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WHITE PAPER

The ever-evolving digital twin

The benefits of the digital twin and how it can optimize processes

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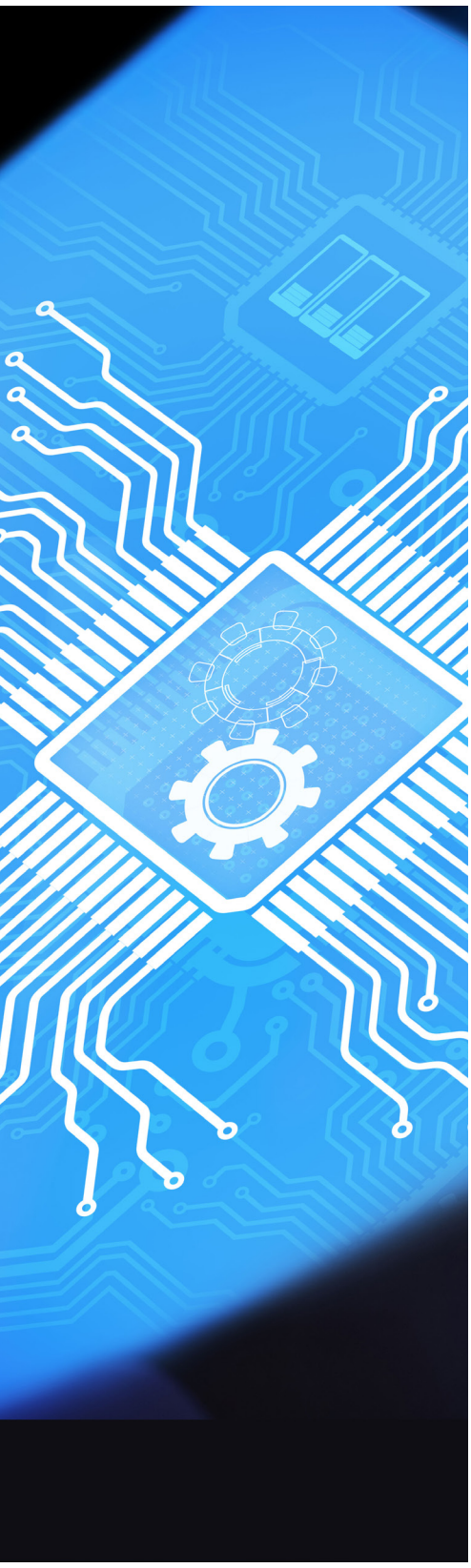

Executive summary

How far can the digital twin go?

When Michael Grieves brought the term “digital twin” to the world’s attention in 2002,[1] he saw it as a digital representation of a physical system. It could mirror, model and optimize that system throughout its lifecycle.

Since then, digital twins have shown huge potential. They improve organizational efficiency and performance while taking more informed approaches in areas such as product design, manufacturing production and inventory management. According to estimates, we can expect to see 65 percent of global manufacturers save 10 percent of their operational expenses through the use of digital twins.[2]

But the digital twin is not just for discrete manufacturers and it doesn’t just address physical systems. If something can be modeled or simulated, it should be possible to create a powerful digital twin around it. Digital twins can be created for individual parts, a piece of machinery, a production line, a factory or even the entire enterprise. And they can be brought together in a ”digital thread” that addresses a complete lifecycle.

That’s just the start. There are now process digital twins that cover individual business areas, such as supply chain operations, or business processes, such as financial management. Digital twins are being created that mirror people to help commercial organizations better serve their customers, health organizations better serve their patients and governments better serve its citizens.

But progress is slow. In 2019, Gartner suggested that 75 percent of companies implementing Internet of Things (IoT) were using digital twins. However, a deeper dive showed that only 13 percent were actually using the technology, while the other 62 percent were still in the planning stage.

Identifying the right use cases and successfully implementing the right digital twin strategy remains challenging. This paper examines the evolving digital twin, the ROI that can be achieved and the best way to progress on a digital twin journey.

1 Grieves, M., Virtually Intelligent Product Systems: Digital and Physical Twins, in Complex Systems Engineering: Theory and Practice, S. Flumerfelt, et al., Editors. 2019, American Institute of Aeronautics and Astronautics.
p. 175-200.

2 ASCM, 10 trends that will drive your IT investments. (March 2020)

Defining the digital twin

A digital twin is a virtual representation of a real-life asset or process. It enables organizations to simulate conditions, test scenarios and explore what-ifs—even where those conditions have never existed. The digital twin delivers a holistic view of its actual counterpart that enables better decision-making. It can boost productivity, enhance operational efficiencies, increase business agility and improve the customer experience.

No longer a "nice to have," the digital twin are now a vital business tool. It underpins digital transformation by turning vast amounts of data related to an asset or process into a competitive advantage. However, a digital twin is neither a single entity nor a single technology. There are a number of different levels of digital twin:

Parts-level

Sometimes called a discrete digital twin, this twin is applied to an individual part, used to record information and describe the operation of that part.

Asset-level

Combining the twins from different components within that asset forms the asset-level digital twin. It helps organizations understand how different parts of the asset interact and provides a holistic view of the operation and the performance of the asset.

System-level

This brings together asset-level twins to provide a composite that allows for monitoring and analysis of an entire system or process—for example, a smart factory or smart city. These twins are increasingly being applied to human beings in use cases such as health, financial management and customer experience.

Enterprise-level

This digital twin links system-level twins to deliver a view across the entire enterprise. The goal is to monitor and optimize higher-level business activities and outcomes.

Process-level

This digital twin addresses end-to-end business processes and would focus on relevant enterprise applications to build a compete model of a process. This enables an organization to monitor and optimize cross-enterprise and cross-ecosystem processes—such as supply chain management, customer experience and financial operations.

The first generation of digital twin has grown within manufacturing and industrial settings, with parts-level and asset-level digital twins dominating. However, Accenture suggests that organizations are missing out on up to 65 percent of the value of their digital twin investments by focusing too tightly on standalone digital twins designed for single functions.[3] Instead, higher-level digital twins (such as enterprise or process digital twins) allow for the creation of a "digital thread." This thread integrates the capabilities of multiple digital twins and unlocks the potential to apply this technology to an almost limitless number of business use cases.

3 Webinar Care, Digital Twin Statistics 2022 - Everything You Need to Know. (December 2022)

Digital twin functions

Depending on the level of technical sophistication within the digital thread and its IoT and system integration (SI) components, these digital twin enablers can provide a range of functions to help monitor and manage an asset or process. These include:

Descriptive: Report on the status of an asset, system or process based on realtime or near realtime data.

Diagnostic: Interrogate and analyze data to identify issues and root causes for the operation of assets or processes.

Predictive: Using realtime data from an asset or series of assets to predict when/where issues might arise and allow for preventative actions.

Prescriptive: Using AI and machine learning to maximize assets/optimize processes and reduce failure rates by imposing proactive measures prior to issues occurring.

Automated: Operational and optimization activities are automated through a bi-directional information flow between the physical and digital twin.

Collaborative: A central hub for all related information on the physical twin. All interested parties (people, systems and things) have access, enabling improved collaboration and information sharing.

Benefits and opportunities

It is challenging to calculate the ROI from digital twin projects and deployments. But recent research from Cap Gemini demonstrates that organizations are beginning to realize impressive business benefits from their digital twin portfolio. And the more advanced the organization is in digital twin deployment, the greater the benefit.

Increased sales, improved efficiency, reduced costs and better customer satisfaction were among the major benefits reported.[4] In fact, top-line business drivers featured prominently, with 73 percent of those surveyed saying digital twins will help reduce time to market. And 67 percent feel it can facilitate the introduction of new business models. However, the key take-away from the survey is that more advanced digital twin users are receiving up to 75 percent more benefits across a range of business areas, compared to other organizations.

4 Accenture, Think thread first. (July 2021)

Read the second paper in this series, Growing use cases for the ever-evolving digital twin ›

Average benefits realized from various digital twin implementations

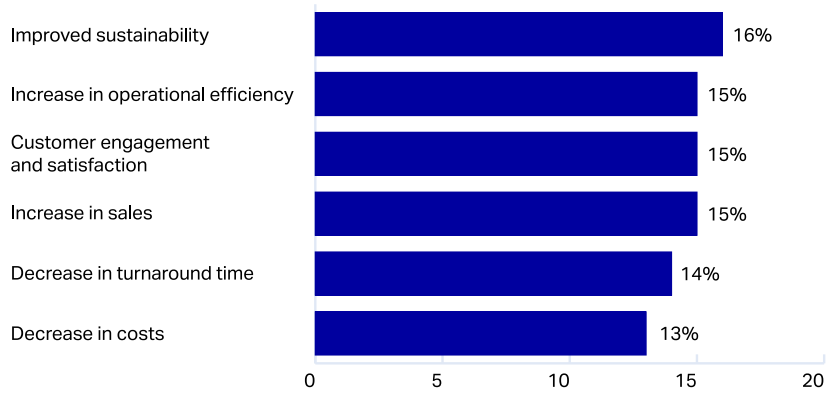

Figure 1: Average benefits realized from digital twin deployments (Source: Cap Gemini)

Other business benefits that organizations are realizing from digital twin investments include:

Business agility: Digital twins allow enterprises to increase the pace of business, shortening design and testing cycles and allowing for faster and more effective changes to products, systems and processes. Everything can be simulated and changed in the virtual environment before being transferred to the physical world, increasing efficiency and leading to products or processes that are far more fit for purpose.

Business resilience: Every part of the enterprise can be modeled and tested, so areas such as supply change management can react quickly to any shocks (such as natural disasters or political turmoil) by leveraging data from internal and external sources to assess the impact to supply and demand in near real time.

Cost savings: Both productivity and asset operation can be optimized to ensure less downtime and lower maintenance costs. Products can be designed, produced and delivered in a way that improves quality and reduces risk, while better satisfying demand and optimizing inventory.

Improved productivity: The organization can see where workers are best deployed and where processes can be automated to reduce manual input or increase worker safety (such oil and gas inspections). Digital twins also facilitate collaboration across teams, ecosystems and geographies by bringing together all information about an asset or process and making it available from one central, secure location.

Resource optimization: The digital twin enables executives to see how all physical, budgetary and human resources are being used, determine whether they are inefficient and decide where adjustments need to be made.

Process automation/optimization: A digital twin can help identify process improvements, bottlenecks and inefficiencies that might otherwise go undetected. Organizations can test process variants and improvements prior to deployment. The entire process, or certain parts of it, can be optimized, automated and controlled from within the twin itself.

Read: How do you create a digital twin? ›

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Improved worker safety: The digital twin can improve worker safety by monitoring essential information such as vital signs or location, as well as ensuring that the appropriate personal protection equipment (PPE) is used. For example, a digital twin of approved and required PPE can be linked to an individual employee, essentially creating a digital twin uniform tied to the identity of the worker. If the worker tries to enter a hazardous space without the approved PPE or using another employee's PPE, access to that space can be restricted.

Technology needed for a digital twin

Many technical components are needed in the construction of a digital twin, including:

Internet of Things (IoT) platform: Core to the digital twins for industrial and manufacturing assets are the sensors and devices that are embedded or attached to the physical device. Together with their software platforms, they become part of the Internet of Things (IoT). These IoT systems facilitate machine-to-machine communication for automated measurement and operation. They manage, secure and integrate all IoT-enabled components and data from their digital twins.

AI/Machine learning: Artificial intelligence (AI) technologies, such as machine learning (ML), reduce the cost and improve the effectiveness of managing and analyzing the vast amounts of data related to a digital twin. In addition, AI capabilities can learn to identify opportunities or issues that would have been missed by human operators and eliminate the time, cost and error inherent in manual analysis.

Modelling/Simulation: Core models for a digital twin can include physics- or chemistry-based models, engineering or simulation models and data models based on statistics, ML and AI. Today, 3D modelling and models based on virtual reality or augmented reality are becoming more prevalent.

Data interoperability: In many instances, the digital twin becomes the repository for the master data and models for the physical object or process. This requires extracting data from a range of sources and ensuring data interoperability across systems.

Security: Identity management and access control are core components of the security technologies in a digital twin. The twin must be able to interact with all of the people, systems, processes and things related to its operation. Only the correct stakeholder roles should be able to access the information they need. This is key to underpinning trust in the twin and supporting effective governance of the digital twin and its associated information.

From product to process

Because a digital twin can help manage and monitor a product throughout its lifecycle, it is easy to consider it a hyper-connected product lifecycle management (PLM) system. It is likely that PLM will be a facet of many digital twins, but there are some important differences. A conventional PLM system (such as those from Siemens, Dassault Systèmes or OpenText) uses one digital model to represent each variant of a product. A digital twin, by contrast, might have one model for each product, which is continually updated using data collected during the product's lifecycle.

However, the digital twin can deliver more benefits than a PLM system for product-based companies. McKinsey suggests that digital twin technologies can increase revenue by up to 10 percent, accelerate time to market by as much as 50 percent and deliver a 25 percent improvement in product quality[6].

The twin can help identify and create new revenue streams in a way that previous systems could not. A major element in this evolution is the move from discrete twins focused on individual parts or assets to composite twins that will address entire systems or processes. Through effective information management and AI-based analytics, these process twins provide a range of different functions to a wider universe of interested parties, including senior executives, product managers, process users and customers or suppliers.

By combining data from the physical world with information from enterprise applications and other sources, enterprise information management techniques can be applied to drive automation and optimization across business processes and entire enterprises.

For example, a supply chain digital twin is a detailed simulation model of an actual supply chain that uses realtime data and snapshots to forecast supply chain dynamics. It incorporates live information feeds from each step in the supply chain (such as incoming shipment schedules, vehicle locations and inventory levels) to assess the supply chain's current state, quickly predict future issues and provide an effective solution that keeps the supply chain flowing.

Digital twins can be transformative to financial services. In this instance, a digital twin can be created not only from a process or system, but also from customers. Estimates suggest that a human digital twin can be created in as little as two weeks.[7] Organizations can model the preferences and behavior of every customer to better target and customize products and services. The digital twin can be used to integrate additional types of financial data when it comes to commercial financing. The digital twin can balance the customers need to see financed inventory and loan utilization along with the bank's need to manage risk and ensure proper loan and lease repayment.

Read the follow-up paper, Growing use cases for the ever-evolving digital twin, which will discuss topics including typical digital twin usage in product design and ethical use cases, such as sustainability.

6 McKinsey, Digital Twins: The art of the possible in product development and beyond. (April 2022)
7 Fintech Futures, Digital twins in the metaverse. (January 2022)

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