An Introduction to Digital Twins: Advancing BIM and Revolutionising the Industry

Building Information Modelling (BIM) is a process of digitally designing, constructing and operating an asset. BIM also means better information management. Although mandated by the government in 2016 to be used on government procured projects, we have only in the last few years seen a great interest in its use. This could be reflective of the need for a digital golden thread of information. As highlighted within the Hackitt report, a 'golden thread' allows for a single source of truth, through greater collaboration and communication between all project parties. This has been further emphasised with the 'building a safer future' consultation and the mandate for BIM to be used on all Residential buildings above 18m or 6 Stories. Digital twins build upon the principles and foundations of BIM and its processes and takes it to another level in digitalisation and digital information.

Published by the Centre for Digital Built Britain, The Gemini Principles define a digital twin as 'a realistic digital representation of assets, processes or systems in the built or natural environment.' In essence, the digital model has a 'twinned', relationship with a physical asset, and can replicate the processes and systems within the real and the digital world and be used for various purposes. A digital twin is more than just an evolution of a 3D Building Information Model (BIM). Where BIM focuses on a building's design, construction, and data for operational use, a digital twin represents how people interact with the built environment and bridges the gap between the physical and the digital. The result of this is strengthening our understanding of how the building works to then create efficiencies such as automated maintenance.

The primary function of using digital twins within the industry is to test virtual construction sequencing and logistics scenarios. The benefit of this is the reduction of construction and operation costs on site as well as the opportunity to collect and monitor real time data. This enables asset owners to make real time decisions on the operation of an asset and gain a greater understanding of their assets at any given time.

Further advanced than BIM, a digital twin will facilitate two way communication with their physical twin by using sensor technology. Theoretically, this should allow for a physical asset to be controlled remotely by the information in the virtual twin asset thus creating an opportunity for autonomous maintenance and measurements.

The Gemini Principles identify six stages to digital twins, demonstrated in the table below.

Stage	Description	Use
0	Reality capture (e.g. point cloud, drone surveys, drawings etc.	Use it on brownfield sites.
1	2D Maps/System or 3D Model	Design/Asset optimisation and coordination.
2	Connected model to static data, metadata and BIM Level 2 (which have documents, drawings, asset management systems)	4D/5D simulation, Design/asset management, Level 2 BIM.
3	Enriched model with real time data from the internet of things and Sensors	This is used for Operation Efficiency.
4	Two way data integration and interaction	This can be used for remote and immersive operations as well as control the physical asset from the digital twin.
5	Creation of Autonomous operations and maintenance	This will mean full self-governance with total oversight and transparency.

Breakdown of stages:

Stage 0 is the lowest order stage to be able to start a digital twin (this is relevant only on existing physical assets).

Stage 1 is the typical entry point is connected to new assets as an outcome of the design process, and is often updated through reality capture as per element 0 post construction to create the as built record.

Stage 2 will see further benefits realised when element 1 is connected to updated data sheets, such as design information, material specifications, inspection reports and asset information management, which is then further enriched with additional metadata. The data is added, tagged and pulled from existing systems. Which are not embedded or stored in a 2D/3D models directly.

Stage 3 is facilitated by the use of sensors, connected devices, the internet of things, dynamic or operational data is obtained and then displayed in near or real time through one directional flow from the physical asset to the virtual digital asset. This data can then be analysed to inform and predict the behaviour of the built asset, which will better inform asset managers when making decisions and the output or results are then fed back and updated into the organisations existing system.

Stage 4 looks at the digital twin being able to change the state and condition of the physical twin.

Stage 5 is about trying to make the digital twin learn and evolve so that information and data can be absorbed, understanding patterns and absorbing behaviour to then make maintenance and operations autonomous.

As witnessed with the advancement of BIM, a revolutionary change within the industry is essential in order to create safer and better quality buildings which are designed and built more efficiently. The influence of Digital Built Britain and a drive for the industry to become more digital and more efficient in our working practices leads to a real business case for digital twins. There are several benefits realised by using digital twins as an effective and efficient way of working, including better business outcomes and greater customer satisfaction, whilst saving on costs. Digital twins offer a useable solution and a set of processes which builds upon the already excellent steps we have taken to introduce BIM to our industry.