Rapid Technology Assessment: Digital Twins

A digital twin is a cyber-physical system that links a computational representation of a physical asset, entity or process with a two-way flow of right-time data from installed sensors on a physical twin. This powerful link between the physical and the digital can help monitor, optimise, and even remotely control the physical asset across its lifecycle.

Introduction

- **Digital twins can enable the remote monitoring of parts, processes, and places and control of complicated physical processes and objects**. This can enable predictive maintenance, speed development, increase efficiency, reduce costs and mitigate risk. Digital twins can be applied to industrial processes, product design and testing, environmental monitoring, infrastructure and logistics, as well as in business and policy decision-making.

- **Digital twins have potential uses in a wide range of sectors**. Multiple sectors are beginning to use increasingly complex digital models, particularly those with high-value assets, complex processes, or where innovation and development is costly.

- **Interconnected systems of digital twins** could increase our understanding of complex system-wide effects crucial to informed decision-making where issues span multiple sectors (e.g. climate change). This relies on sector cooperation and a clear framework for the use and development of digital twin systems.

Recent Developments

- **Many countries including the UK are developing digital twin programmes.** National digital twins would likely be federated systems, a collection of interconnected digital twins built by different organisations, rather than a single massive digital twin of a nation. In the UK, the National Digital Twin Programme (NDTP) was launched in 2018 to grow the UKs capability in digital twins.

- **The technologies that enable digital twins** such as artificial intelligence, 5G, virtual reality, and distributed ledger technology have all seen advancements that have helped to facilitate the development of digital twins.

- **Large organisations including Ocado, Rolls-Royce, and DHL are focussed on developing and using digital twins.** The value of digital twins is also being considered in development or optimisation of energy and water infrastructure in the UK. While at an early stage of development, there are reports from industry that digital twins have led to efficiency improvements.
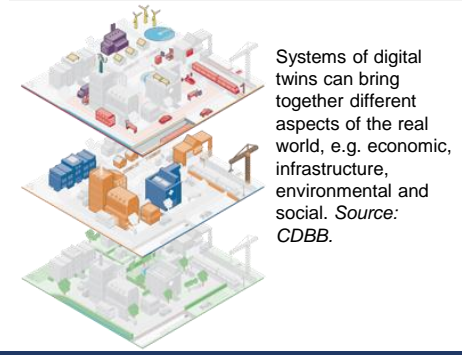

UK Position

- The UK has strengths in the underlying technologies for building digital twins, such as AI, sensors and computer science. Globally, activity in this field is growing quickly. The UK publishes impactful research but files less patents than leading nations. From 2014-2021, the number of patents filed globally grew at an annualised rate of 213%.

Systems of digital twins can bring together different aspects of the real world, e.g. economic, infrastructure, environmental and social. *Source: CDBB.*

Opportunities

- **Machine and equipment monitoring is expected to be the largest application of digital twin technology in the UK by 2026,** particularly in the manufacturing sector. Testing and monitoring infrastructure, industrial processes, or high-value items could reduce costs and improve efficiency and sustainability.

- **As the technology develops digital twins could present benefits to a sectors beyond industry and manufacturing**, including health and defence. For example, digital twins could improve understanding of how healthcare systems are used or enable more personalised treatments.

- **Digital twins could help to increase our understanding of the built environment.** This may enable more efficient infrastructure or transport networks.

- **Connecting digital twins can increase their value and power, creating a 'system of systems'.** This could support improved decision-making in complex areas and form the basis of a federated UK Digital Twin.

Challenges & Risks

- **Numerous research challenges remain to fully realise the benefits of digital twin technology** and as the use of digital twins in society increases, further consideration will likely be needed for **data protection, data ownership, and ethical issues such as equality and bias.**

- **Building a digital twin is currently a bespoke and expensive process** that requires substantial computing power, infrastructure, and multi-disciplinary skills. Research challenges remain to further develop the component technologies.

- **The lack of standardised framework for the development and networking of digital twins could be a barrier to development and adoption.** The NDTP is creating the standards, guidance, and processes to enable ecosystems of multi-sector digital twins. This work could help increase understanding of DTs and their applications.

- **Ensuring that sensitive data underpinning digital twins is protected by appropriate levels of security** will be critical.