The first well-known implementation of the “digital twin” concept was introduced by NASA’s John Vickers to create simulations of spacecraft and capsules for testing. The concept quickly caught on, and is now used in a variety of capacities, enabling manufacturers to anticipate equipment and supply chain failures before they happen, optimize production lines in real time, and virtually test designs without ever touching a physical prototype.

Gartner defines digital twin as a digital representation of a real-world entity or system whose implementation encapsulates a software object or model that mirrors a unique physical object, process, organization, person or other abstraction. The power of a digital twin lies in its ability to connect disparate data points and create a collection of information without having to copy or move the data, which can be used for insightful decision-making.

By connecting the dots of data across the supply chain, users can achieve insights and efficiencies that were previously hidden in the chaos of data. The challenge lies in integrating and making connections with the data, because even with significant advancements in digitization, manufacturers and the supply chains still lag in making use of their unstructured data.

The key to accelerating digital-twin development is through the use of knowledge graphs — machine-readable representations of the physical and digital worlds, such as people, companies, digital assets, and their relationships, all adhering to a graph data model.

Ensuring a Successful Initiative

For manufacturers, a digital twin is a virtual replica of a physical asset, like a machine or an entire production line. It ingests data from various sources, including internet of things sensors, images, scanning and other methods. The result is a dynamic representation of the real world, with “digital threads” that tie back to their sources. Think of digital threads as the interconnections woven through a digital twin. They connect individual data points across the manufacturing process or supply chain, from raw material to finished product delivery. Users can simulate, monitor and predict key processes, gaining unprecedented views into, and control over, operations. They can effectively simulate and track parts and materials throughout the production process.

Digital twins can also help in responding to supply chain disruptions. Supported by the

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inference capabilities delivered in a semantic knowledge graph, a digital twin can simulate, visualize and test multiple scenarios. The process of reflecting the physical world digitally requires tremendous amounts of data, which must be safely stored, easily accessed, and dynamically analyzed to gain new insights and improve collaborative decision-making across the enterprise.

To enable the digital twin to represent domain knowledge and run and share simulations, data must be pulled together from disparate sources and have a consistent representation. Semantic knowledge graphs take the digital twin concept one step further, by unifying meaning, enabling data virtualization, and providing a single point of access. These intricate knowledge maps connect the relationships between data points, from individual parts to complex systems. Acting as the neural network of a digital twin, they provide context and meaning to the vast amount of information being collected.

Digital Twins in Action

One of the most impactful ways that knowledge graphs speed up digital twin development is in breaking down data silos. Manufacturers' information is often housed within disparate, isolated systems, frustrating efforts to achieve a holistic view of operations. With information gaps caused by these data silos, creating a digital twin accurately is nearly impossible. Knowledge graphs serve as a bridge, by seamlessly integrating data from sources such as IoT sensors, enterprise resource planning applications, video, unstructured text and engineering files.

Just as important as the data are the connections between them, and this is where knowledge graphs shine. Beyond just storing the data, they can help identify patterns and relationships that might not be obvious, such as how changes in sensor readings connect to equipment failures, or how changes in production schedules may affect or create supply chain bottlenecks. This allows manufacturers to use all their data and insights to optimize operations at levels they may not have considered.

With the ability to access, track, and analyze relevant data across the organization and break down information silos, production teams can use the knowledge graph to make well-informed decisions quickly. By eliminating silos and enabling cross-functional collaboration, the knowledge graph also promotes agile decision-making. Connect this power with a digital

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twin, and all available data can be used for simulations, predictions and analytics.

With real-time visibility to data about equipment performance, usage and environmental conditions, analysts can obtain a clear perspective on all the factors that should be considered in building, implementing and maintaining a piece of equipment. Insight from IoT sensors can tell the business that a specific production line could be increased by, say, 15% to deliver greater productivity. It can also assess the impact of heat and moisture conditions, and the weights of items being moved along the line, to paint a picture of how the machinery is being used.

Knowledge graphs are game-changers in the digital twin revolution, as they unlock hidden connections within data, empower deeper insights, optimize operations, and facilitate smarter decision-making across the supply chain. This translates to increased efficiency, reduced costs, improved product quality, and a more competitive edge in the ever-evolving manufacturing landscape.

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