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Twinning

Pairing the real with the virtual

By Grant McDonald

Digital twins – virtual replicas of a physical asset or process - have changed the manufacturing landscape including how business is done in the aerospace and defence (A&D) sector.

Instead of physically shutting down a plant or factory line, engineers can redesign and test a new component or piece of critical machinery through the simultaneous pairing of the physical plant with its virtual recreation.

Digital twins help to better understand the physical counterpart and offer insights, or even predict how the physical counterpart will react or behave. It answers the 'what if' questions. It's a much more agile, cost-efficient, and time-saving process to improve product and system efficiency. Potential issues can be identified before they occur, reducing time and cost and improving employee safety.

Pairing the real with the virtual can play an important role in achieving sustainability goals in the sector. That is, digital twins are a tool which can be used to innovate new types of aircraft and propulsion systems. Technologies including electrification, hydrogen fuel cells and engines and distributed electric propulsion can be developed more quickly if not relying solely on physical test data for certification.

Going green

A digital twin is one of several levers to help drive greenhouse gas (GHG) emissions reduction.

The monitoring of and accounting for carbon emissions is one of the most-important starting points in "going green". Scope 1 emissions are GHGs released directly from the company's owned or controlled sources. Scope 2 emissions are indirect, for example, purchased electricity consumed by organizations. Scope 3 is all other indirect emissions, which are widely considered the hardest to control.

Digital twins not only can pinpoint inefficient operating parts but also increase energy efficiency, reduce waste by providing greater visibility on energy consumption, water, and carbon footprint. By monitoring their energy usage in real time, organizations can both improve their operational efficiency and ensure compliance with regulatory standards. A digital twin of the supply chain – think scope 3 – also provides the kind of end-to-end visibility that's needed to optimize the supply chain networks across costs, quality, service, and sustainability.

In advanced manufacturing facilities such as those in A&D industry, people and production systems connect seamlessly with technology. Digitally enabled devices continuously collect, produce and swap real-time data for their modelling. A digital twin taps into a data stream, learns, and runs alongside and ahead of real-world manufacturing and asset management systems. Organizations can then model, simulate, monitor, analyze, test, and optimize their physical world. So beyond simply providing insight, digital twins also inform decisions, enable oversight of more complex systems, and optimize operations in real-time.

In A&D, some original equipment manufacturers (OEMs) are creating digital twin ecosystems and digital threads that allow them to collaborate in real time across their facilities and with supply chain partners. For example, clean-sheet aircraft designs can now be done entirely with digital engineering.

In use with U.S. military

The U.S. military is using virtual twinning to better understand the effects of climate change and find ways to reduce their carbon footprint. Similarly, in Canada, the Department of National Defence in collaboration with the National Research Council and the Royal Canadian Navy have used, or plan to use, digital twins. One potential use case is to monitor structural fatigue within a ship's digital twin which mirrors the actual hull's structural condition.

Increasingly, digital twins are being applied to every type of infrastructure, whether buildings, plants, roads and rail, bridges and tunnels, electricity grids, or a water distribution network.

They can take many forms. They could be simple 3D models, or a highly immersive visualization environment (HIVE) where operators can view, monitor, and remotely control an asset or process. They can be complex, real-time, and data-based models of production lines, facilities, and even whole ecosystems. They can be used for anything from training to operation without being capital intensive.

Regardless of their form or application, a digital twin should always have a clear purpose. A key part for any enterprise-wide investment is demonstrating the business case and return on investment.

The first step is to define the business outcome, and then reverse engineer the requirements to ensure that the digital twin is purpose-led.

Data governance is another key factor to consider. It's imperative to establish clear policies and procedures for managing and protecting data, including who has access to it and how it can be used. Robust cybersecurity measures also need to be in place to secure the data. Indeed, all systems should be secure by design regardless of whether it's a physical asset, a production system, or a digital twin.

All A&D organizations – no matter their size – can benefit from digital twins. How are you applying this in your organization?

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