborious and time consuming. Capturing and recording measurements that are later translated from photographs, often manually, into 2D drawings or 3D models, takes countless man hours. In a professional site survey comparison, Brian Mayfield, COO of Atlantic – a remote sensing, surveying and consulting company – reports that an Airborne LiDAR Survey approach saves end clients nearly 91% in cost per line mile.<sup>19</sup>

*3D scanning, LiDAR and photogrammetry, along with other digital analysis tools (such as computer vision and machine learning software) are far superior ways to generate accurate and reliable existing conditions data. Digital techniques speed up design and engineering while also improving accuracy and reliability of the data, saving developers money.*

## Digital design simulations improve the future user experience

At the building, district or urban scale, creating brick-and-mortar prototypes to test design hypotheses can be so time consuming and costly that they're rarely attempted. However, research has shown that up to 52% of a project's cost overruns stem from rework arising from errors, changes, and omissions during design.<sup>20</sup> Online data collection and environmental sensors are now capable of generating volumes of data, thereby improving the predictive power of statistical models and simulations. Geospatial information systems (GIS) enable geographical analysis that leads to clear design-actionable insights and compelling visualisations.

*Data-driven simulation allows planning, design and engineering teams to produce hypotheses and test them systematically. This means optimised user experience outcomes and a reduction in the likelihood of costly mistakes.*

### CASE STUDY

## *Machine learning: drawing design actionable conclusions from a single image*

Predicting depth is an essential component in understanding the 3D geometry of a scene. But assessing depth from a single image is not straightforward, requiring lengthy analysis. A team of researchers from the department of computer science at NYU have developed a process that uses machine learning to generate accurate depth and geometry data from single still images.

*As the technology progresses, design and engineering teams will be able to make more reliable calculations and decisions using a wider range of inputs, including those that may previously have been seen as sub-standard.*

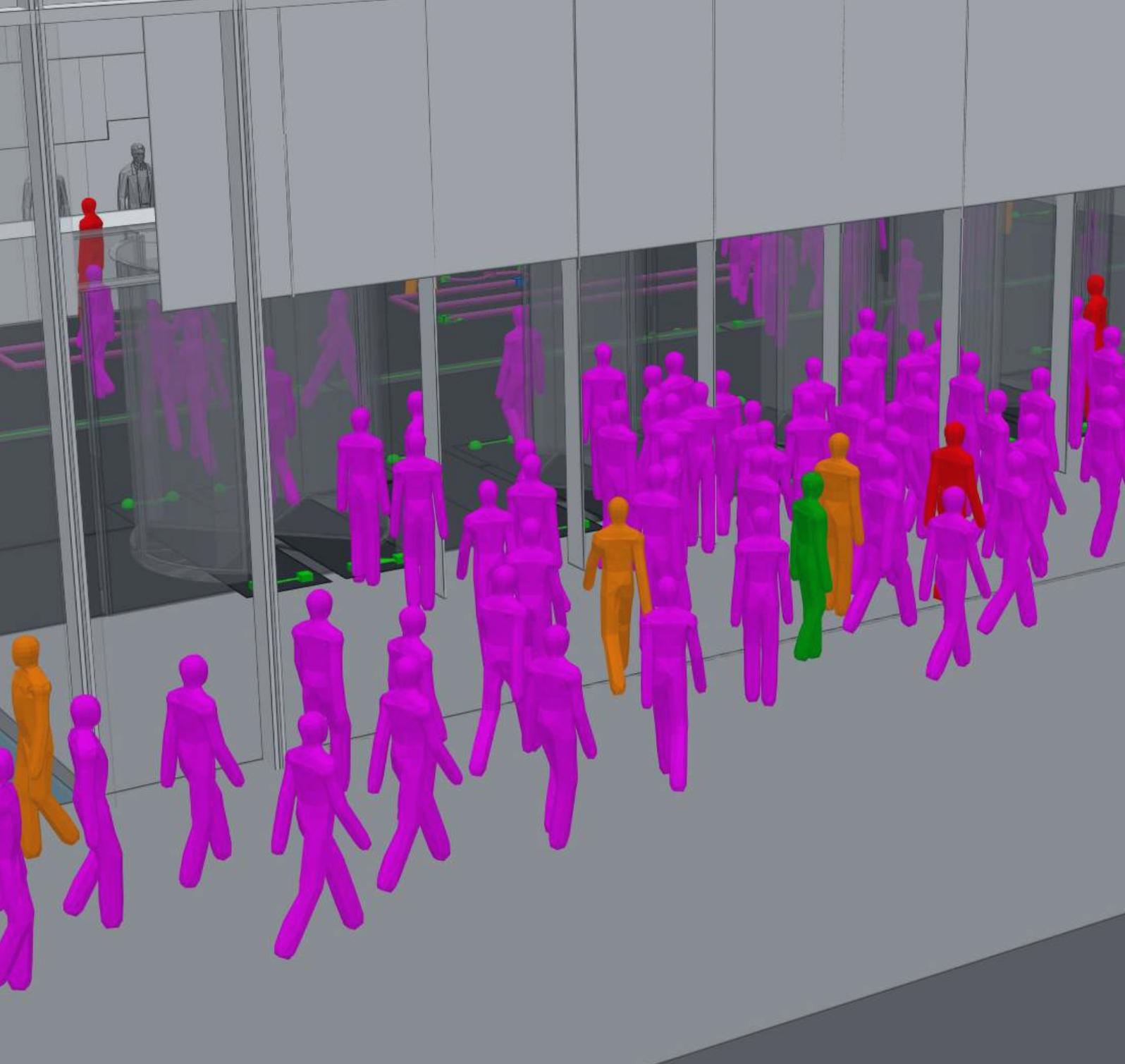


Ron Blum

**CASE STUDY: Faster, cheaper, and more accurate existing conditions modelling**

*From virtual to real: improving spaces with 3D technology*

Using 3D scanning technologies, Arup's visualisation team has been capturing highly accurate 3D representations of many public and private spaces across the globe. These scans serve as the basis for analyses and digital services: VR, analysis models, construction modelling/planning, and engineering retrofits. The team recently coupled this approach with a powerful 3D rendering and light-modelling tool to develop photo-realistic views of a Janet Echelman sculpture that will be installed in a corporate lobby in the US. *The approach is helping ensure that the investment made by the building yields the most delightful experiences for the viewing public upon completion.*



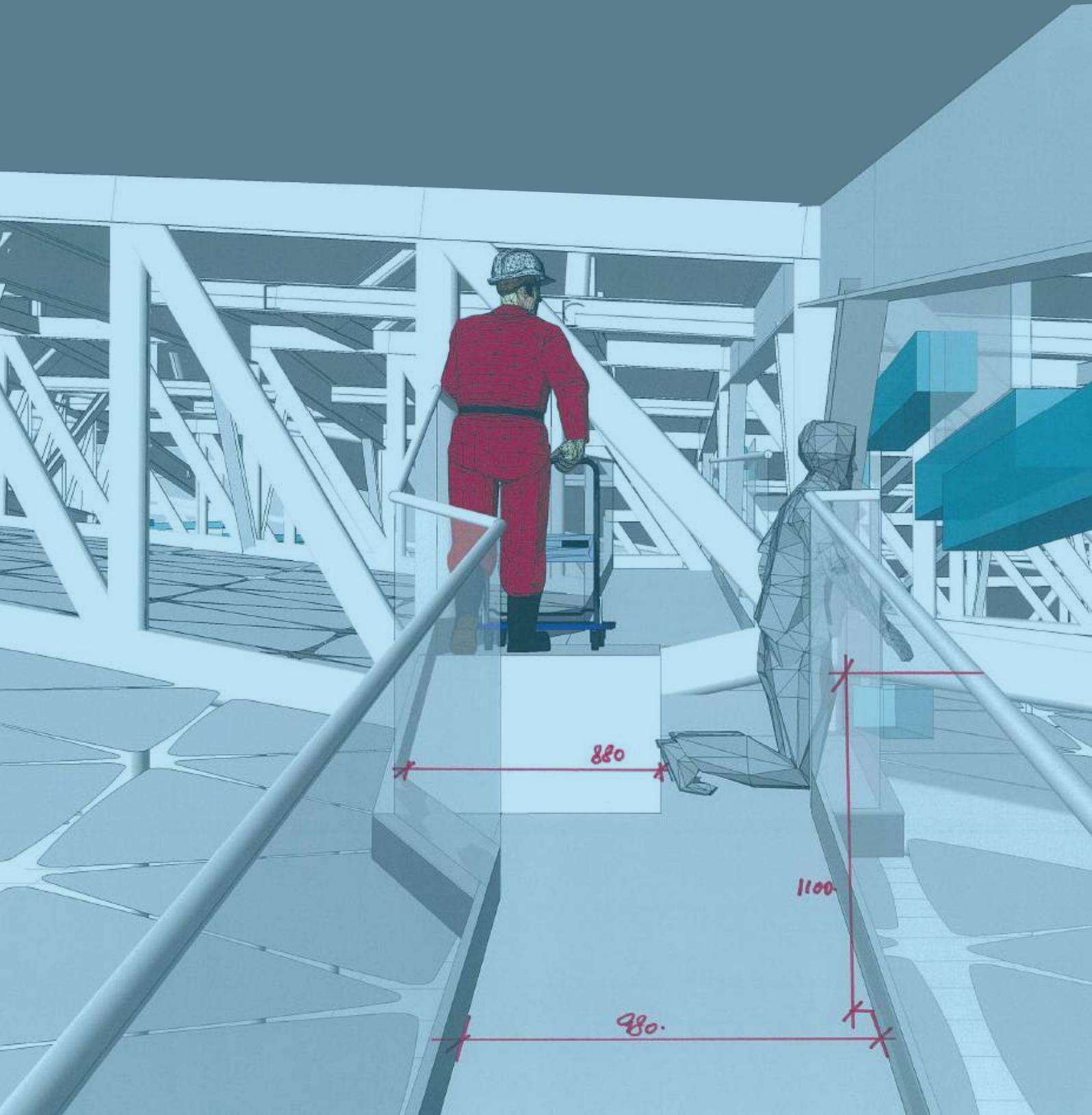
**CASE STUDY: Digital design simulations improve the future user experience**

## *Advanced simulations are transforming design*

A US-based property client recently embarked on the design and development of a Class A commercial tower in a booming new neighbourhood. Due to its location and proximity to transit, the tower's entry points and lobby would need to effectively accommodate waves of foot traffic during peak periods of the day. Arup used its MassMotion modelling software to run advanced pedestrian simulations which helped our client assess anticipated user demands at building entry points and within circulation spaces in the lobby. *This approach enabled the developer to understand user flow patterns and magnitude of demand, and optimise the design to create the best possible experience for future employees who would flow through the space every day.*



# Construction + fit-out





## Faster, more cost-effective and accurate project delivery

Cloud-based Building Information Modelling (BIM) creates a single, unified model that design teams, and owners/decision-makers can access in real-time at any stage of project delivery. This shared model links project planning, design, engineering, construction planning and simulation, as well as enabling construction visualisations and digital fabrication. In the pre-construction phase, BIM enables easier, quicker visualisation to communicate with general contractors, subs and inspectors. 3D and 4D visualisation also enables optimised logistics and sequencing efficiencies as well as faster, more accurate pricing.

*According to a recent webinar by the Institute for Civil Engineers (ICE), BIM and lean construction management can accelerate the construction process by as much as 26%.<sup>21</sup>*

## Process virtualisation enables a more efficient transition between design/engineering and construction.

The construction of most complex assets (including buildings) requires the careful coordination of a number of teams. With traditional 2D drawings, the transition points between teams can be fraught with issues, requiring time-consuming back-and-forth coordination and often leading to mistakes and delays. But that's changing with the use of digital and virtual tools like BIM, augmented reality, and virtual reality. According to a 2016

study by Oxford Economics and Virgin Business Media, only 44% of UK construction industry stakeholders say they are currently able to collect relevant and reliable data, but 76% believe digital information will be a key priority in 3 years' time.<sup>22</sup>

*For property executives, this signals a future with higher levels of transparency and accountability between them and their design partners, as well as increasingly joined up and well-coordinated delivery processes.*

## Safer, smarter construction

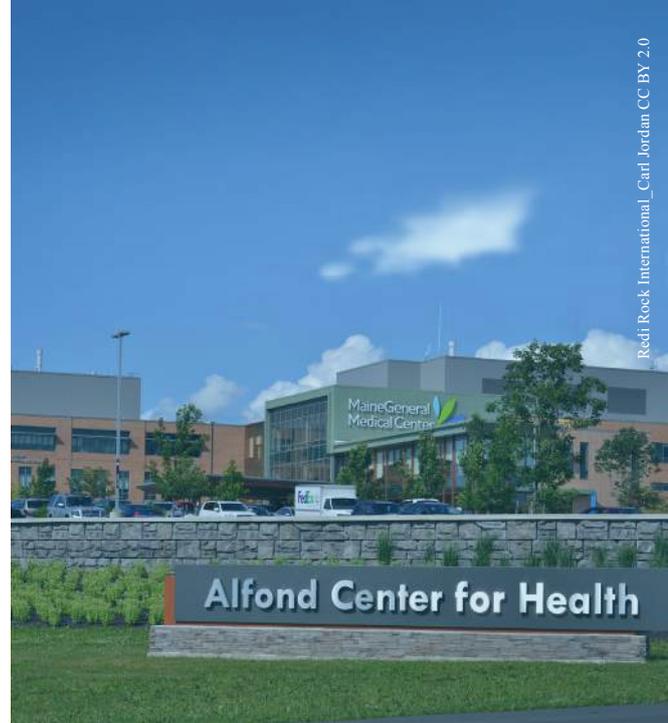
Together, the internet of things, remote sensors and data processing are de-risking the construction site. According to the US Occupational Safety and Health Administration, the construction sector accounts for 21% of annual workplace fatalities in the US.<sup>23</sup> New technologies, however, are making it possible to track the location and key attributes of people, tools, and materials in real-time on construction sites, hopefully helping to reduce these numbers. Wearable devices, for example, can now be instrumented to monitor worker location, heart rate, and temperature, helping site managers spot safety hazards and respond quickly. Concurrently, machine and equipment telematics can capture and transmit critical performance data to manage the upgrade and maintenance process.

*This new level of awareness means more transparency, safer worksites with more oversight, lower risk, and proactive maintenance to reduce delays.*

**CASE STUDY:** Faster and more cost-effective project delivery

## *The BIM effect: ahead of schedule and under budget*

Maine General Medical Center, is a new 640,000ft<sup>2</sup> hospital complex in Augusta, Maine, which merges two hospital campuses into one location. The project used an Integrated Project Delivery (IPD) contract with a three-way agreement between the owner, the architects, and the contractor. A centralised BIM model allowed for seamless coordination between design, engineering and construction, speeding up the problem solving and the decision making processes. This enabled tighter feedback and solution loops during construction. As a result, the consolidated hospital campus was completed more than 10 months ahead of schedule. The collaboration BIM facilitates also enabled the delivery team to return approximately \$20 million in value-added savings to the client.<sup>24</sup>



**CASE STUDY:** Process virtualisation enables more efficient transitions

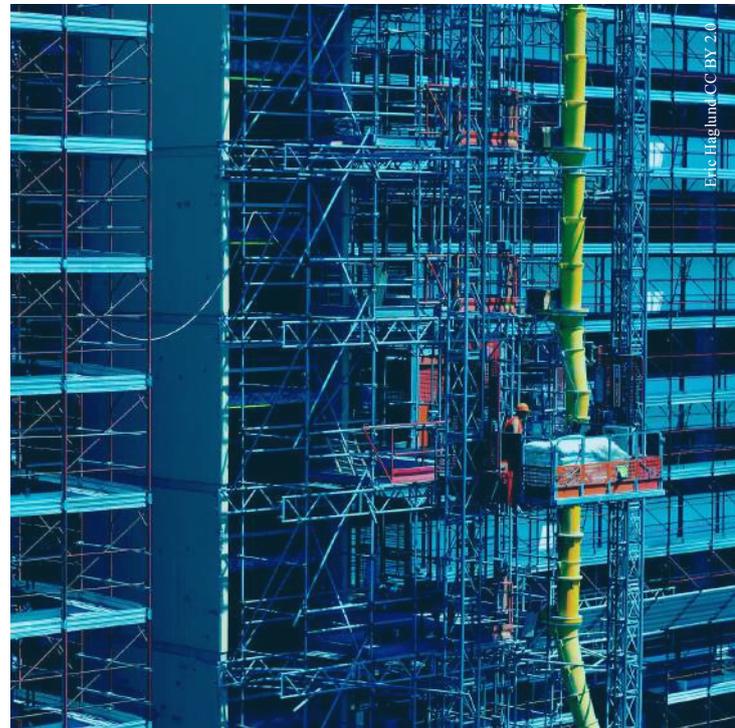
## *Augmented reality enables better project monitoring*

Using Microsoft's augmented reality (AR) HoloLens and Trimble Technology, Cambridge University researchers have effectively blurred the boundary between digital design tools and the physical construction of the built environment. In one trial, researchers developed an "automated progress monitoring tool that allows inspectors to perform visual inspections of a building site or other structure without generating excessive paperwork. Instead, all of the necessary information is displayed on top of the physical object and inspectors can simply check and report their findings using the HoloLens," saving time and reducing potentially costly or disruptive clerical / human errors.<sup>25</sup>

**CASE STUDY:** Smarter, safer construction

## *Sensors and data protect construction sites from damage and delays*

Water, fire, mould, and numerous other on-site hazards can cost owners, construction companies, or insurance companies millions of dollars in damage, not to mentioning slowing projects to a stand-still. New York construction tech start-up Pillar Technologies has developed a sensor and data processing back-end that enables real-time hazard alerts and longitudinal analysis of site risk levels for these types of accidents. The sensors detect temperature, humidity, dust particulates, pressure, noise, vibration, and volatile organic compounds. This data is collated to provide a detailed understanding of the site conditions.<sup>26</sup>



*“For years, we painstakingly calculated ROI on every single project because we were still in that phase of trying to justify BIM. After analysing over 100 projects, we realized that we were achieving three to five times payback on the number of dollars we put into a project. Eventually, we got to the point where we just realized that there is an ROI. Now, we have an inherent knowledge that there is value to BIM.”<sup>27</sup>*

**BIM Manager**  
Construction Industry



# Asset operations





## Transforming asset operations through digital infrastructure and processes

Running a building efficiently is essential to maximising performance and value, for both the owner and occupier. A major UK developer we're working with has achieved a 33% reduction in its carbon footprint since 2013 by tracking energy usage from 500 metering and sub-metering points and then acting aggressively on the insights gained. Maximising results like these requires a steady stream of interoperable data (to produce real-time insights) and a smart and flexible network. Sadly, traditional infrastructure often consists of a multitude of proprietary, black-box, legacy systems that don't easily share data, which makes it difficult to design these flexible systems, especially in existing buildings.

*By gathering detailed data using flexible IoT technology and combining it with ongoing analysis, property owners and managers can ensure better comfort for occupants. Problems can be tracked earlier and dealt with quicker, and detailed intelligence allows those managing*

*the asset to make better decisions about where and how to invest to maintain the property value.*

## Understanding the occupant experience

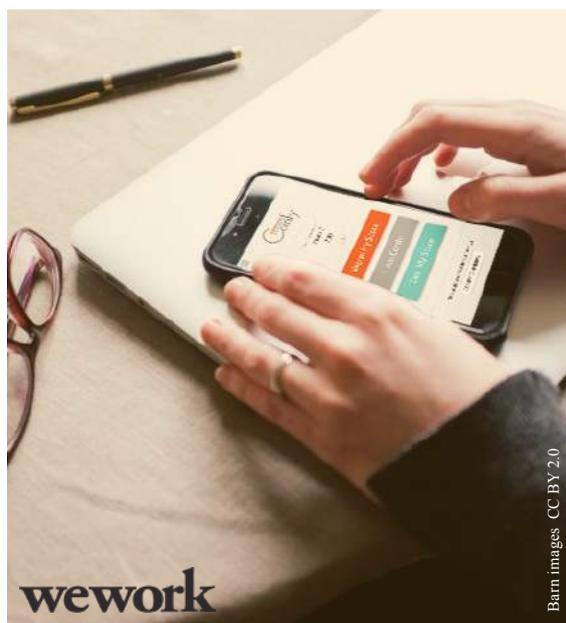
According to the 2016 *What Workers Want* survey by the British Council of Offices, the level of worker satisfaction fell consistently short of expectations. Highlighting this "expectation gap", the data suggests a real opportunity to improve worker experience, increase productivity, and support employee retention. For example, 80% of respondents said the "Overall cleanliness of the office" was important yet only 50% were satisfied with the level experienced. This same dynamic played out across many metrics, from "quality of the wireless" to "internal design and layout."<sup>28</sup>

*Whether to improve employee or tenant retention, increase productivity, or simply create more enjoyable environments, real-time understanding of the tenant experience will reveal new opportunities for the end-user experience, and ensure you stay competitive.*

### CASE STUDY: Real-time tenant insights

## *Taking control of the workplace experience*

Joshua Emig, R&D lead at innovative workplace operator WeWork, says that making sure members are comfortable and productive is "one of the toughest issues" for the company. In 2016 WeWork piloted Comfy, a mobile app-based system that enables employees to use their own smartphone to personalise their environment (i.e. temperature, humidity and light). The system integrates with existing BMS and HVAC systems to give users a degree of control over their environment.<sup>29</sup>



Barn Images CC BY 2.0



### Increasing flexibility and integration through open building systems

Operational costs for buildings (and thus whole portfolios) are in part a function of the systems that are designed, specified, and installed within them. Many providers currently provide black-box, proprietary solutions that seem like the right capital investment at the outset (due to price or perceived functionality) but ultimately tie the hands of the owner, occupier or manager during the whole lifecycle of operations.

*Designing and specifying open systems from the outset reduces the likelihood that your technology provider will lock you into a maintenance contract. This also opens up the competitive bidding process that could drive operating costs down. These open approaches facilitate widespread system and data integration which in turn mean new functionality for the end user.*

### New value-added service propositions result from digital / data infrastructure

Owners and developers consistently compete for tenants, just as corporations compete for the best talent. A crowded market means that the quality of the experiences and services they deliver in their spaces will be increasingly critical. Rob Speyer, CEO of Tishman Speyer recently stated “Our most important job is to serve the 250,000 people who work in our buildings each and every day. Instead of defining ourselves by the square feet we own, we will define ourselves by the quarter million people who use the square feet and how well we tend to them”.<sup>30</sup>

*Planning and delivering the right ICT infrastructure (flexible, robust, secure, etc.) can enable a near-limitless spectrum of possibilities for value-added digital services that speak directly to your target user needs and expectations.*

#### CASE STUDY: Flexibility requires open systems

### *Senseware: plug-and-play intelligent building systems*

Increasing numbers of firms want access to building data from building management systems (BMSs). They might need it to optimise employee well-being and productivity or to inform workplace design and refurbishments. Cloud-based BMS replacements, such as Senseware, can be wireless, use machine learning, and are constantly updated. This is a platform philosophy where you're not locked into a single BMS provider, and gain the freedom to monitor your assets on-site or remotely.



**CASE STUDY:** New digital value-added service propositions

## *Levi's 49ers stadium: New digital services yield better fan experiences and new revenue*

The new Levi's Stadium – home of the San Francisco 49ers – is considered by many to be the most high-tech stadium in the world. With 600 wireless access points delivering 40GB/sec internet, the stadium provides a brilliant digital experience for fans. Through its own custom mobile app, Levi's Stadium visitors are able to order food directly to their seats to avoid queues, and watch exclusive high-definition replays in near real-time on their devices.



**CASE STUDY:** New digital value-added service propositions

## *Smart lighting for better user experiences and lower costs*

The emergence of Bluetooth Low Energy (BLE), Zigbee, and other low-power wireless systems are enabling smarter and more efficient lighting systems. Connected lighting can be controlled by sensors that might respond to the number of people in a space, or the nature of activities they are undertaking, or some other aspect of their preferences. Systems such as Silclair and Organic Response use mesh network designs where individual lights can communicate with each other without expensive cabling.



**CASE STUDY:** New digital value-added service propositions

## *The Edge: the responsive building*

A day at The Edge in Amsterdam starts with a smartphone app that checks your schedule and a building system that recognises your car when you arrive, directing you to a parking space. Workspaces are based on your schedule: sitting desk, standing desk, work booth, meeting room, balcony seat, or concentration room. Wherever you go, the app knows your preferences for light and temperature and it tweaks the environment accordingly.





William Warby CC2.0

**CASE STUDY: Transforming asset operations through digital infrastructure and processes**

*Intelligent asset management is transforming energy usage and building performance across the Crown Estate portfolio*

The Crown Estate's central London portfolio includes some of the capital's most prestigious real estate, including on Regent Street and in St James's. The Estate has a plan to significantly reduce carbon emissions, and with Arup's help, is using Intelligent Building Management to take a big leap towards achieving this goal, reducing energy costs in the process. By gathering detailed data on heating and ventilation usage, The Crown Estate has identified energy and financial savings, extended plant lifecycle and made their maintenance programmes more efficient. IoT technology allows the monitoring and analysis of additional aspects of the internal environment, revealing where internal conditions are falling below expected levels. The information is tracked in real time so that there are daily updates to the Crown Estate, potentially allowing them to move from schedule-based maintenance to a performance-based approach. Fixing what needs to be repaired only when it requires attention. This means greater reliability, as bigger problems are pre-empted, and improved tenant comfort.

*“The systems designed in the building will allow for mobile and tablet-friendly apps that could enable building users and managers to ‘see’ in real time how the space they’re working in is operating – providing feedback to improve comfort and energy performance. This means those running the building could get real time feedback on any issues being experienced by users, and have greater information at their fingertips about how things are working.”*

## **Richard Baldwin**

Head of Development, Derwent London



### **CASE STUDY: Understanding the occupant experience**

## *White Collar Factory: London’s new benchmark for intelligent buildings*

White Collar Factory is a workspace designed for the office worker of the digital era. Arup helped developer Derwent London use technology to design the building in a radical way, providing those working there with greater control over their professional environment. This focus on the experience simultaneously achieves real reductions in energy consumption. The 16-storey building’s occupiers are technology and creative companies, who demand a high level of connectivity, resilience and security, and more flexible ways of working. A mobile and tablet-friendly app enables building users and managers to ‘see’ in real time how well their space is operating, and provide feedback to improve comfort and energy performance. This means those running the building get real time feedback on any issues being experienced by users. This highly responsive building is the first in the UK to achieve a Platinum WiredScore, a new certification that rates buildings’ digital infrastructure.



# Asset renewal





### **Portfolio-wide intelligence means smarter asset renewal**

In large, complex portfolios, making strategic decisions about asset renewal schedules and site prioritisation is essential. Not having access to the right data or not being able to efficiently manage and query data can lead to sub-optimal asset and portfolio valuation. In the worst cases, it can also lead to dangerous or deadly site conditions due to lack of clarity about existing issues or how to resolve them.

*A joined-up, asset and portfolio-level digital strategy with a focus on data collection and interoperability is essential to driving best-in-class renewal programmes.*

### **Online platforms enable the sharing, sale or reuse of valuable materials at their end of life**

The engineering and construction industry is the world's largest consumer of raw materials, accounting for 50% of global steel production, using more than 3bn tonnes of raw materials per year. According to the World Economic Forum, "adopting circular economy principles could significantly enhance global construction industry productivity, saving at least US\$100bn a year."<sup>31</sup>

*Efficiently making decommissioned or unwanted materials available on secondary markets can create economic and environmental wins for all stakeholders. Optimal 'circular' re-use of materials is easier when recorded and tracked through digital tools.*

### **Digital knowledge platforms streamline renewal projects**

For large property portfolio holders, working with numerous architects, designers, engineers and contractors across a range of local, regional, or global sites, data consistency can be a challenge. This is especially true for firms with global and mobile workforces where the building occupants spend time in multiple locations and want the same productive and comfortable experience wherever they are. "The global mobile workforce is set to increase from 1.32 billion in 2014, accounting for 37.4% of the global workforce, to 1.75 billion in 2020, accounting for 42.0% of the global workforce."<sup>32</sup>

*Creating consistent digital and physical standards and using best-in-class platforms to empower all of the players in your design and delivery teams is critical. Searchable databases of design guidelines, shareable BIM libraries, and visualisation tools make it possible to refresh your assets effectively with fewer discrepancies.*



*“Around 60 - 70% of the Microsoft campus has unified, integrated dashboards and reporting. We use this dashboard information to monitor our systems [and] see if we need to send out a technician... Our energy smart building software tells us the 500 most expensive faults, in a descending order of dollar value. And it predicts potential cost-savings — for example, if we were to fix a certain issue, it would save us \$5,000 a year. These faults auto-generate a work order for issues to be fixed remotely or dispatched to an onsite technician.”<sup>33</sup>*

**Microsoft**

IT, Real Estate and Facilities

**CASE STUDY:** Online sharing platforms increase value capture

## *Globechain: new value from unwanted materials*

Globechain is a reuse platform that matches businesses, charities, and individuals who want to acquire or give away unwanted or surplus stock and equipment in the construction, retail, and office sectors. By gathering and analysing data, the company also evaluates the social, economic, and environmental impacts of the exchanges to enable businesses to assess and report on the effects of reusing, upcycling, and recycling items. Telefonica used Globechain to pass on unwanted office furniture to the charity Growing Networks. In doing so it saved around £3,000 in landfill charges and the charity saved between £3,000 and £4,000 on the cost of new furniture.

Erik Brahl CC SA 3.0



**CASE STUDY:** Digital knowledge platforms streamline renewals

## *Consistently better fit-outs*

Many corporate property executives are rolling out design and technology standards across their portfolios. Arup recently helped a leading global technology firm with over 40 million ft<sup>2</sup> of workplace (including 9,000+ conference rooms across hundreds of buildings) develop a digital platform to improve consistency, quality, and efficiency in new buildings, fit-outs and retrofits. By converting their 1400-page design guidelines into an easy-to-use online portal for all design and delivery teams, and systematising design through an approved BIM library, they will be able to deliver projects faster, more consistently, and at lower cost. The web portal provides custom views for each project team member. The platform enables BIM adoption and provides approved BIM content families that meet global standards and include all parametric and metadata required for asset / facility management.



**CASE STUDY:** Portfolio level performance data drives asset renewal

## *Get ready for intelligent asset tracking*

Between 2003 and 2013, the US Department of Energy's (DOE) Office of Environmental Management (EM) decommissioned roughly 2,000 contaminated facilities across 19 sites. However, they were hamstrung by limitations in data collection and standardisation in the process. Both DOE and EM kept databases of info on facilities that were undergoing or had recently undergone decommissioning but neither system was comprehensive or up-to-date enough for officials to effectively make portfolio level decisions. To rectify the situation, the agency took steps to ensure data systems were comprehensively kept up to date in order to support more effective action.<sup>34</sup>



energy.gov

# Toward an integrated future

Across the property sector, digital technologies are beginning to have an impact. However, in most cases this remains a series of tactical implementations which produce real benefit, but remain unconnected to other elements of strategy, design, construction or operations.

There are some firms who are moving beyond that and reaping the benefit of a more comprehensive approach. This is often at an asset level, rather than across their portfolio. It is our view that the real leap forward will only come as sector leaders begin to join the dots across the different stages of their projects, and then do so at a portfolio level. At that point a digital masterplan spans their entire property footprint, one that improves every aspect of their business, and the experience and productivity of their buildings' users.

Digital design tools save time and money and ensure consistency with critical design standards. Intelligent building management means owners can anticipate the needs of tenants or employees before they become apparent, and provide real time information to end users. And a combination of sensors and data analytics offer improvements to operational performance of buildings across every metric.

But we believe it's time to look beyond tools and techniques. In reality a strategic approach must integrate a deep understanding of the physical environment with awareness of digital possibilities, centred around the digital citizens who now live, work and shop in the property. This results in better decisions at every stage, better design and engineering and better outcomes across the portfolio.

In many ways the property sector is behind some other industries in the way it incorporates digital in its strategy. But property's digital transformation is definitely under way. It is our hope that this report helps leaders in the sector decide what to do next.

*“Our thinking about digitization is fundamentally shifting from a tactical approach (broadband, email, a little BIM / GIS, some visualisation, rent accounting, spreadsheets, old school FM) to being informed by a strategic vision that drives better end-user experiences, unlocks portfolio-level operational improvements, and improves financial outcomes.”*

**Commercial Property Executive**

2.5m Sqm office portfolio, plus retail and industrial



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