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Digital Twins
A human perspective

This paper is based on data gathered from a virtual event with Symetri's customers within the Architectural, Engineering and Construction (AEC) industry in Q3 2021.

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Why read this paper:

There remain many misconceptions or differing points of view of what a Digital Twin is, therefore, this paper provides some insights of what it is, the benefits of considering it, and different types of digital twins applied within the AEC industry and other sectors.

When speaking with our customers, we were surprised to discover that their focus was predominately on the human aspect.

3 main take aways:

1. **Gain an understanding of what a Digital Twin is**

2. **There is a keen interest in the human element and how we interact with the built environment**

3. **Digital Twins can bring proactivity, not reactivity**

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What is a Digital Twin and what does it mean for the Construction industry?

Digital Twins is a topic area that is being discussed more frequently across the Architecture, Engineering and Construction industry and with increasing excitement, especially by those who may not have originally considered Building Information Modelling (BIM) relevant to them but see the significant opportunities Digital Twins could potentially provide.

The basic concept of Digital Twins is to have three parts:

- A real-world object,
- A digital representation of that object and,
- A connection between the two.

This connection could be automated via sensors, measurement and monitoring devices, with real-time data being fed to a Building Information Model (BIM). The connection could also be less automated by collecting data manually and inputting into BIM or an Electronic Asset Management system with 3D viewing capabilities as examples, although the latter is less efficient it remains a viable method although without immediacy.

Of course, the concept of Digital Twins is not exclusive to the construction sector. For example, it is being explored extensively within the healthcare sector with the development of Digital Twins of the entire human body, so there is a lot of opportunity to learn from others. Connecting information management systems with real world data is not a new concept, and the use of Supervisory Control and Data Acquisition (SCADA) systems connected

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to computers, networked data communications and graphical user interfaces for the management of machines and processes is commonplace. This can include the use of sensors and other devices, such as programmable logic controllers interfacing with plant, machinery, or equipment.

In our psyche, Digital Twins have often been depicted in Sci-fi or Action genres of movies, where the viewing of the built environment in virtual 3D via holographic glasses or mobile devices has been presented to audiences for decades and maybe this is the reason why it is easy to imagine a world using Digital Twins.

As we exponentially produce more BIM outputs and associated data, the natural evolution was always towards Digital Twins, but what can we do today, what are the challenges, and what are the benefits? The immediate response is always “What questions do you need answers to?” Having an answer to this starts the investigation towards the best solution for a Digital Twin, but if that cannot be answered immediately some organisations are now exploring solutions such as Autodesk’s Tandem, a cloud-based Digital Twin technology platform to start their own exploration into Digital Twins whether they are designers, contractors, or asset owners.

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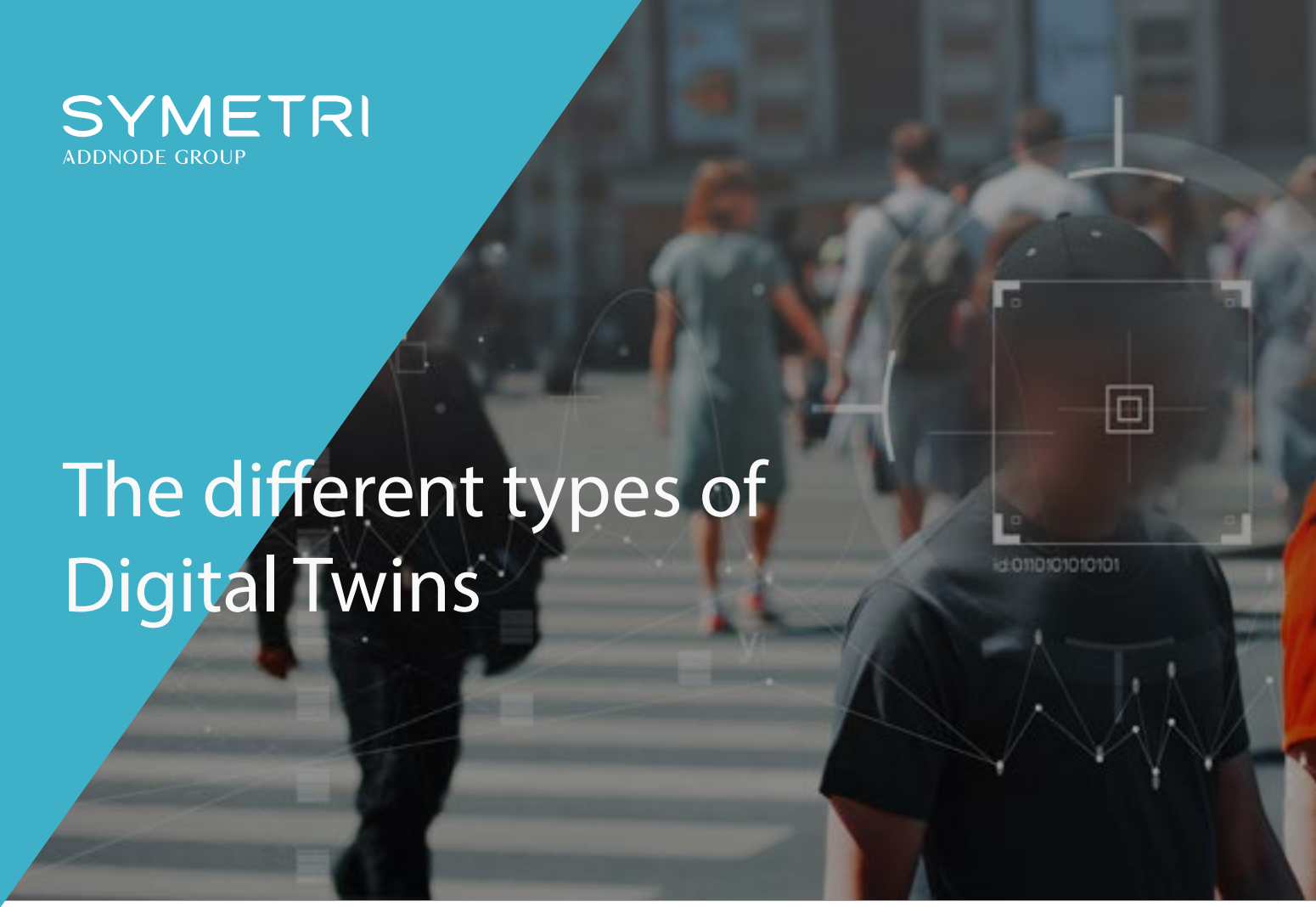

The different types of Digital Twins

During the virtual event, we asked our attendees to consider different types of Digital Twins they were interested in. It was surprisingly predominantly human focused.

Monitor and analyse the human population

Digital Twins can go beyond the bricks and mortar of the built environment, real-world systems and components. It can also include the monitoring and analysis of the human population, which is where our attendees predominantly chose to focus.

For a designer to understand how humans interact with the built environment via a Digital Twin with full 3D spatial context and awareness, was identified as a primary area of interest. Having this information available to inform Post Occupancy Evaluations was one cited use, but if we take that concept further and consider a databank of a Post Occupancy Evaluations sourced from say one sector, such as education, we will start to fully understand how space is used and presented via Digital Twins which may inform and optimise future design options.

For those working within Space Planning, understanding space utilisation is a primary requirement with proximity sensors a commonplace technology. However, if we overlay the digital representation of the building and use the same sensors, we can start to analyse use in real-time to see the full context of how spaces are being used. By applying Artificial Technologies we may discover patterns of use previously unexplored.

Evaluating hot desk use via Digital Twins was also proposed by our attendees. With a dramatic shift to flexible working, this is an area of increasing

interest. By capturing use data via proximity sensors this will indicate that a particular hot desk is not being used, but in this theoretical scenario if we collect environmental data at the same time, we may also identify that the HVAC systems is a contributing or the main factor why certain hot desks are not being selected due to too much cold conditioned air being supplied from a diffuser above, making the space uncomfortable and therefore avoided. The Digital Twin and the data contained within it may be combined with Computational Fluid Dynamic analysis and test different damper configurations to equalise the air to solve the immediate issue and propose seasonal configurations. Employee's complaining because certain desk positions are uncomfortable due to air conditioning is a common occurrence and the above scenario promotes pro-active rather than reactive resolutions based on users' interactions, or in this scenario lack of interaction with the space.

Using CCTV with digital skeletal representations

There were many methods of data capture and monitoring suggested from proximity meters to RFID tags, many very familiar to Asset Managers, but CCTV was the most predominantly proposed. There may be personal data protection issues to consider here, but technologies to anonymise CCTV captured data via analytics and replicating humans with digital skeletal representations are already in existence and being developed. Autodesk has been conducting research into developing tools for semantic human activity annotation using skeletonised surveillance videos, known as Skelletonator. By replacing CCTV capture video data with skeletal representations, calculating the geospatial position, and overlaying this onto a BIM model in real-time may seem very sci-fi, but is either available now or is being developed at speed.

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Ways data collection can support operations

Our customers proposed the following uses for data collected via presence checking sensors, near field communication (NFC) tags, GPS or CCTV:

- Evaluate hot desk utilisation
- Track which individuals are using which spaces
- Help understand how many people are located within each space
- Avoid bottlenecks during normal operations and in the event of an evacuation
- Identify where visitors are located
- Provide real-world data to improve future designs and occupational use
- Support security monitoring to ensure individuals are only within approved areas
- Assist staff or visitor wayfinding, e.g., the location of meeting rooms
- Track parking permits to actual locations
- Analyse energy consumption based on human interaction with spaces
- Link data to Artificial Intelligence systems to understand an environment better
- Provide BIM links to Building Management Systems to advance those platforms.

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Contractors looking for early warnings or improved decision making

If we consider Contractors, there were many examples proposed where mature BIM processes such as 4D planning or scheduling could be greatly advanced by using real-time data. Again, there were examples proposed during the event which included tracking activities or labour on site via CCTV or other means to enhance planning via 4D. An immediate opportunity may exist to improve health and safety on site. In 2020-21, the HSE reports contimued to show there were more deaths in the construction sector than any other. Falls from height and being struck by vehicles were the main causes. This is an area where potential early warnings using Digital Twins could be explored, not because safety systems such as smart hi-viz vests and site helmets with vehicle proximity alarms do not exist, but because there may be opportunities to use Digital Twins and AI to predict unsafe scenarios based on real-time data and previously unseen site working patterns.

Summary

Prior to the event we predicted conversations around building or infrastructure systems, connected with monitors and measurement devices, with BIM as an overlay to provide spatial content and ease of understanding. We did have these types of Digital Twins proposed during the event, but it seems that tracking and analysing our own interaction with our built environment is one area of immediate interest and the value seems compelling whether an individual is a designer, contractor, asset owner or maintainer.
There are, however, many other areas to be explored. At the event we evaluated which new roles and services might emerge, who the main stakeholders maybe, and what technology stacks can be applied today. Our discussions in these areas continue but one thing is very clear, the potential opportunities Digital Twins offer will enable improved insights, support better decisions, and better outcomes in the real world.

If you would like to discuss how your organisation can embed and implement Digital Twins, please do not hesitate to get in touch with us.

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At Symetri we support our design, engineering and construction clients with digital BIM, buildings and infrastructure, and product design and lifecycle solutions to help them work smarter and do more with less. As a trusted partner, we constantly seek to challenge people to work smarter for a better future. With our expertise, leading-edge technology and services we always strive to enable our customers to gain an increased competitive advantage. That's why our partnerships are long lasting.

Our services include the provision of software, consultancy, training and support, and we offer a comprehensive range of IT and Document Management solutions.

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