Connected Digital Twins for the Public Good

Built Environment Digital Twins workshop report

Introduction

A recent BSI workshop explored the potential benefits of connected digital twins in the built environment – and how best to achieve them.

BSI recently welcomed stakeholders from the built environment sector to an in-person interactive workshop in London to consider the theme **of 'Connected Digital Twins for the Public Good'.**

The event set out to:

- Refresh understanding of connected digital twins
- Pool participants' knowledge, experience and expectations of them
- Explore the value that can be unlocked by connecting digital twins
- Assess implementation challenges – and how these can be overcome.

Participants were encouraged to take part in group activities and provide feedback. They included decision-makers from various stakeholder groups in the built environment sector, including owners, consultants, contractors, manufacturers, facility managers and government. Most attendees were already familiar with the concept of digital twins in the built environment. For some, their prime objective in attending was to learn more about the potential benefits such digital innovation can bring, while others prioritized practical advice on implementation.

Connecting Digital Twins

Globally, there is a strong desire to digitally transform the way society interacts with the built environment. In doing so, the sector has begun to realize that you cannot make decisions about a road without impacting on the overall transport network. No longer satisfied with considering structures in isolation, concepts such as 'systems thinking' and 'data-driven decision making' have emerged.

Through the advent of information management and building information modelling (BIM), the built environment sector has begun to realize the value of both concepts: The availability of structured information; and the frequent exchange of information, both support data-driven decision making. Information related to BIM has typically focused on the work itself (either capital works projects or operations activities). However, the sector has expressed a need to also capture and exchange more dynamic information relating to day-to-day utilization such as: Weather; Indoor Environments; User Locations; Component or System Performance; and Energy Usage. This is where digital twins can support the built environment.

Digital twins, converging bi-directional information exchange systems, provide a means of both sensing and controlling dynamic information related to the built environment. Initially adopted within the aerospace and manufacturing sectors, digital twins can support a wealth of use cases, including near real-time analytics, predictive maintenance, and process optimization.

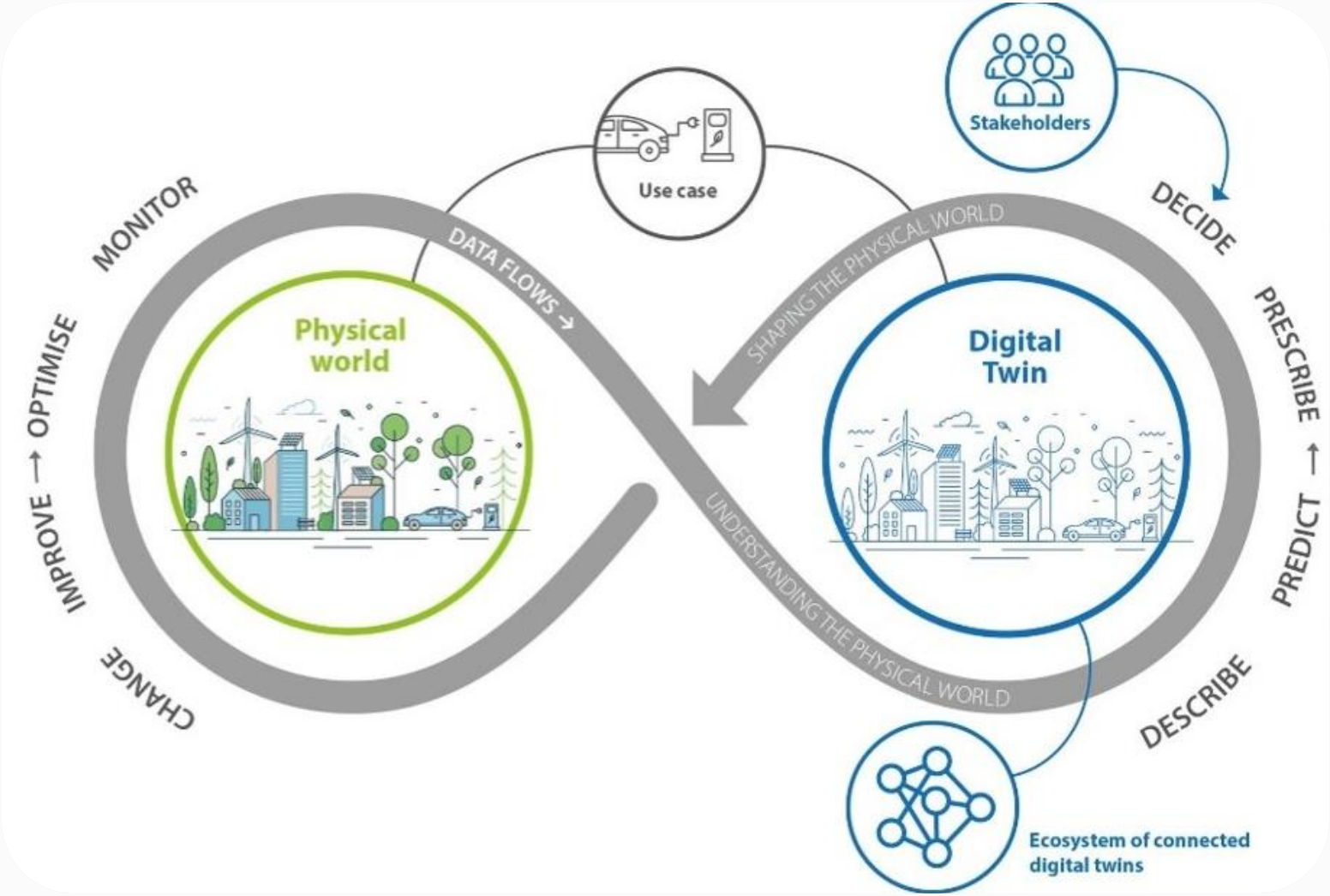
Interconnected digital twins, the focus of these workshops, extend this idea further to incorporate systems thinking into data-driven decision making. We hope you find this report useful as it explores the value of interconnecting, the reasons why we struggle to interconnect, and how to overcome these barriers to realize genuine public good.

Note: As Digital Twin has the potential to support businesses and communities achieve USNSDG goals, the workshop focused discussion around these objectives, as appears on the right.

What is a Digital Twin?

The workshop began with participants refreshing their understanding of what is meant by a connected digital twin, which was defined as: *"a digital representation of an observable element with a means to enable bi-direction convergence between the observable element and its digital representation,"* as illustrated right.

A digital twin unlocks value by supporting improved decision making. It turns data into insights that enable improved decisions and provide better outcomes. What distinguishes a digital twin from any other digital model is its dynamic connection to the physical twin leading to better interventions. A digital twin can be a digital representation of a physical asset, but also a process or system, including an organization.



What do we mean by public good in the built environment?

"If our goal is to ensure that the built environment allows people and nature to flourish for generations, then connected digital twins are the enabler for managing the scale and complexity of the interconnected systems that make up the built environment."
Melissa Zanocco, Head of Programmes, Infrastructure Client Group

Source: Our Vision for Built Environment UK

Workshop approach

- The workshop was aligned with the Gemini Principles, published by the Centre for Digital Built Britain (CDBB) in 2018, which are effectively the conscience of connected digital twins. They comprise nine guiding values to build consensus for their ongoing evolution, as set out on the right.

- Participants were then divided into groups to focus on activities around three topics – **Why connect? Why is connecting hard? What can we do about it? –** recording their thoughts on whiteboards for further feedback and discussion.

Why connect?

Why is connecting hard?

What can we do about it?

Why connect?

The first session was led by **Rahul Shah, Global Director, Built Environment, BSI, and Mark Enzer, Strategic Adviser, Mott MacDonald and Visiting Professor at the University of Cambridge.** They considered the theme of why digitization in the built environment matters.

They introduced the topic by explaining what is meant by 'public good' in the built environment, sharing the vision of a built environment whose explicit purpose is to enable people and nature to flourish together for generations.

This vision underpins government policies to promote interventions that enhance the performance of built and natural systems to achieve better outcomes for people and nature.

Attendees highlighted that nowhere is it more crucial to leverage the potential of digital innovations than in tackling climate change. According to the United Nations (UN), buildings, energy and water supplies, waste and communications systems are responsible for 79% of harmful greenhouse gas emissions.

The group agreed that the potential benefits of digital twins include:

- Achieving net zero
- Providing climate resilience
- Delivering infrastructure equity
- Creating a circular economy
- Protecting biodiversity.

"There is a clear case for developing an ecosystem of connected digital twins to help us understand our built and natural systems better so that we can intervene more effectively: – it will increase the performance of our existing built environment and improve the delivery of new infrastructure assets."
Mark Enzer, Strategic Adviser, Mott MacDonald

Why connect?

The first group activity session sought to 'crowdsource' a clear value proposition for connected digital twins that will have impact within the built environment market.

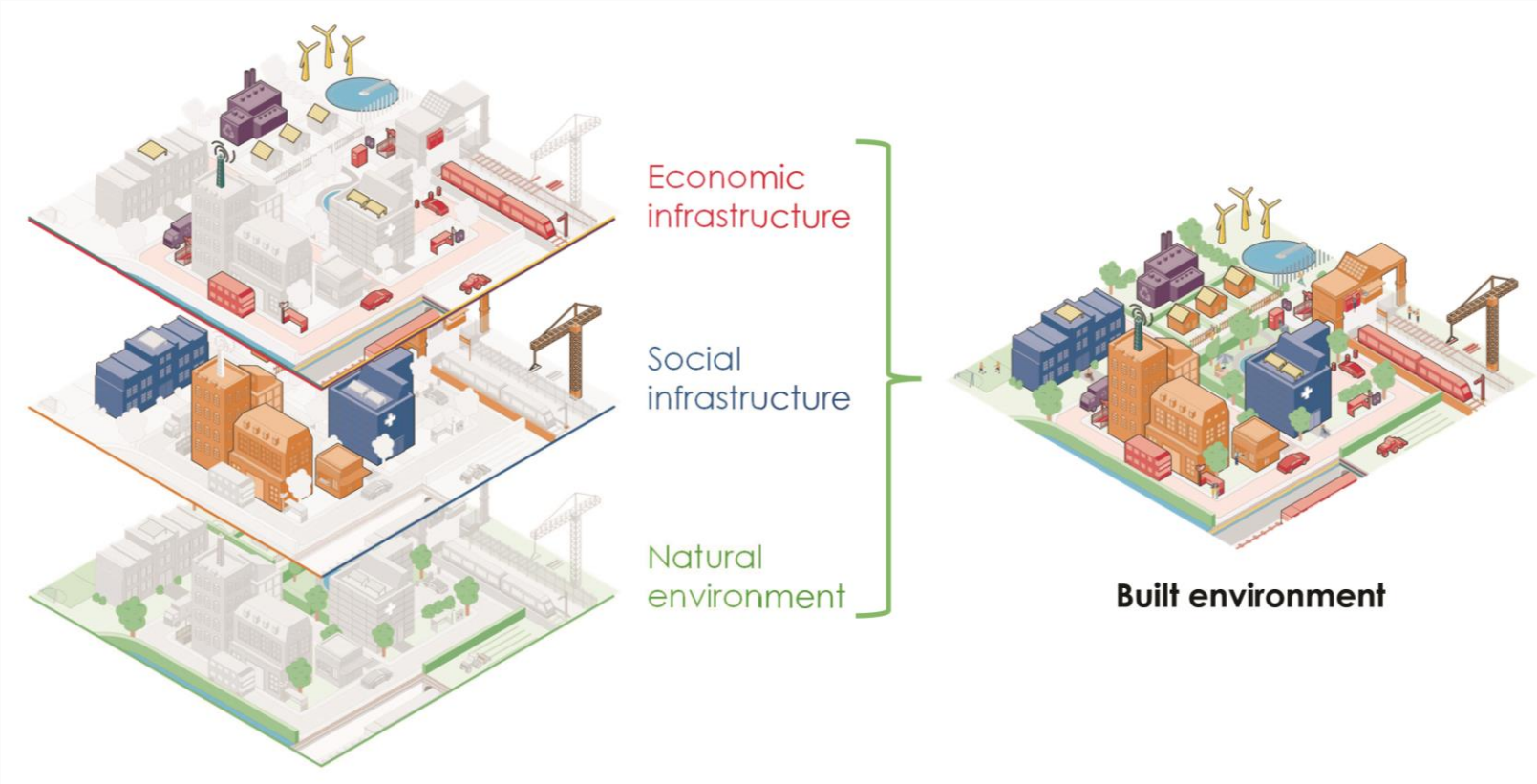
Participants were asked to discuss how to motivate key decision-makers in stakeholder groups – vendors, contractors and consultants, asset owners/operators, regulators, policymakers etc. – to see the value of connected digital twins.

By connecting digital twins, organizations can collaborate and share information more efficiently, enabling greater transparency, efficiency, and carbon management.
Rahul Shah, Global Director, Built Environment, BSI

Participants were asked to feed back what they saw as the most convincing arguments.

- Optimized operations through data analytics and trends
- Better measurement for clarity and speed of decision-making
- Improved asset management, integrated with building information modelling (BIM)
- Greater efficiency and reduced costs
- Competitive advantage by demonstrating capability
- Enhanced reputation
- Holistic knowledge for policymakers.

The built environment is a system of systems



Source: Our Vision for Built Environment UK

"It's time that we saw the built environment differently, not as a series of construction projects, but as a system of systems whose explicit purpose is to enable people and nature to flourish together for generations."."
Mark Enzer, Strategic Adviser, Mott MacDonald

Why is connecting hard?

The second session was led by **Melissa Zanocco, Head of Programmes for the Infrastructure Client Group (ICG)** and Co-chair of the Digital Twin Hub Community Council, and **Alex Plenty, Digital Construction Manager at Skanska buildingSMART UK&I and buildingSMART International**. They sought to address some of the key challenges around digital transformation in the built environment.

They began by recapping the potential of digital innovations to be applied to all built environment systems, delivery processes and organizations to enable people to use information to make better decisions, improve processes and apply technology more wisely.

Turning to the fundamental theme of 'interoperability', they defined it as "the ability of two or more systems to securely exchange information and to use the information that has been exchanged", either for a defined purpose, to meet multiple use cases, or during the whole asset lifecycle.

> *"Just as the outcomes we want to achieve from our projects need to be effective at a project, community, national and global level, so our digital twins need to have the interoperability to connect within organizations, between them, across sectors and across countries."*
>
> ***Melissa Zanocco, Head of Programmes, Infrastructure Client Group***

They described different levels of interoperability to achieve:

- **Global outcomes** – such as the United Nations' Sustainable Development Goals
- **Strategic priorities** – where national government policies should align with global goals (for example, to meet net zero targets)
- **Local requirements** – where decision-makers in the built environment must satisfy both national priorities and the needs of users, communities and the environment
- **Effective interventions** – with organizations' investment decisions aligned with local, national and global objectives.

Why is connecting hard?

While digital twins can combine live data with asset data to make improved decisions, there was a recognition that there are significant challenges when connecting digital twins, including implementation blockers around interoperability, data governance, and security.

The importance of using consistent high quality data models was discussed, to ensure the integrity of data stored in databases. Ontologies set out how objects are ordered and how they relate to each other. This helps to enable interoperability and data integration.

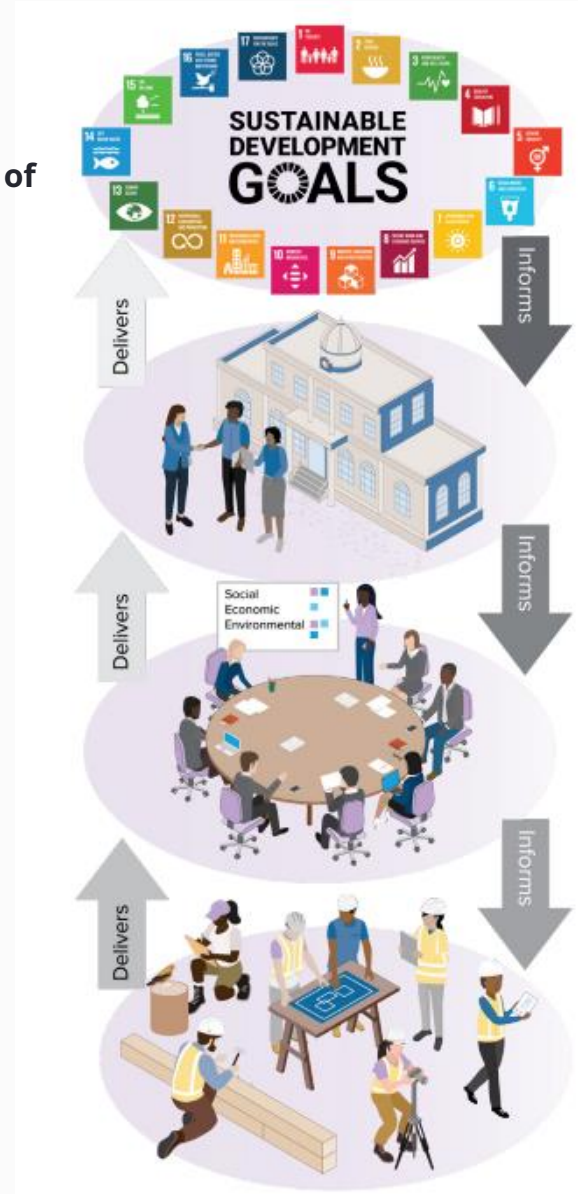
"The promise of digital twins within the built environment hinges on interoperability. Without this, information exists only in silos and never achieves purpose past project or organisation level. To ascend further, digital twins are reliant on use of open standards"
Alex Plenty – Senior Digital Construction Manager, Skanska & buildingSMART

Participants then took part in a second group activity to examine the reasons behind the challenges and consider some of the solutions. To gain deeper insights, different groups discussed the specific topics of **'People', 'Information', 'Processes' and 'Technology'.** They identified common interoperability blockers across the various levels **– Global, Strategic/national, Local/community, Organizational.**

Among the frequently mentioned were:

- Business disruption
- Intellectual property risks (from too much transparency)
- Data and cultural silos
- Unclear or disputed project ownership
- Incompatible technologies
- Inadequate understanding and skills
- Lack of common standards.

Different Levels of Interoperability



Source: [Our Vision for Built Environment UK]

What can we do about it?

The third session was led by **George Mokhtar, Head of Real Estate Digital, Turner & Townsend, and Dan Rossiter, Built Environment Sector Lead, BSI, and Vice President Technical, CIAT**. Here, the goal was to explore key enablers that would help to resolve the interoperability blockers identified in the previous session.

They suggested that the starting point must be to bring stakeholders together to address market needs speedily – within the 'innovation window' of opportunity. They described an organization's typical journey, beginning with analysis of its current level of digital maturity, followed by the development of a meaningful digital strategy – supported by a detailed transformation plan of sequenced digital initiatives – to ultimately realize its digital vision.

They highlighted ISO 56000 as a key enabler. A series of standards that outlines good practice in relation to innovation management, ISO 56000 helps organizations to:

- Ensure alignment of innovation activities with the strategic direction of the business
- Manage the trade-off between optimization and new opportunities
- Foster an innovation culture and create the conditions to nurture innovation effectively
- Remove barriers to innovation activities
- Ensure innovation activities are based on an understanding of needs and expectations.

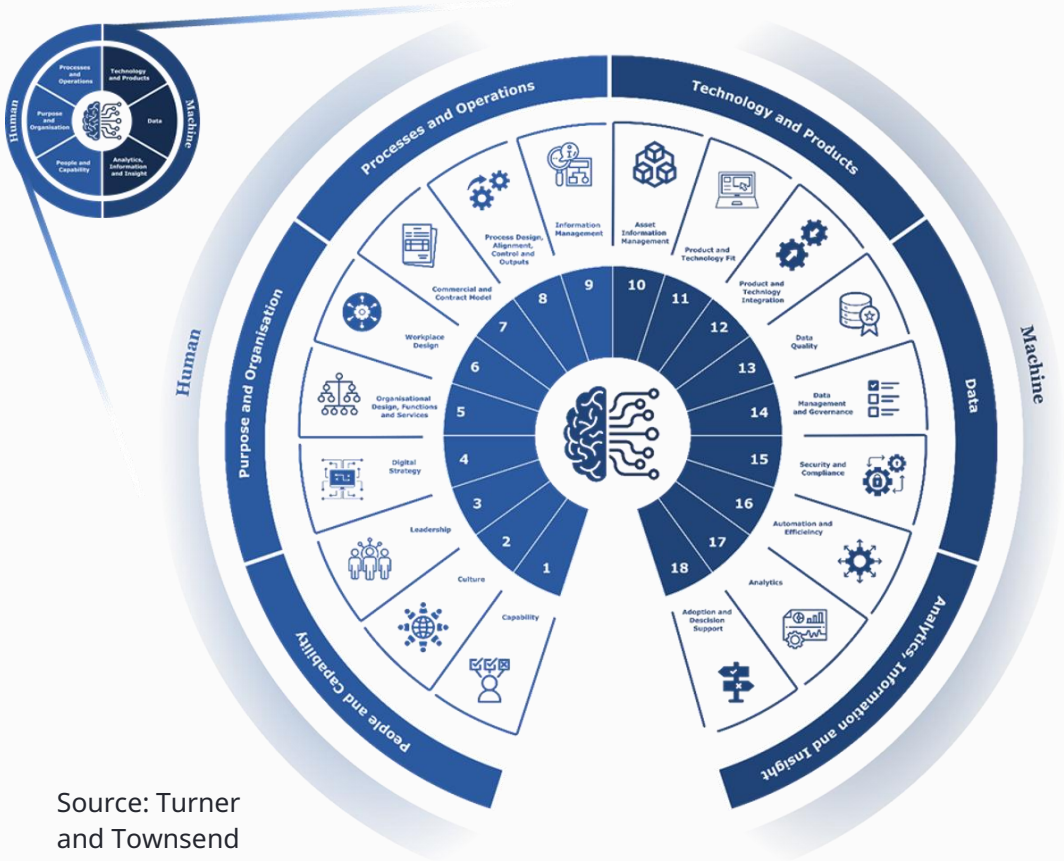
What can we do about it?

According to George Mokhtar, Turner and Townsend, it is important to:

Discuss Digital Twins through a digital transformation framework – enabling us to understand and assess the digital maturity of each part of your operating model while also examining the interdependencies between each element and your organisation as a functioning 'system'.

The framework is fundamentally split into 2 sides:

- **Human** - which focuses on people, the structure of your organisation, and the way people work.
- **Machine** – which focuses on the technology you use, how data is treated, and how information is used to inform actions.



Source: Turner and Townsend

"Exploring the purpose, vision, and experience of digital twins was enlightening.
The groups really engaged with the practical journey of digital maturity, getting the brilliant basics, culture, and leadership right to enable the creation of a ***purpose-driven*** *'system of systems'. The call to arms was to take a value driven approach to digital twin's, adopt the emerging standards and also recognise that the industry is on a journey, one size fits all will not work in this space."*
George Mokhtar, Head of Real Estate Digital, Turner & Townsend

What can we do about it?

Through a final group activity, workshop participants were encouraged to consider digital twins through a digital transformation 'framework', to understand and assess the digital maturity of each part of their organization's operating model, while also examining interdependencies between the parts and the whole organization as a functioning 'system'.

The framework is fundamentally split into two: 'human', focusing on people, the structure of the organization and the way people work; and machine, focusing on the technology used, how data is treated and how information is used to inform actions.

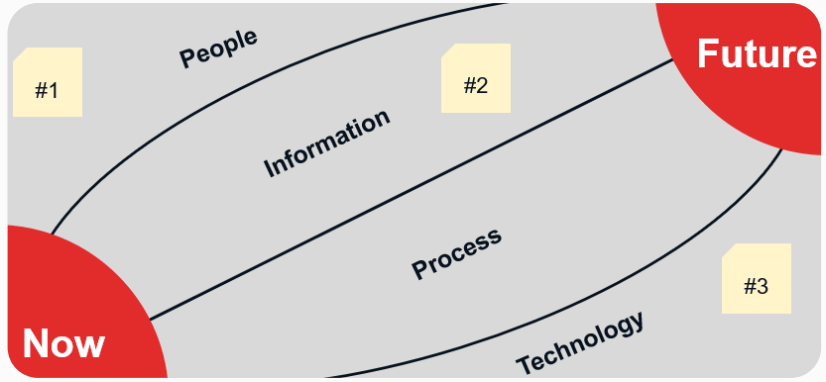
Key 'human' issues that the groups felt must be addressed included:

- Leadership and engagement
- Education and skills training
- Investment
- Culture, communication and behaviours
- Learning from previous digital implementations, notably BIM
- Procurement routes, contracts, and commercial agreements to capture digital workflows
- Legal considerations, such as responsibility and liability.

"Standardized good practice allows sectors to be guided by consensus-driven principles and benchmarks. As a result, conforming to such standards can reduce wasteful duplication by mitigating the need for separate organizations to invent their own solutions to common problems."
Dan Rossiter, Sector Lead, Built Environment, BSI

Key 'machine' issues mentioned included requirements around:

- Hardware (types of sensors, assets to be monitored)
- Software (analytical tools etc.)
- Data sharing, security and resilience
- IP rights and technical specifications
- Auditable systems to build trust.



Conclusion

- It was acknowledged that effective connection of digital twins presents challenges for organizations across the built environment sector, but that interoperability blockers can be removed through innovation and industry collaboration to realize their full value.
- Participants recognised the need to commit to and invest in connected digital twins in the built environment to deliver better outcomes for organizations, the economy and society. This can unlock value by improving sustainability, efficiency, commercial effectiveness, productivity and organizational resilience.
- In short, connected digital twins can deliver benefits for the public good.

Our standards and other documents that assist digital transformation

- **ISO 19650 series** for managing information over the whole lifecycle of an asset using building information modelling (BIM),
- **ISO 27001** for information security management
- **ISO 8000 series** for data quality
- **ISO/IEC 30145-3** Smart city engineering framework
- **ISO 37106** Guidance on establishing smart city operating models for sustainable communities.
- **ISO 16739-1** Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries
- **PD ISO/IEC TR 30172** Digital Twin – use cases
- **BS ISO/IEC 30173:** Digital Twin – concepts and terminology.

The National Digital Twin Programme (NDTP)

The NDTP is the UK government-led initiative committed to growing national capability in digital twinning technologies and processes throughout the country and is run by the Department for Business and Trade.

Following an extensive consultation, the programme has reviewed the Gemini Principles developed when it was based at the Centre for Digital Built Britain. The principles are now divided into two groups:

- Those which apply to the way the programme is organised and managed and ensure that the benefits arising from the programme are measurable and deliver for to business, government, society and the environment; and
- The requirements with which it should be possible for digital twins, individually and when connected, to comply – namely that they are appropriately safe, secure, trustworthy and ethical, sustainable, adaptable and interoperable.

More information on these principles and requirements is available here.

Acknowledgements

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Mark Enzer OBE FREng
Strategic Adviser, Mott MacDonald; Visiting Professor, University of Cambridge

George Mokhtar
Head of Real Estate Digital, Turner & Townsend

Alex Plenty
Digital Construction Manager, Skanska
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Dan Rossiter
Built Environment Sector Lead, BSI
Vice President Technical, CIAT

Rahul Shah
Global Director, Built Environment, BSI

Melissa Zanocco OBE
Head of Programmes for the Infrastructure Client Group (ICG); Co-chair Digital Twin Hub Community Council

Thank you

Continue the conversation

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- BSI firmly believes that effective industry collaboration will ultimately enable connected digital twins to fulfill their potential for the built environment.

- Connecting various stakeholders to agree good practice and identify areas that unlock value is an essential step towards accelerating the benefits of connected digital twins in the built environment.

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Resources used on the day

Note: Since running this workshop Flex 260 has now been withdrawn. Non-sector specific principles for digital twin are provided within ISO 30173.

Thank you