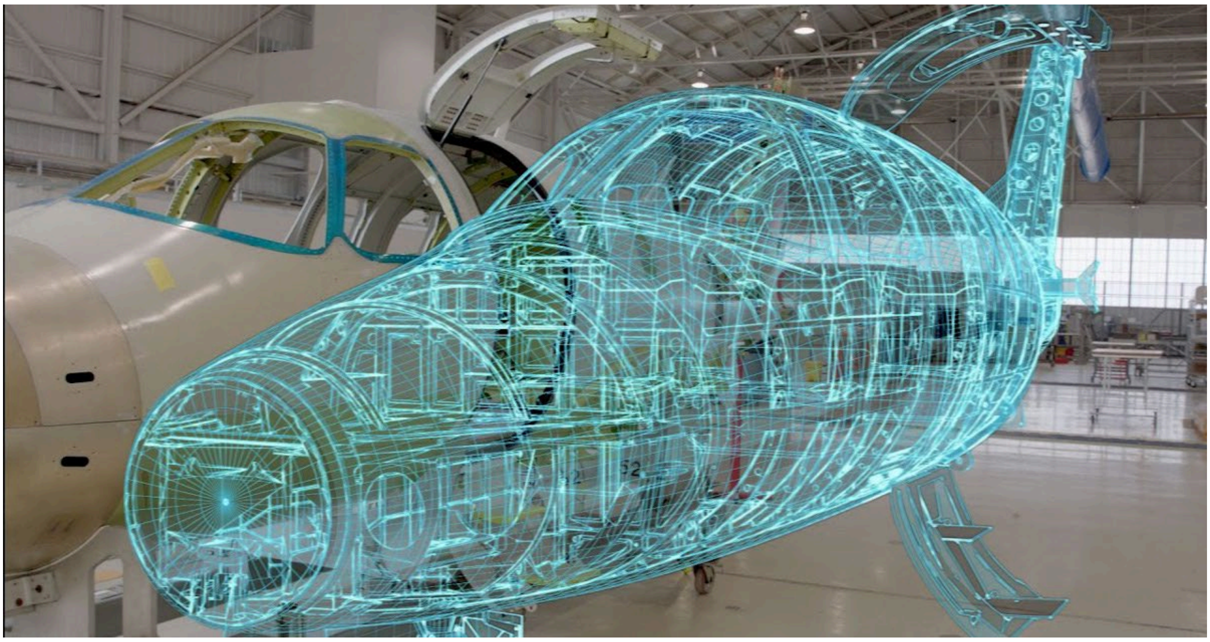
THE DIGITAL TWIN



The digital twin - or avatar - as exampled above, is a significant element of the fourth industrial revolution, especially in such manufacturing industries as aerospace. But what is it?

A digital twin is a virtual representation that serves as the real-time digital counterpart of a physical object or process. The first practical definition of a digital twin originated from NASA in an attempt to improve the physical model simulation of spacecraft in 2010. Digital twins are the result of continual improvement in the creation of product design and engineering activities. Product drawings and engineering specifications progressed from handmade drafting to computer aided drafting/computer aided design to model-based systems engineering.

The digital twin of a physical object is dependent on the digital thread, the lowest level design and specification for a digital twin, and the "twin" is dependent on the digital thread to maintain accuracy. Changes to product design are implemented using engineering change orders (ECO). An ECO made to a component item will result in a new version of the item's digital thread, and correspondingly to the digital twin.

An example of digital twins is the use of 3D modelling to create digital companions for a physical object. It can be used to view the status of the physical object, which provides a way to project physical objects into the digital world. For example, when sensors collect data from a connected device, the sensor data can be used to update a digital twin copy of the device's state in real time. The term 'device shadow' is also used for the concept of a digital twin. The digital twin is meant to be an up-to-date and accurate copy of the physical object's properties and states, including shape, position, gesture, status and motion.

A digital twin can also be used for monitoring, diagnostics and prognostics, to optimize asset performance and utilization. In this field, sensory data can be combined with historical data, human expertise and fleet and simulation learning to improve the outcome of prognostics. Therefore, complex prognostics and intelligent maintenance system platforms can use digital twins in finding the root cause of issues and improve productivity.

Digital twins of autonomous vehicles and their sensor suite embedded in a traffic and environment simulation have also been proposed as a means to overcome the significant development, testing and validation challenges for automotive application, in particular when the related algorithms are based on artificial intelligence approaches that require extensive training data and validation data sets.

The digital twin is disrupting the entire product lifecycle management (PLM) from design to manufacturing to service and operations. Nowadays PLM is very time-consuming in terms of efficiency, manufacturing, intelligence, service phases and sustainability in product design. A digital twin can merge the product physical and virtual space. The digital twin enables companies to have a digital footprint of all of their products, from design to development, and throughout the entire product life cycle.

Broadly speaking, industries with manufacturing business are highly disrupted (radically changed) by digital twins. In the manufacturing process the digital twin is like a virtual replica of the near-time occurrences in the factory. Thousands of sensors are placed throughout the physical manufacturing process, all collecting data from different dimensions, such as environmental conditions, behavioural characteristics of the machine and work that is being performed. All this data is continuously communicating and collected by the digital twin.

Due to the Internet of Things, digital twins have become more affordable and could drive the future of the manufacturing industry. A benefit for engineers lays in real-world usage of products that are being designed by the digital twin. Advanced ways of product and asset maintenance and management come within reach as there is a digital twin of the real thing with real-time capabilities.

Digital twins offer considerable business potential by predicting the future, instead of analysing the past, of the manufacturing process. The representation of reality created by digital twins allows manufacturers to evolve towards ex-ante (a prediction ahead of an event) business practices. This future of manufacturing is based on the following four aspects: modularity; autonomy; connectivity; and the digital twin. As there is an increasing digitalization in the stages of a manufacturing process, opportunities are opening up to achieve increasingly higher productivity.

Furthermore, autonomy enables the production system to respond to unexpected events in an efficient and intelligent way; and connectivity, like the Internet of Things, makes the closing of the digitalization loop possible by then allowing the following cycle of product design and promotion to be optimized for higher performance. This may lead to increases in customer satisfaction and loyalty when products can determine a problem before actually breaking down. Moreover, as storage and computing costs are becoming less expensive, the ways in which digital twins are used are increasing.

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