Digital Twins

Background

A Digital Twin (DT) is a “virtual model of an object, a system, or a process. It is connected to its real-world counterpart by a 2-way flow of right-time data, meaning it mimics it in all aspects.” (National Digital Twin Centre, 2023). They are used across all sectors and all parts of life where we are able to test decisions before we make them and understand how different actions might affect the real world, for example, there are models which make predictive proposals (the forecast) based on the current weather feeding into a model based on historical records. There are many ways that digital twins can help to ensure success for government policies such as the pledge to build 1.5 million new homes over the next 5 years and meeting net-zero targets, in addition to applications in the defence, healthcare and the construction sector. It is essential, however, that the real-world counterpart is able to continue to operate safely and securely without its digital twin.

Evidence

DTs promise more effective asset design, project execution and asset operations by dynamically integrating data and information throughout the asset lifecycle to achieve short and long-term efficiency and productivity gains. It’s a data resource that can improve the design of a new asset or understanding of existing asset condition. This has the potential to vastly reduce errors and discontinuities present in more traditional methods of information management.

The global market valuation of DTs is expected to increase by $32bn from the years 2019 – 2025, and it is predicted that half of all large companies will use some form of Digital Twin by 2021 – resulting in a 10% improvement in effectiveness. (Source: Digital Twins for the built environment, IET)

Manufacturing applications for DT technology consist of specific stages (Source: Apollo protocol: unifying digital twins across sectors):

- **Product design:** An engineering design application DTs can be used to learn from products currently in operation to assist with design optimisation of next-generation assets.
- **Process design:** Offline analytic applications using historical state of DTs with current synchronised control applications to modify the future state, making changes to a manufacturing process in real time.
- **Process management:** Managing data from synchronised processes during production enables identification of issues and the improvement of materials/processes by displaying and interpreting the live state of an asset in operation.
- **Predictive maintenance:** Information analysed in real-time scheduling adaptive maintenance activities. When machine conditions are always being informed, it can lead to a reduction of unplanned downtime by as much as 30 percent.

Built environment applications for DT technology also consist of several stages:

- **Citizen-centric data models:** Ensuring citizen involvement in the infrastructure decision-making processes, from local planning through to impact assessment of infrastructure investments.
- **Retrofit of at-risk infrastructure:** Enabling visibility of latent risk in existing fixed capital stock, including service operations risks, such as the digital requirements published in Dame Hackitt's Independent review of building regulations and fire safety.
- **Regional resilience, response and simulation:** Using connected data and organisations to enable simulation and response capabilities across interconnected infrastructure, and to test potential mitigations.

Despite the many benefits of adopting these technologies, there are challenges to adoption, including initial cost and interoperability of data between systems.

Recommendations

Digital Twins adoption – The Government should make use of best practice in DT technology to help support changes to national infrastructure, healthcare, new housing and energy targets and other sectors to ensure taxpayers money is used optimally and the final product is efficient and resilient. In housing Birmingham's smart city digital twin supports urban planning and allows for real-time decision making to improve the city's resilience and growth (Source: Development of a Digital Twin for East Birmingham, University of Birmingham). Likewise, Siemens' city of London digital twin tracks energy consumption in buildings and can simulate the impact of potential changes, thereby increasing the future resilience of the city (Source: Digital City Twin, Siemens Global). The government should ensure it sets examples of good practice, when procuring and developing digital twins.

Clear understanding: Stakeholders expect to see a return on their investment, but the value may come further down the line from increased security and resilience and non-financial. Through collecting the right data, setting standards and sharing data securely for the public good, the UK could release an additional £7bn in benefits per year across the infrastructure sector. This is equivalent to 25% of the total UK infrastructure spend. The Digital Twin catapult centre and National Digital Twin Centre will be pivotal in outlining case studies and blueprints for good practice and standardised definitions, frameworks and/or guidance, which is something that professional organisations can support.

Skills – Skills in this area are not specific to digital twins, as they require skills from a range of engineering disciplines. Upskilling would be needed across the wider supply chain as skills for digital twins would include data collection, data analysis, cyber security etc. UK firms are already the least likely to recognise digital twins as a priority technology for reaching net zero (5%) – in the construction sector, only 3% say digital twins are important. Only 23% of employers think that the UK has the skills in this area. We recommend that government should collaborate with institutions such as the IET to develop, certify and deliver training.

Clear labelling - There's a lack of clarity over what comprises a DT, a continuum between simulation/CAD to more advanced models. This affects the investment decision process. Much of the problem lies with software sellers labelling DT models incorrectly, which leads to varied definition. We recommend that the Government should champion standardisation in this area through procurement and the new Digital Twin Centre and the Digital Catapult.

As a professional body that spans all engineering sectors, the IET is well placed to provide a convening role between industry, government and academia to address these challenges. To view the full reports referenced in this paper, please contact: policy@theiet.org