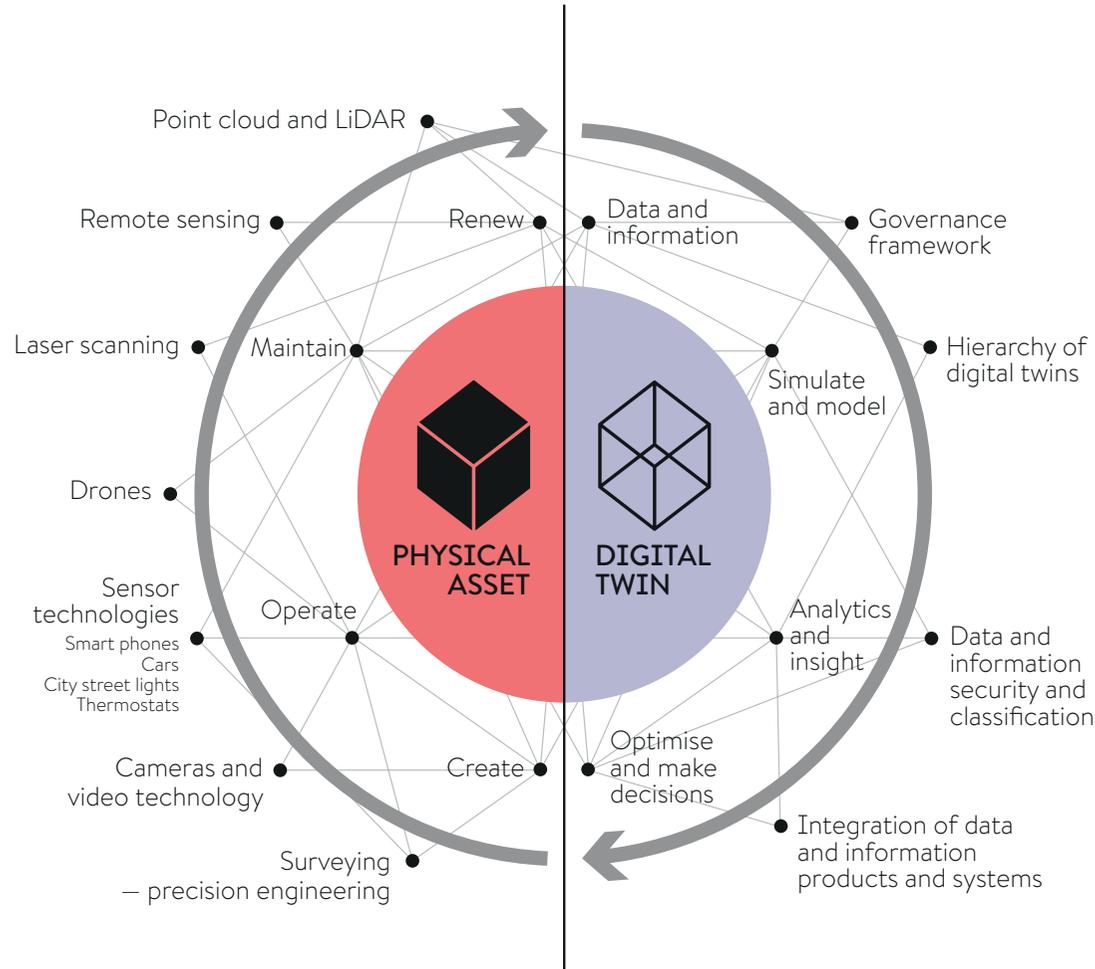


In conversation with Buro Happold

Digital Twinning



The digital twin connectors



Three parts of digital twinning:

- the physical asset;
- the digital representation of the object;
- the link between the physical object and the digital representation which keeps both in sync.

In conversation

The case for digital twinning¹

All industries are rapidly embracing the age of digital revolution². As a result, digital twinning is a much talked about concept in every industry; from aerospace to oil and gas; and increasingly at every scale of the built environment.

Real Estate developers and owners are no exception facing new decisions on whether or not embrace the digital twin opportunity.

Buro Happold is being engaged in conversations to understand the potential scope for digital twinning technologies at many scales:

- **At building scale –**
such as for a real estate company or university campus
- **At city scale with city authorities –**
such as Singapore or Helsinki
- **At infrastructure scale –**
such as for a utility company or infrastructure owners/operators
- **At country scale –**
such as the UK National Digital Twin.

Connectivity and integration between the different scales bring high levels of complexity.

1 Digital Twin – a referenced academic definition taken from Michael Grieves – University of Florida, 2002 – A digital Twin is defined by 3 parts: i) a Physical Twin (the Asset), ii) a Digital Representation of the Asset, its processes and states; iii) a connection between the physical asset and digital representation. All 3 must be present.

2 Silvija Seres: The fourth Industrial Revolution – Digital Futures – Olso 2018.

Purpose of this report

This document is not meant as an exhaustive paper but a starting point for **further conversations**.

In this short compendium we will focus on the recurring questions that arise on the topic of digital twinning, sharing some of the recurring themes and concepts that we encounter while **in conversations** with our partners: clients, technology vendors, academic institutions, policy makers and governmental bodies.

Read more at

[Centre of Digital Built Britain,](#)
[Alan Turing Institute,](#)
[The IET,](#)

or the

[Advanced Manufacturing Research Centre.](#)

All too often, the term “digital twin” is used to mean different things by different people. This is particularly the case across different industries, but especially in property and construction. To bring clarity, we share insights from Buro Happold’s journey into digital twinning.

What is a digital twin?

The definition of a digital twin is “a virtual representation of real-world entities and processes, synchronised at a specified frequency and fidelity”³. For the built environment, a digital twin is therefore a digital representation of a physical asset, and the activities within it. It is a bridge between the physical and digital world, fusing disparate data sources from the physical twin into the digital world where it can be processed and **mined for**

insights to create previously unreachable value. It is a digital representation that mirrors the real world **and evolves** as the physical asset evolves. As such it acts like a “black box” for all the data relating to the asset.

Digital twins could be applied for example to monitor the performance of the physical assets in real time to predict future scenarios, identify potential issues and rectify them before they occur.

It could also can act as a record for assurance and circularity needs; whilst at the same time provide insight to support future planning.

Digital twins revolve around the collection of digital data which could be applied to monitor the performance of the physical assets in real time.

3 Digital Twin Consortium definition retrieved October 2021 – <https://www.digitaltwinconsortium.org/initiatives/the-definition-of-a-digital-twin.htm>

Google Trends results for 'what is a digital twin':

+90%

Google Trends results for 'digital twin examples':

+130%

Google Trends results for 'digital twin technology':

+400%

Data: <https://trends.google.com/> covering 13/Dec/2020 – 5/Dec/2021

In this short compendium from our client conversations, we focus on the recurring questions that arise on the topic of digital twinning:

- 1. Is the term “Digital Twin” over-hyped?** → 9
Should we invest time in this topic?

- 2. Digital twinning as a corporate strategy** → 12
Should we prioritise the approach to digital twins?

- 3. How can we get started?** → 13
What is the correct level of ambition, in line with our current maturity?

- 4. Navigating technology: IoT, BIM and digital twinning** → 15
Who in my organisation should lead the digital twin initiative?

- 5. Adapting the organisational design and partnership up** → 21
How should adapt my organisation and choose my partners?

- 6. Buro Happold project examples and use cases** → 23
What are the examples of digital twins “in action”?

1. Is the term “Digital Twin” over-hyped?

Digital twinning is not a new concept. It was anticipated in the 1991 novel “Mirror World” and formally defined by academia in the 2000s.

Gartner placed digital twins at the “Peak of the Hype Cycle⁴” in 2018 – predicting they would soon become commonplace.

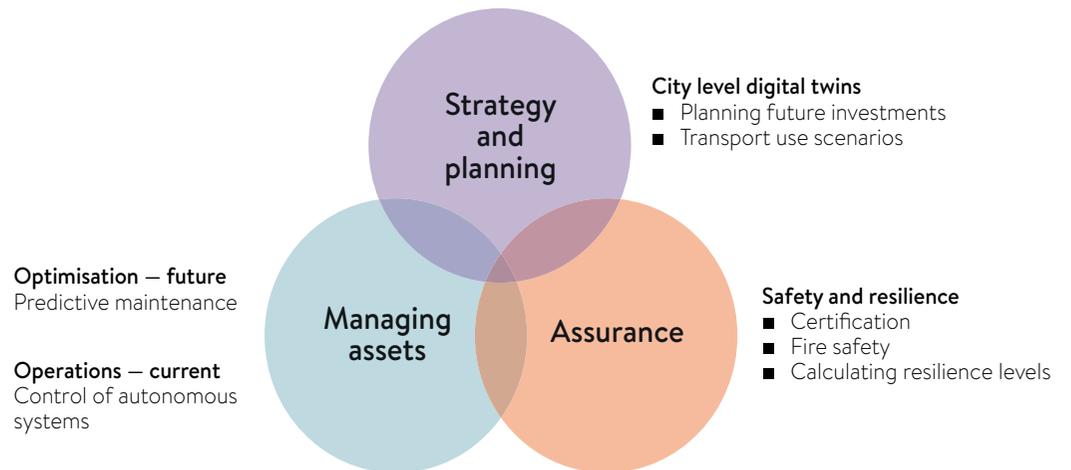
Their prediction seems to become a reality in fact businesses, governments, and academia highlight the potential of digital twinning for our built asset, classifying use cases and sharing the learnings from early examples of digital twinning implementation.

The Centre of Digital Built Britain⁵ (CDBB) highlights that “investing in a digital twin is rarely a single, one-time effort” – proposing multiple use cases around strategy, assurance and operational management.

We believe that we have moved beyond the stage of hype and we are now looking at concrete solutions.

How can a digital twin be used to drive meaningful cost savings/revenue generation/citizen satisfaction opportunities and competitive advantage for organisation?

The different case uses of digital twins as proposed by the CDBB. This supports that digital twins are not hype, but have real application.



4 Immersive Application of Industrial Digital Twins – Eyre and Freeman – Advanced Manufacturing Research Centre, UK.
5 Digital Twin Toolkit – Developing the business case for your Digital Twin. Centre for Digital Built Britain – February 2021.

Hype cycle for emerging technologies, 2018

The Gartner hype cycle is a graphical presentation developed, used and branded by the American research, advisory and information technology firm Gartner to represent the maturity, adoption, and social application of specific technologies.

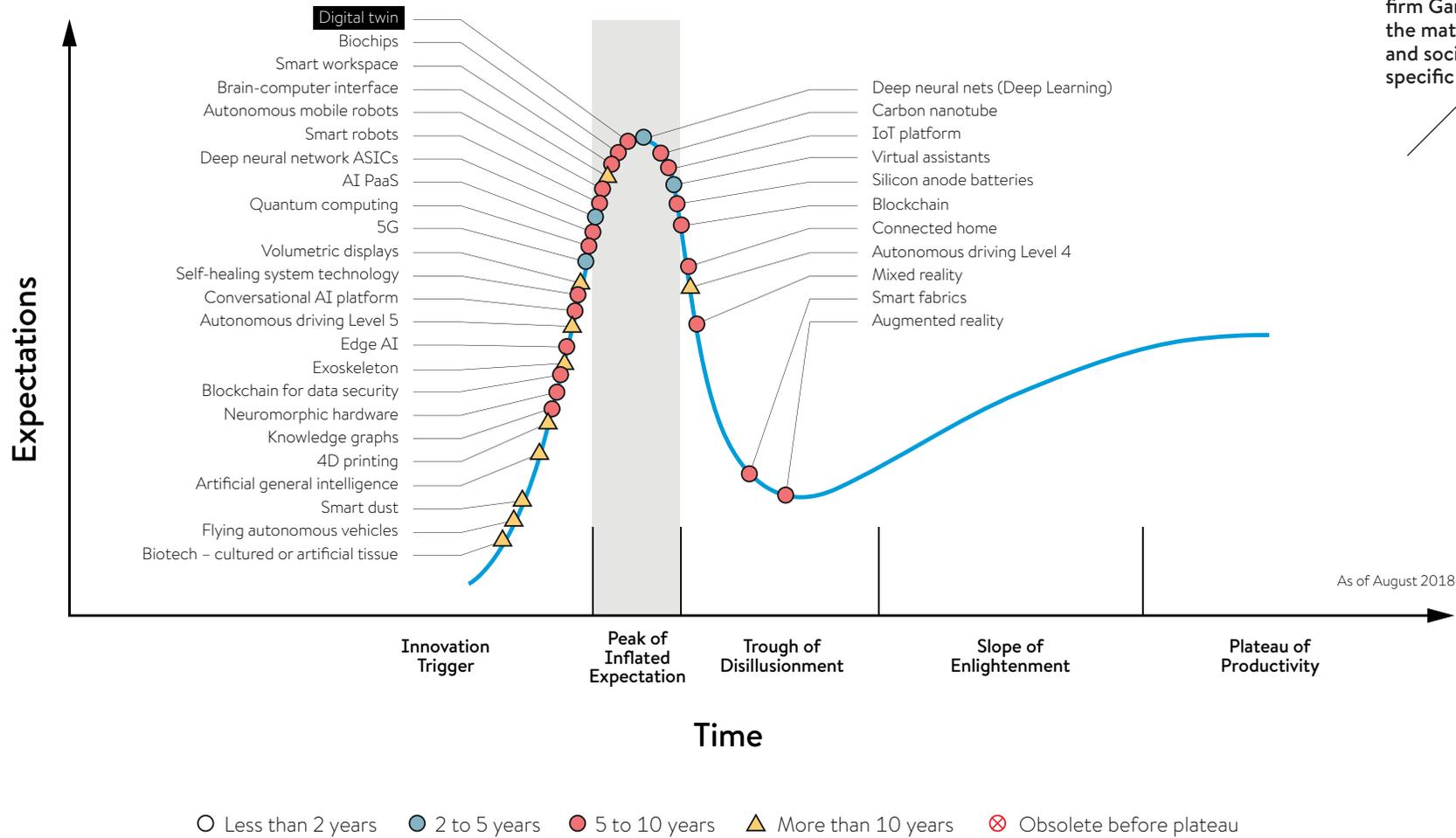


Image: Buro Happold from an original by Gartner Inc, 2018.

Our eight takeaways

Digital Transformation is not a process or a strategy. It is a mindset and a culture that persists.
Digital Twinning follows the same rhyme..

1/ Digital maturity as a strategy

Leaders establishing a long-term strategy gradually raising “organisational digital maturity” building digital twins one use case at a time have greater chances of succeeding.

2/ It’s a journey

Successful leaders establish roadmaps, recognising that achieving digital twinning involves multiple (“learn as you go”) incremental steps.

3/ Two-way doors

Leaders preserving agility and resolutely keeping technology choices flexible in response to the fast-changing environment are more resilient.

4/ Fail fast mentality

Leaders encouraging high levels of curiosity and willingness to experiment/test new ideas such as pilots, proof of concept, proof of value, sensor deployment, make greater headway.

5/ Partnering up

Leaders engaging and collaborate with their broad ecosystems (architects, engineers, contractors, technology vendors, academic thought leaders, venture capital incubators) have more experience to rely upon.

6/ Hybrid organisations

Leaders deploying an organisational model designed to foster cross functional take up and learning, stand the greatest chance of successfully create value for the organisation.

7/ Industry involvement

Leaders actively seeking involvement and leadership in industry groups, data task forces and learning from other industries (oil and gas, automotive, aerospace, industrial) learn from the journeys made by others.

8/ Quality data dictates outcomes

Leaders scrutinising the quality of digital twinning data which has great impact on certainty of predictions and outcomes have mastered the importance and centrality of digital data.

2. Digital twinning as a corporate strategy

Survive and Prosper Report 2017 from AMCA.

Digital twinning is increasingly featured in the corporate strategies of real estate companies and considered to have the potential to yield significant long-term value bringing competitive advantage to the business.

This high level of expectation is leading to greater levels of investment as well as greater levels of scrutiny (KPI setting, investment monitoring, monthly/annual reporting) to whether the strategy is delivered according to expectations.

As digital twinning becomes a priority, it is also transparent that many companies are still struggling to define the way forward.

The lack of “digital maturity” at many level of the organisation often becomes a barrier to formulating and implementing effective plans.

Questions persist, such as:

What technology should we use? How can we future proof: will technology and strategic choices be able to evolve with us?

What people and capabilities do we need to hire?

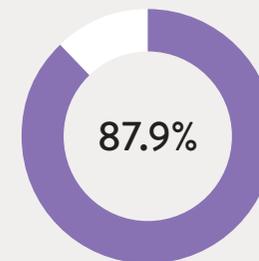
What are the business cases, the use case and the potential ROIs. Should we opt for a big bang or an incremental approach?

Can experienced veterans embrace the change?

Technology adoption is vital, but not sufficient.

The **challenge** is partly technical, **largely organisational**.

Companies must have a **strategy for testing, measuring and integrating technology** across their organisation, which requires the right **structures, culture, and practices**.



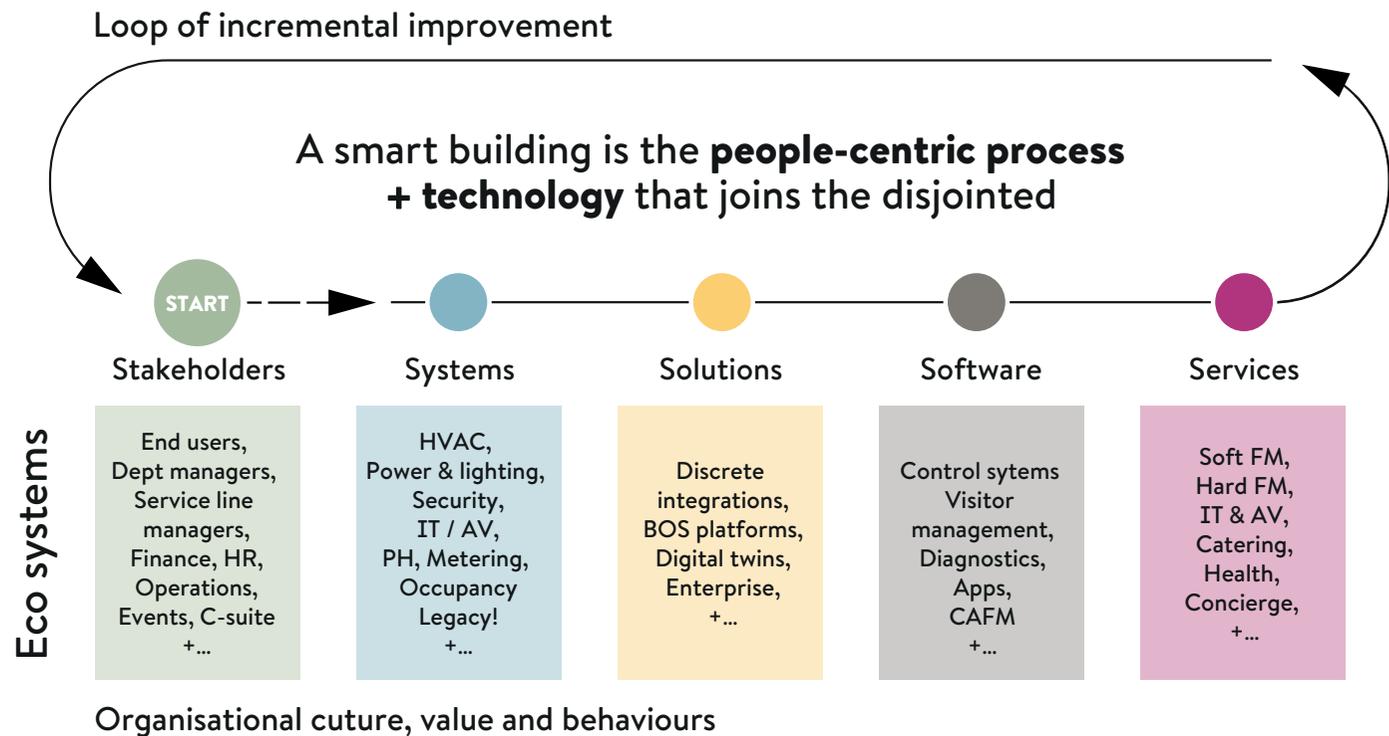
Respondents expecting use of technology to increase.

3. How do we get started?

Those organisations making the most progress tend to drive themselves to take incremental (learn as you go) steps accumulating over time knowledge and skills within the organisation, as well as helping deliver the wider strategic goals.

As an example, the developer who first uses digital twins to target energy savings across the portfolio, then, having sealed the knowledge, moves forward, starting a series of incremental steps to explore and deliver operational efficiencies in the gambit of predictive maintenance.

To get started, Buro Happold recommends this approach for buildings assets:



Buro Happold suggests that companies break their broad strategic goals into a well thought out roadmap which include measurable and achievable incremental steps through which the organisation can build digital twinning knowledge and skills to support the acquisition of real incremental gains.

The roadmap should consider organisational and market maturity and be implemented as a journey, as the MIT Digital Transformation framework explains.

The roadmap should start with some innovations; before shifting to digitalising and optimising the existing business intensively. By building the roadmap in this way, digital maturity is acquired in the “innovate and digitise” zones (1), ahead of deploying deeper business change (2) to reach “optimisation zone” (3). The “transform zone” is required to make meaningful change to business outcomes; but should not be attempted in isolation.

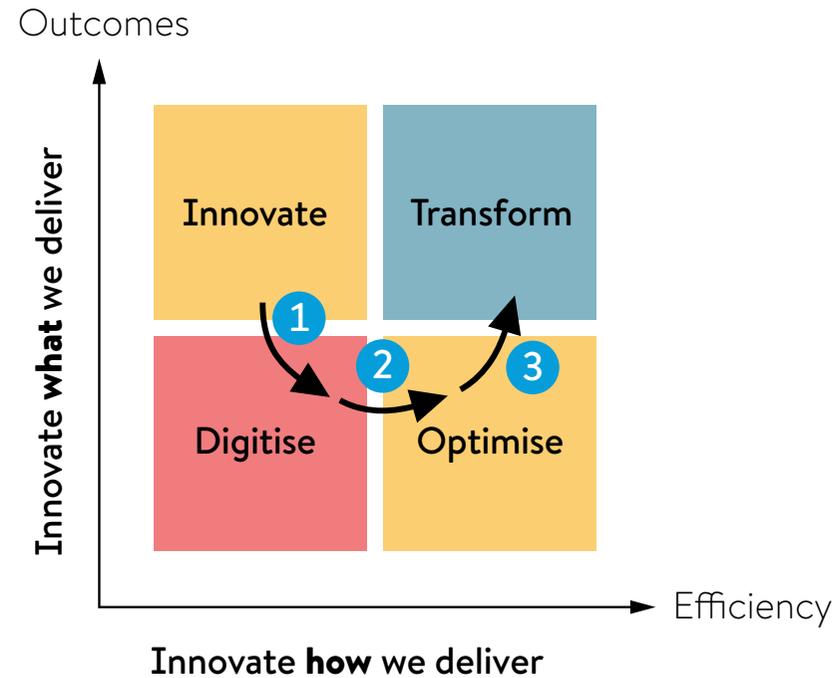


Image: Cogital AECO Digital Transformation Framework
MIT Sloan: Digital Transformation Framework

4. Navigating technology: IoT, BIM and digital twinning

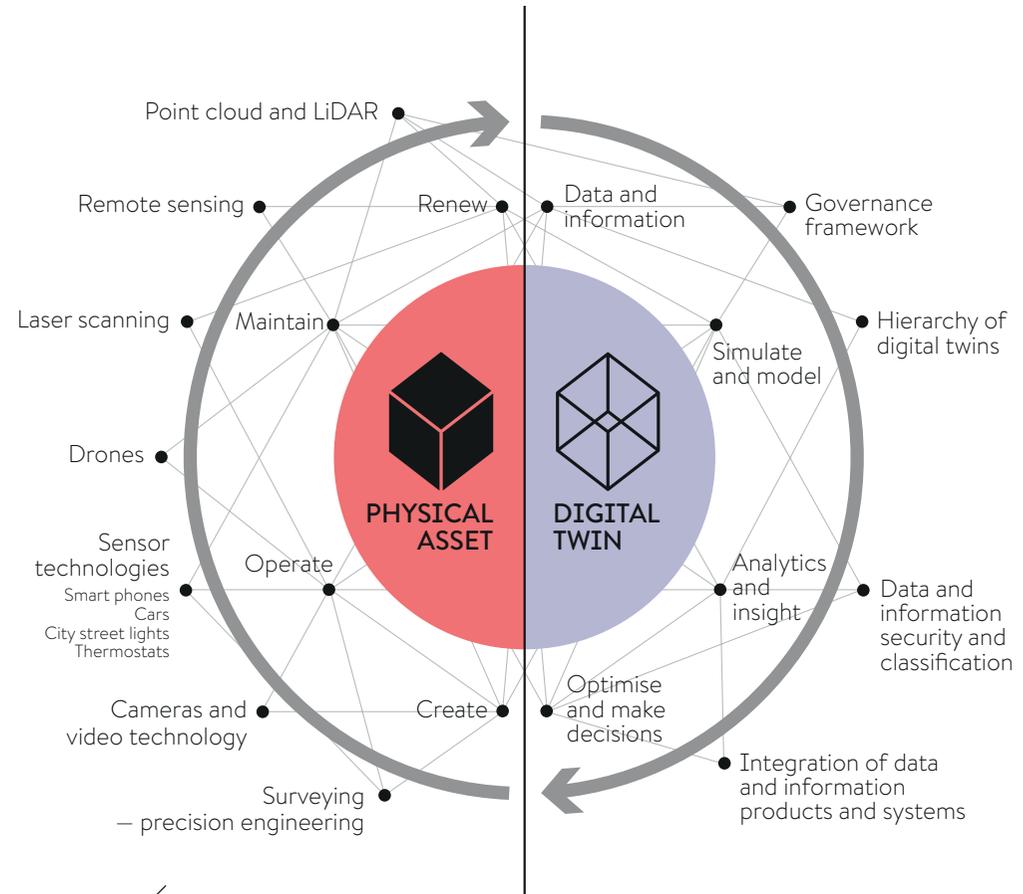
Digital twins also have a technology dimension. Understanding key technology choices requires making sense of the jargon and developing technical maturity. This is ever more important at the intersection of the built world (which operates on a slow development cycle) and the technology world (which operates in fast cycles).

Moore's Law⁶ teaches us that the power of silicon technology doubles every 18 months. This means that the technology for the users of the buildings we are designing today, is not yet imagined.

To recall Wayne Gretzky's quote "Skate where the puck is going to be, not to where it has been".

Many key technologies will be influencing the future of digital twins such as AI, cloud and edge computing, the Internet of Things and Building Information Modelling (BIM). Some of these assume the connector's function of the digital twin frequency and fidelity. Finding the right balance brings opportunities as well as new challenges.

6 Moore's Law states that we can expect the speed and capability of our computers to increase every couple of years, and we will pay less for them – [Investopedia](#)



Three parts of digital twinning:

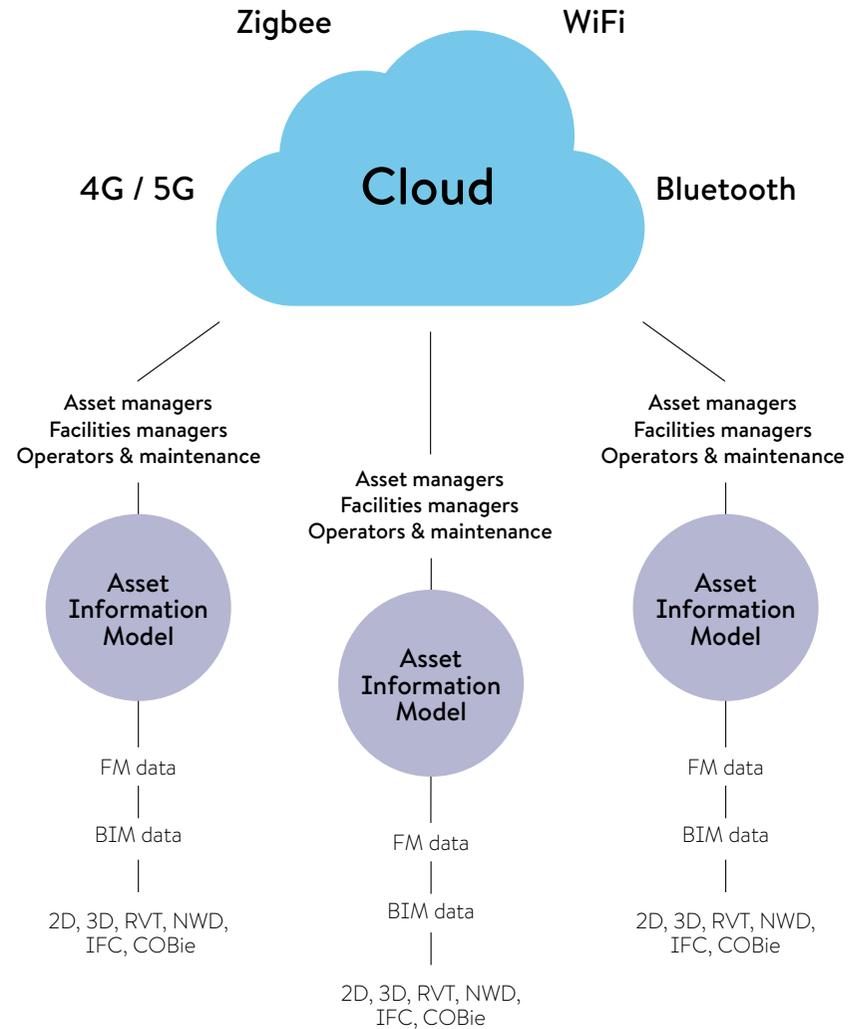
- the physical asset;
- the digital representation of the object;
- the link between the physical object and the digital representation which keeps both in sync.

On the one hand, technologies such as IoT are fast developing, driven by the decreasing cost of sensors, and the availability of faster and lower power wireless networks (wifi, Bluetooth, Zigbee, 4G, 5G, ...).

On the other hand, we notice that asset owners tend to work with static “Asset Information Models” which hold the static information describing the

asset in BIM geometric and operational and FM information needed by the asset managers, the FM teams and the O&M teams.

From selecting the right data, its fidelity and frequency, collecting, maintaining, organising and integrating all the data sources, the process has proven to be a very cumbersome and challenging for many organisations.

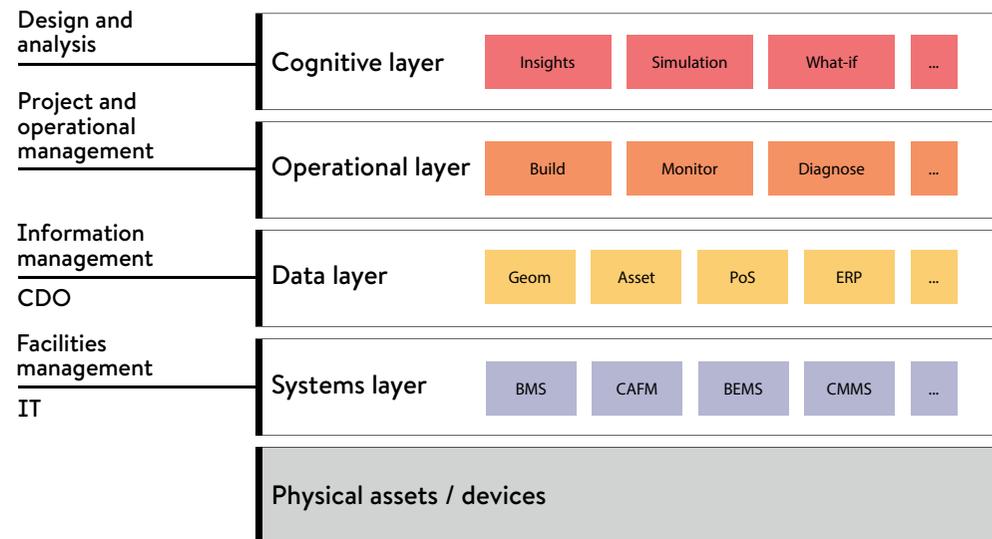


To summarise, we learnt that the technical architecture of a scalable, future-proof digital twin is best thought of as a layered cake, structured to grow and survive the next 50 years of technological evolution.

Our experience suggests that those companies that proactively experiment and trial with various technologies and use cases and build it into their road map, achieve the greatest success and competitive advantage.

Examples are: sensors which sense people in a building can be visualised and recorded within the digital model and used to fine-tune performance/create savings across a variety of systems (lighting, cooling, heating, elevators, etc.).

Another example is sensor information from critical assets (e.g. pumps) that can be used to assess historical and future performance across the whole “pump” portfolio.



5. Adapting the organisational design and partnership up

In any organisation, teams dealing with complex technical matters, such as IT, Legal, or Tax, can often find themselves becoming isolated within the organisation and in some cases, marginalised. We witnessed that teams leading digital transformation initiatives can in many cases, fall into this “isolated” category.

What we notice is that when a digital initiative such as digital twinning becomes marginalised, failure often follows.

As an example, in the early 2000s, the digital teams in charge of “the internet strategy” were marginalised

in retail firms, banks and hospitality groups which led to a negative impact, in fact Amazon, Wise, TripAdvisor respectively outshone the legacy firms.

We observed that those organisations that design their organisational model to properly integrate digital twin teams into the rest of the business (Leasing, Operations, Facilities Management, Design, Project & Construction Management) stand the greatest chance of successfully creating value for the organisation.

In practice, the digital twinning philosophy and goals need to cut across the entire

suite of business verticals and the organisational structure needs to be designed and operated accordingly.

In addition to this, choosing the right leader is key, as it is necessary to identify the right individual with the right credibility and degree of influence across the entire organisation.

Organisations that design their organisational model so digital twinning is properly integrated into the rest of the business stand the greatest chance of successfully creating value for the organisation.

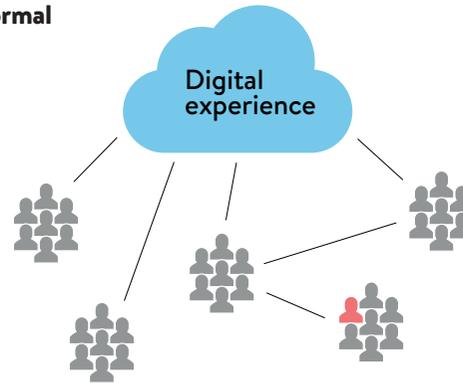
Organisational model

To deploy digital twin teams successfully we recommend adopting an **Informal** model, to later transition to a **Centralised** and to **Hybrid** models.

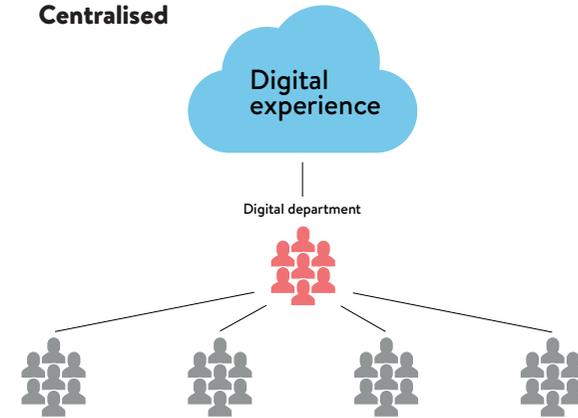
A **Hybrid** model is recommended for scaling; and a **Centralised** model for pilots.

We would discourage using an **Independent** model.

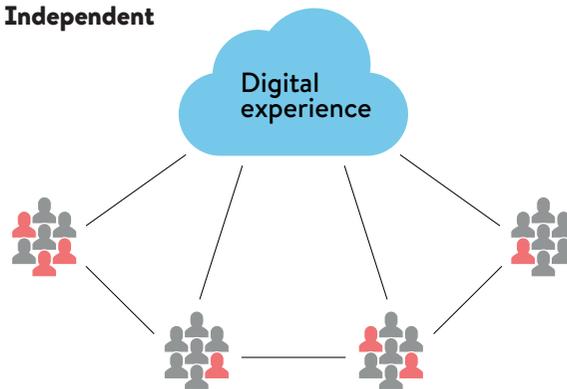
Informal



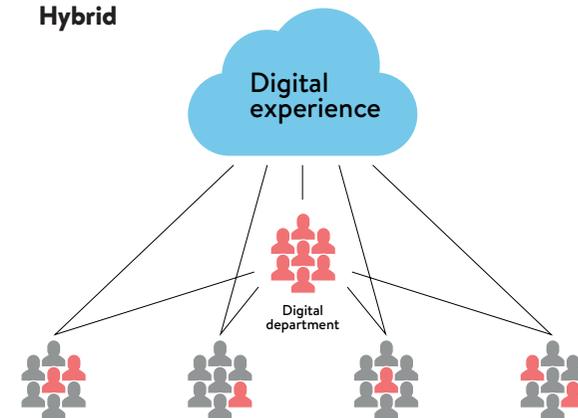
Centralised



Independent



Hybrid



-  People with digital roles
-  Departments

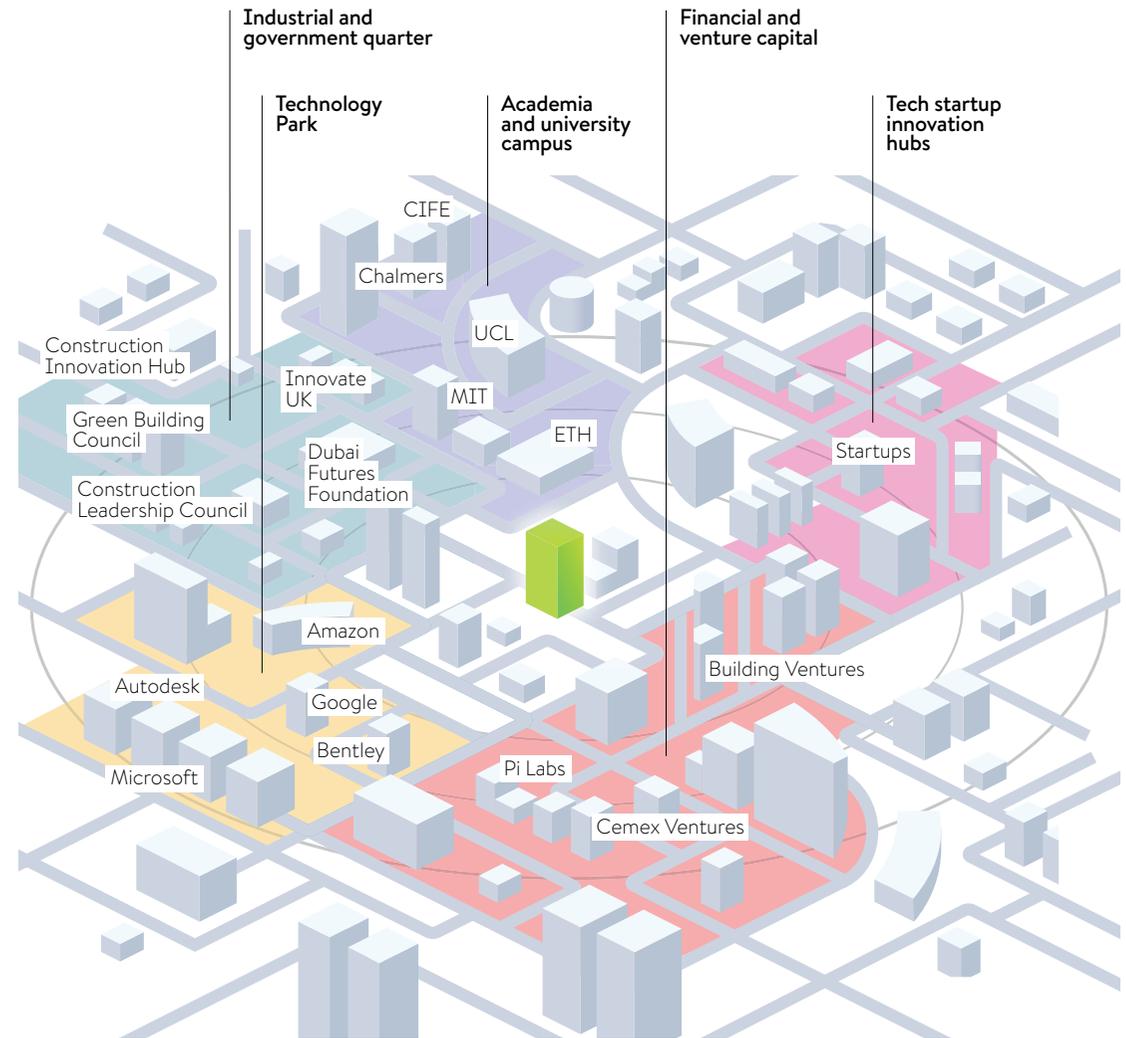
Building an ecosystem of partners

Our industry works as an ecosystem, more than any other industry. Digital twinning of the built world is no different. Developing the right ecosystem of partners is essential.

Digital Twinning brings also a new breed of partners: technology vendors and their ecosystems: hardware supplier, network providers, systems integrators, software developers, cyber security experts, systems architects, information regulators, radio spectrum authorities, government and city digital authorities, academic researchers, venture capital innovators, and more.

Traditional supply chains planners, architects, engineers, contractors, FM companies contribute extensively in the digital twinning strategy, and its successful implementation therefore it is essential to assess their level of digital maturity as well as elevate those most aligned to the company's vision.

We recommend to select carefully the most progressive partners in order to build a long-term ecosystem of high value digital twin partners and collaborators.



5. Buro Happold project examples and use cases

With any project involving complexity and unknowns, quick wins can be a powerful way of cementing support especially if the ROI involved is considerable.

We notice two areas of relatively 'low hanging fruit' which we believe could be built into the early stages of any commercial real estate digital twin roadmap.

1/ Energy efficiency

Which could bring considerable savings as well as increase sustainability.

2/ Predictive maintenance

Early sight of major issues can generate significant savings.

Our experience suggests that digital twinning can be easily applied to **energy efficiency** programs in the commercial real estate sector. These seems also best done in conjunction with a well thought-out people movement and correlation studies as this can often lead to revamping the way space is deployed across the entire portfolio.

Predictive maintenance is also another area where digital twinning can bring

significant benefits. However, there seems still be only a very few real estate companies making inroads into this field. Those that appear to be making the most progress are those that have split the problem down into 'learn as you go' steps that allow gains and experience/knowledge to be accumulated before moving on to tackle progressively larger steps in the road map.

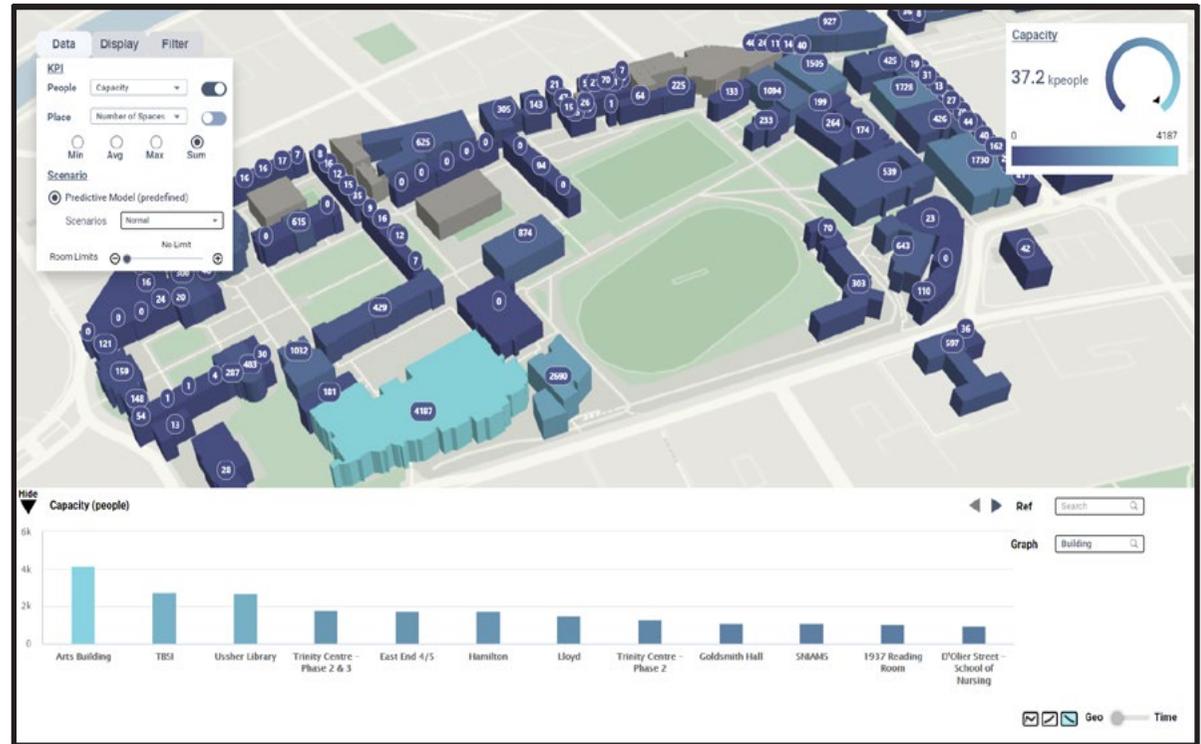
Where we made a difference

Trinity College Dublin

Ireland

A **cognitive digital twin** of the campus, mapping all spaces – teaching, labs and offices was created for the Trinity College. The model is integrated with the CAFM and building management systems to provide a real-time overview.

The digital twin provides insights on asset mapping, space utilisation, movements and ‘day in the life’ usage. A real-time **strategic planning** feature allows scenario planning and ensures timetables are optimised against capacities.



“Buro Happold’s digital twin provides the University with a realtime view of occupancy and spatial capacity across all our spaces: teaching, labs, and offices. It also provides insights on occupancy limits within the campuses, and helped us plan the re-opening of the University to students, researchers and staff.”

Mike Clark, Director of Campus Infrastructure, Trinity College Dublin

Where we made a difference

Newcastle University Urban Sciences Building

Newcastle, UK

A **descriptive digital twin** of the Newcastle University building was created as an open source project connecting the Asset Information Model to the building management system (BMS) sensors' live data stream.

This building was designed and developed by Hawkins Brown Architects and Buro Happold. As part of the Open Urban Observatory BH co-created a descriptive digital twin, which has been collecting live data since the building opening in 2017.

The main benefit of the twin is to **manage the energetic** footprint of the building, to reduce carbon emission as well as optimise the BMS controls.



[Click here](#) or on the image for live link to the building.

Where we made a difference

CommuniHeat, Barcombe

East Sussex, UK

A **predictive digital twin** is being developed for the Community in Barcombe, UK paving the way for decarbonisation of off-grid communities.

Buro Happold's energy consultants are enabling the community in Barcombe to energy transition by developing a viable techno-economic approach whilst improving industry standards. This includes building enhanced datasets, **applying digital twin technology** to plan out and **explore future scenarios** and working with new and innovative financial models.

This project will also be used to empower many more communities to build their roadmaps to zero carbon.



Buro Happold have been working with the suppliers, local groups and citizens to help the town of Barcombe to transition to low carbon heating methods.

Where we made a difference

Bridgend Borough County Council

Wales, UK

A **diagnostic digital twin** was created to produce accurate digital representation of the local authority energy network.

The aim was to create a real-time district heat network that automates optimised plant, pipe sizing, and network routing based on peak load analysis using actual property data in conjunction with established benchmarks.

The twin allows design iterations to be rapidly analysed as soon as new building data becomes available, **reducing costs** and maximising comfort to consumers.



The digital twin allowed the Bridgend Borough County Council to interrogate different network configurations to gain deeper insights on social, environmental, and economic benefits.

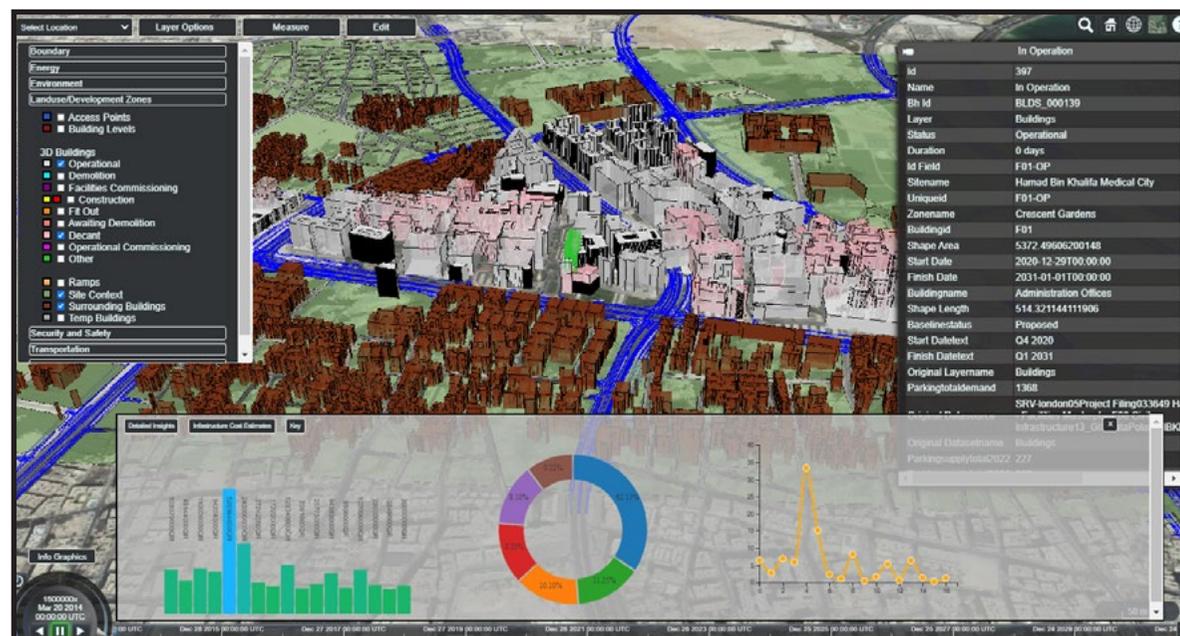
Where we made a difference

Hamad Bin Khalifa Medical City Digital Twin

Doha, Qatar

Buro Happold was engaged to provide the masterplan design and change management approach for the medical campus in Qatar. Buro Happold used the project geospatial data and information to develop a **digital twin solution**. The platform integrates various datasets on the project including construction cost estimates, project scheduling, buildings, environmental, energy, transportation, utilities, security and safety features designed for the site and existing infrastructure earmarked for demolition.

By using a digital twin approach Buro Happold delivered a collaborative, engaging, and multiuser platform which provides valuable insights on all aspects of the current site, and development aspirations for the campus.



The components of the digital twin solution consists of an unified data warehouse, data and information governance framework as well as computation and analytics to streamline manual processes and provide valuable insights.

Where we made a difference

Integrated Digital Development Concept (IDEK)

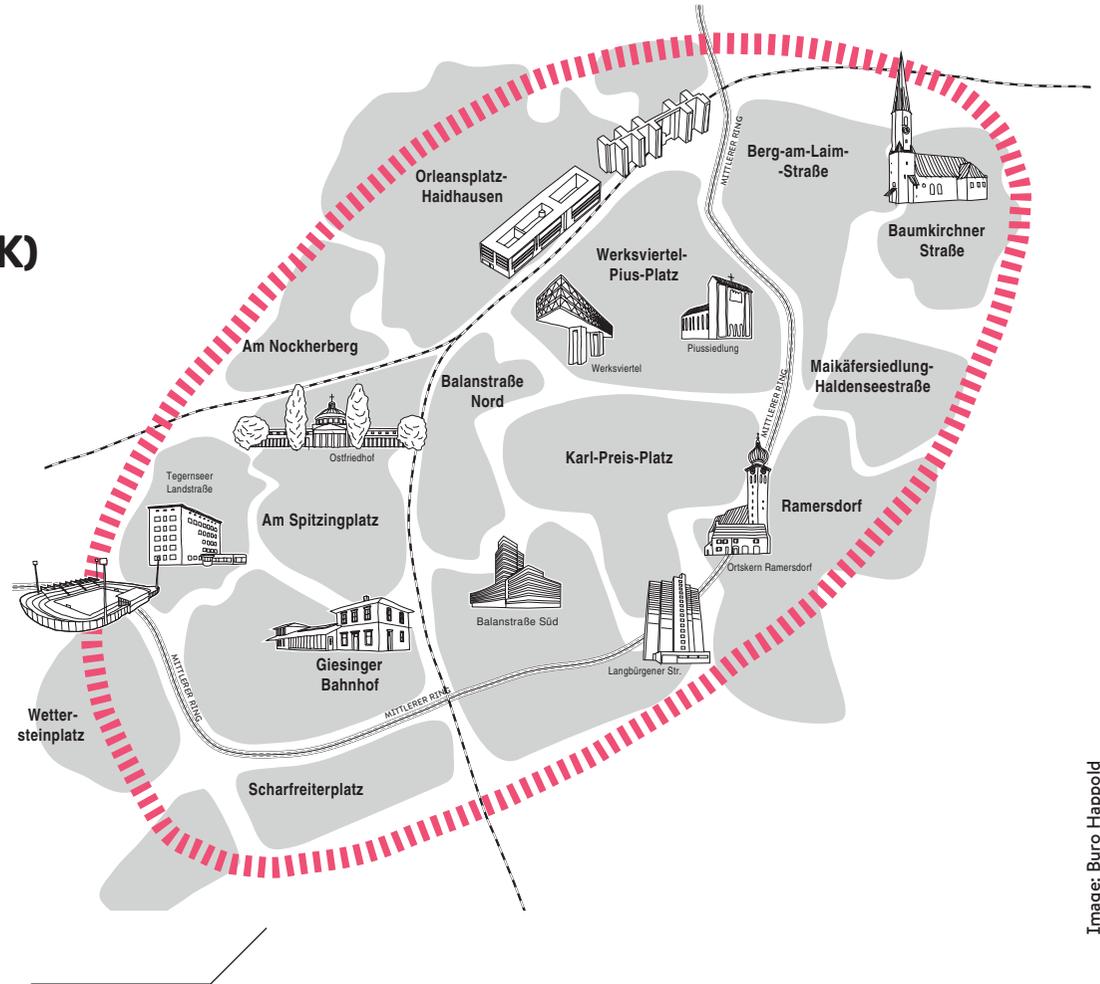
Munich, Germany

The goal of the IDEK pilot project is to support the digital transition of Eastern Munich to enhance its future planning development by focusing on how spatial and digital challenges can be planned and implemented in the pursuit of a Smart City approaches with a particular emphasis on the social challenges of the digital transformation journey.

To enable a comprehensive holistic approach a co-creative method was used during the IDEK development process, which allowed the integration of many stakeholders bringing a large number of perspectives into consideration.

As base of **design a digital inventory** analysis was created and recommendations for actions were derived with the help of a SWOT analysis. With the help of the analysis, previous planning measures adopted by the city council were also reviewed to bring to light unused potential to integrate into the IDEK concept.

The analysed requirements for action were used to develop guiding principles and strategies to enable improved future planning tool by using the IDEK concept.



The process will be concluded with an evaluation of the planning process to enable this project the ability to improve the planning tool in the future.

IDEK is funded by Smart Cities Smart Regions – Bayern, and commissioned by the Munich Department of Urban Planning and Building Legislation.

Image: Büro Happold

Where we made a difference

Workplace Analytics for Vodafone

London, UK

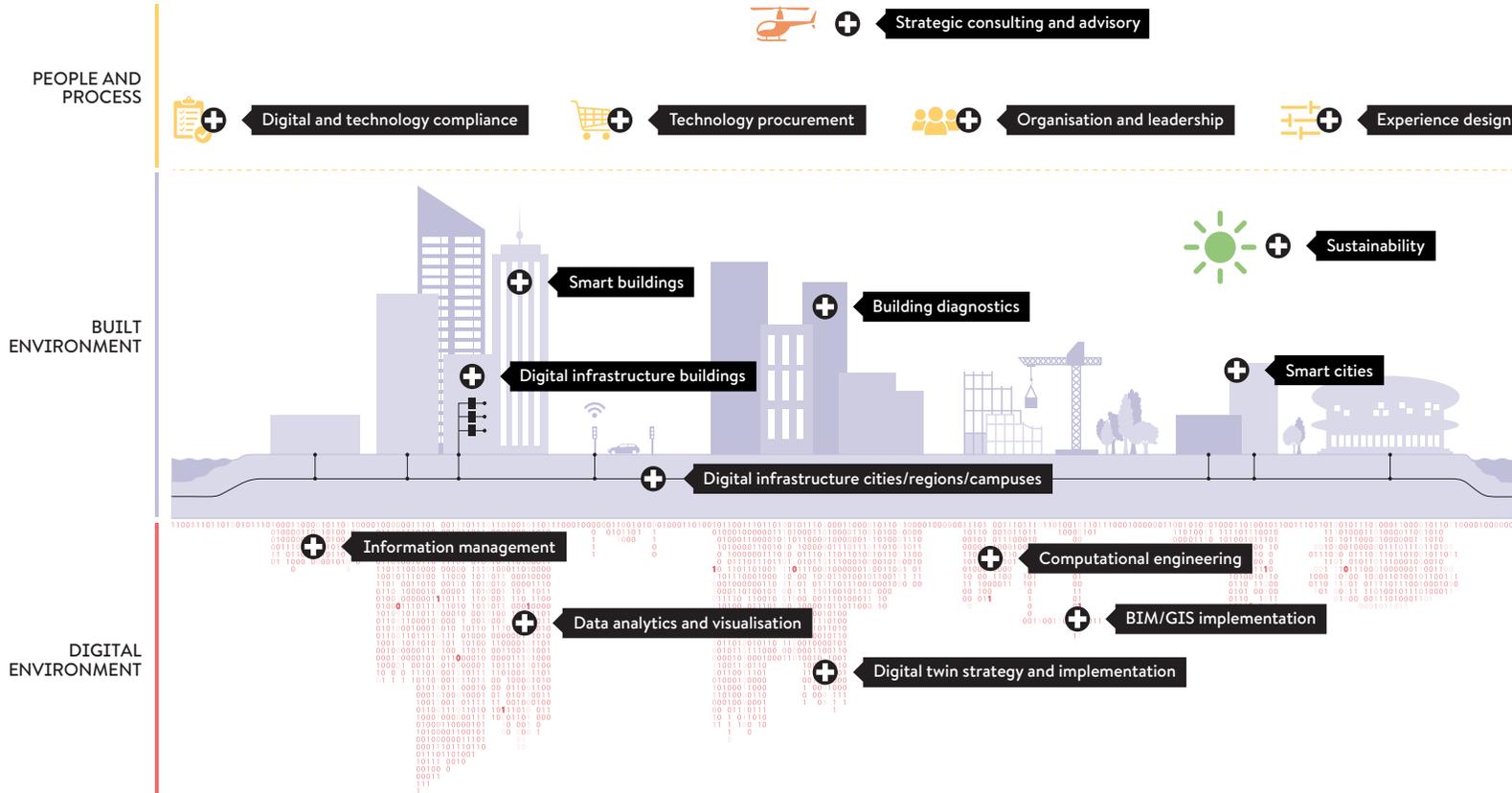
Buro Happold's smart building consultants worked closely with Vodafone to transform its workplaces, to integrate the latest smart building technologies to support the company's ways of working, employee wellbeing activity and to use technology to drive the overall productivity of the business.

Our experts helped the business to interrogate the mass of raw data produced by its global portfolio, and has supported the company with the installation of Internet of Things (IoT) sensors to maximise the utilisation of the spaces available.



“Vodafone is committed to using data to transform workplaces, ways of working, employee wellbeing and productivity. The analytics and insights provided by Buro Happold have helped us not only streamline the data across our global portfolio of assets, it has also helped us expand our use of IoT sensors and data in boosting space utilisation and employee productivity.”

Richard Muraszko, Group Property Strategy Manager, Vodafone



Consultancy for the digital built environment

We believe in the transformative power of technology. Buro Happold has built a world-class reputation for delivering creative solutions – often using novel technologies.

As a trusted advisor, we take pride in understanding the emerging technologies that will make a real difference to our clients. From building performance management to masterplan-scale smart infrastructure – at every level, we are evolving our

design and consultancy services through the use of digital tools. These are tools that help us to navigate, interrogate and provide insight from the data generated by our increasingly digital built environment.

Digital technologies are transforming the way we approach built environment design. We can unlock greater value through a smarter approach to data.

BURO HAPPOLD

Contacts

Our key digital technology people.

Alain Waha

Chief Technology Officer

alain.waha@burohappold.com

Rob Moyser

Cities and Infrastructure

robert.moyser@burohappold.com

Kauts Gaur

Director Consulting

kauts.gaur@burohappold.com

Shaun Farrell

Information Management and BIM Advisory

shaun.farrell@burohappold.com

Jack Treble

Digital consulting, smart cities
and experience design

jack.treble@burohappold.com

Tom Hopton

Smart Buildings

tom.hopton@burohappold.com

Anthony Tuffour

GIS, Data Management – Digital Twin Advisory

anthony.tuffour@burohappold.com

Our offices

Buro Happold expertise around the world.

United Kingdom

Bath, Edinburgh, Leed, London, Manchester

Dr Sarah Prichard – Managing Director

sarah.prichard@burohappold.com

Europe

Berlin, Copenhagen, Munich, Rotterdam, Warsaw

Christian Ulrich – Managing Director

christian.ulrich@burohappold.com

Middle East

Abu Dhabi, Dubai, Riyadh

Ante Baric – Partner

ante.baric@burohappold.com

Gareth Kirkwood – Managing Director

gareth.kirkwood@burohappold.com

Asia

Beijing, Hong Kong, Jakarta, Shenzhen

Robert Gordon – Director

robert.gordon@burohappold.com

India

Hyderabad, Mumbai

Krishnendu Mukherjee – Managing Director

Krishnendu.mukherjee@burohappold.com

United States

Boston, Chicago, Detroit, Durham, Los Angeles,
Minneapolis, New York, Pittsburgh, San Francisco,
Seattle, Washington DC

Robert Okpala – Partner

robert.okpala@burohappold.com

Australia

Melbourne

Andrew Bell

andrew.bell@burohappold.com

www.burohappold.com