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ASK THE EXPERT

HOW TO BENEFIT FROM CLOSED-LOOP DIGITAL TWINS

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INTRODUCTION

In its broadest terms, "digital twin" can describe the way any real-world system is represented digitally. The term has been used to describe virtual representations of the geometry, functions, and physics of real objects or systems. Others use the term "digital twin" to describe an onboarded asset, the virtual model of a piece of manufacturing equipment or a system described by industrial Internet of Things (IoT) data streams.

As digitalization becomes more pervasive, both types of digital twins have grown more representative of their real-world counterparts. However, because each type developed independently for the purposes of its own users, sharing information between them can be challenging. Comprehensive closed-loop digital twins seek to form a bridge between manufacturing, design, and customer experience silos so that industrial IoT data is put to its best use across the enterprise.

Q: What is a comprehensive closed-loop digital twin?

A. Alex: Comprehensive closed-loop digital twins represent the evolution of the digital twin concept into tools that can inform design iterations and continuous improvement with real-world data. "Comprehensive" refers to the fact that a comprehensive digital twin incorporates data relevant to the product design, production processes, and product performance. The comwprehensive digital twin creates a digital thread connecting traditional organizational siloes with real-world data.

A. Abhinav: "Closed-loop" means that the digital twin model constantly evolves using real-world data collected through industrial IoT channels. The initial models that represent products and production processes use industrial IoT data to reflect reality instead of relying on assumptions. For instance, incorporating real-world load conditions into the sizing of structural components lets designers more quickly optimize their designs and avoid oversized or undersized parts. Likewise, data from the shop floor can help optimize production and back up certain scenarios with simulation.

Q. What benefit do closed-loop digital twins provide for manufacturing businesses?

A. Alex: Comprehensive closed-loop digital twins provide different benefits at each stage of the product life cycle. The concept of a digital twin can be further refined to focus on the details of the product, production efficiency, and performance characteristics.

For example, a wind turbine manufacturer could benefit from the ability of a comprehensive closed-loop digital twin of product to inform part design with real-world data. The digital twin lets the manufacturer's designers virtually test, validate, and analyze products before they are put into full-scale production. By digitally simulating designs through the digital twin, the manufacturer can shorten the design cycle, cut prototyping cost, and reduce risk.

A. Abhinav: During production, the same manufacturer could use a comprehensive closed-loop production digital twin to model the myriad processes that go into wind-turbine assembly.

Using this comprehensive model, the production line can be set up for efficiency from the start. Data from the shop floor then feeds back into the model to catch problems before they occur, speed and strengthen root-cause analysis, and support data-driven continuous improvement.

A. Alex: Comprehensive digital twins of performance let manufactures continue to improve after the product is in service. By collecting performance data, the wind-turbine manufacturer can validate and improve its virtual simulations. For instance, performance data can feed more robust product models to identify over- or under-engineered parts.

The performance digital twin is also an asset to the manufacturer's customers. Using it, the manufacturer may be able to inform the utility operating the wind turbine of the most efficient operating conditions for the equipment and predict when maintenance will be required.

Q. What are the biggest challenges businesses face when trying to create a closed-loop digital twin of their own?

A. Alex: Although the concept of a closed-loop digital twin is straightforward, putting one into practice is not. Businesses invest millions of man-hours of coding to build design and engineering simulations and industrial IoT shop floor and product performance frameworks. However well these tools function independently, they often are unable to share data with other systems.

Businesses hoping to implement a closed-loop digital twin may feel caught between two bad choices: settling for manual input of static data or investing additional resources to help siloed systems communicate. Manually inputting data is costly and time-consuming. More problematic is the fact that static data only represents a moment in time; it rarely provides the context to fuel data-driven improvements.

Making another huge investment in coding manpower is also risky since in-house resources may not have the expertise to help the systems communicate in an automated, scalable way.

Companies risk trying to reinvent the wheel while diverting resources from other initiatives more closely tied to their core missions.

Many businesses choose a third path: leveraging tools and expertise that already exist to craft their closed-loop digital twin. For example, MindSphere®, the industrial IoT as a service solution from Siemens, provides many businesses out-of-the-box solutions that help them build a bridge between the worlds of design and manufacturing.

Q. Is there an efficient way for businesses to implement closed-loop digital twins?

A. Abhinav: The MindSphere industrial IoT solution, enables manufacturers to combine their industrial IoT-data with product lifecycle management (PLM), and simulation technologies to build powerful closed-loop digital twins of product, production, and performance. It also facilitates the incorporation of newer technologies like artificial intelligence (AI) and machine learning (ML) into digital twins.

Engineering applications typically leverage multi-physics simulations or previously established mathematical models to predict behavior, resulting in simulations that are as accurate as the physics behind them. ML plays a role for aspects of reality that can't be modeled, when physical models are not yet refined enough to reflect reality, and in conserving computing resources as the algorithm "learns" which parts of the physical model to focus on. Simulation combined with ML powered by industrial IoT data has the potential to change the landscape of engineering design in the future.

Q. Why is industrial IoT data critical for a closed-loop digital twin?

A. Alex: Industrial IoT data is a key component in closing the loop to create a comprehensive digital twin. By leveraging industrial IoT data, manufacturers can realize new efficiencies, avoid product and production issues, and shorten development and design cycles.

Businesses can leverage an industrial IoT as a service solution like MindSphere for its extensive communication capabilities. MindSphere capabilities help ensure the collection of everything needed to create a complete digital representation of a physical product, production system, or performance that can fuel data-driven decision making.

Using Siemens' solutions, businesses can then build a digital thread between applications which author engineering data and the real-world industrial IoT data from physical machinery and infrastructure corralled by MindSphere. This thread closes the loop to create a truly comprehensive digital twin.

Q. What value can businesses expect when implementing a closed-loop solution?

A. Alex: Comprehensive closed-loop digital twins leverage industrial IoT data to give businesses the tools to improve their product designs, production, and performance. Robust models based on real-world data help engineers get product designs right the first time. The result is lower development costs and a shorter time-to-market for designs informed by digital twins.

A. Abhinav: Digital twins also help increase throughput and reduce production cost. Data-driven simulations let engineers predict production scenarios to avoid issues before they happen or stop a problem before it's too late. They can also ensure safe and healthy operating conditions for workers.

Performance digital twins help manufacturers quickly identify and correct any lingering product issues to ensure customer satisfaction. Data flowing back into the performance digital twin informs the next design iteration and can delight customers who can use it to optimize performance or predict maintenance requirements.

MindSphere fuels the creation of comprehensive digital twins with its out-of-the-box tools and enables businesses to create the industrial IoT frameworks that feed comprehensive closed-loop digital twins without distracting valuable IT assets from mission-critical goals. Laying the groundwork for a comprehensive closed-loop digital twin that connects previously siloed groups with industrial IoT-fueled digital threads starts businesses on their journey toward continuous innovation.

MindSphere is an industrial IoT as a service solution from Siemens that is built on Mendix, the low-code application development platform. Because it is offered as a service, organizations can implement the solution without significant upfront investments and benefit from CapEx pricing. MindSphere offers an accelerated route to digitalization, with technology based on over 200 years of industrial automation expertise, giving you confidence that it can meet your business' unique needs.

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