Four misconceptions are hampering the advancement of digital twins

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Digital twins (DTs)—living digital replicas of physical entities—are used widely in manufacturing to mimic and improve real-world processes and systems. However, there are far fewer applications of the technology in supply chain management. DTs could deliver similar benefits in supply chains if it were not for certain misconceptions that prevent companies from unlocking the technology's huge potential.

Contrary to these mistaken beliefs, DT technology is accessible and can be implemented in well-defined steps. And as is the case with any new, innovative technology, companies need to understand what they want to achieve before implementing it.

Pioneering projects

Digital twins can deliver efficiency gains in a wide variety of supply chain functional areas. Here are some illustrative examples.

- The consolidation of shipments in distribution centers.
- Optimizing the size of freight transportation fleets.
- Testing different warehouse layouts.
- Adjusting goods flows and routing, in alignment with demand.

- The tracking of assets in real-time.
- Supporting predictive maintenance programs.

An early adopter of digital twin technology in manufacturing operations, the $13 billion packaging company Tetra Pak, built a digital version of a warehouse in Southeast Asia together with logistics services provider DHL. A continuous stream of operational data harvested from the physical facility's Internet of Things (IoT) infrastructure feeds the digital model. The warehouse digital twin is used in a variety of ways. It helps Tetra Pak to dynamically adjust stock locations, manage inventory as well as seasonality and shifts in demand, balance workflows and allocate equipment in the physical warehouse. These applications enable the company to optimize storage space utilization and improve both operational efficiency and workplace safety standards.

Amazon uses DTs to maintain service levels in its two-day doorstep delivery services. The technology helps the online retailer to dynamically optimize delivery operations by continuously tracking shipments and streamlining product flows.

Examples of DT applications can also be found in the packaging area. A pharmaceutical company has improved the way it tests the durability of packaging for the distribution of temperature-controlled products with the help of DTs. A home furniture company utilizes DT technology to predict the performance of new materials in packaging designs. The technology enables these companies to test different packaging alternatives in a simulated environment and reduce the cost and duration of testing procedures in distribution processes.

However, such applications tend to be the exception rather than the rule in the supply chain field. A primary reason is a lack of understanding about how DT technology can deliver value. The MIT Digital Supply Chain Transformation Lab has identified four misconceptions that stymie the adoption of DTs in supply chains.

1. What exactly is a digital twin?

There is some confusion over what constitutes a DT. The term digital twin implies that DTs are living entities as they mimic their physical counterparts, and to some extent this is true. But they also are learning entities. Failing to recognize this nuance prevents companies from capturing the technology's full value, and restricts DTs to the role of tactical decision-making tools.

What distinguishes DTs and makes them so powerful is their ability to continuously sense ongoing conditions in the physical (living) environment using streaming data generated by various sources, and to evolve by dynamically learning from this information and its contexts (learning). For example, by embedding AI in simulation scenarios, companies can explore numerous what-if scenarios, identify the long-term outcomes of decisions, study the tradeoffs between efficiency and resiliency and predict the risks associated with supply chain disruptions. Also, DTs are connected to each other, learn from their experiences through feedback loops and enhance each other's knowledge via these networks of DTs.

Perceiving DTs as living, learning entities enables companies to use the technology

as a critical tool for strategic decision-making in complex supply chain settings. DTs inform decisions and hence help organizations to adapt quickly to different operational contexts.

2. A digital twin is a sensor, a simulator or an application of AI technology.
The most common misconception in supply chain circles is that DTs are one of the above applications. This is untrue.

A DT is a combination of enabling technologies and analytics capabilities. The mix depends on the requirements of the application and may, or may not, include one or more of the three enablers listed above. There are many others to choose from such as Cloud computing, edge computing, 3D modeling, visualization and augmented reality.

Confining a DT to the role of a sensor, simulator or AI application hinders its adoption and limits its ability to deliver value. This is a holistic technology composed of component technologies that can grow with the addition of more enablers. Additionally, DT implementation and expansion to its potential requires a digital mindset along the supply chain function and the company, in which data availability, granularity and harmonization have to be guaranteed.

Before selecting which DT building blocks to use, companies need to understand which core supply chain functions they want to mimic, which KPIs need to be improved and which the analytical capabilities and data sources that are currently available.

3. DT technology is largely theoretical and not relevant for our supply chain.
The futuristic nature of DTs leads many companies to mistakenly believe that the technology is not ready for prime time or is the product of hype that belongs in the realm of science fiction. Some companies might accept that the technology is relevant today but primarily in manufacturing—not necessarily in supply chain.

However, the technology's adoption in manufacturing began in the early 2000s, and the aerospace and defense industries have been using it

for several decades. DT technology has become more accessible and affordable over recent years thanks to advances in digital connectivity, computing, data storage, Big Data processing and analytics and complex modeling.

As the above examples show, DT applications in supply chain management are compelling and deliver value. Enabler technologies are paving the way for faster adoptions in a wide variety of functional areas within supply chains. Also, as implementation costs continue to come down, it takes less time for projects to reach the breakeven point after the initial investment.

4. A DT cannot be built before the physical twin exists.
Contrary to what some supply chain professionals believe, a DT can be created before its equivalent physical asset is built or acquired. The digital entity gives companies the opportunity to start analyzing the asset's performance whether it be a production line, a new product or a supply chain network. For example, companies can perform cost-benefit analyses before investing in the asset. Such analyses improve long-term decision-making and support prototyping.

However, the physical entity must become a reality at some point otherwise the twin will remain a digital model and its potential will not be realized.

Three-phase implementation plan
Armed with a more accurate picture of what DT technology can achieve in supply chains, companies can approach the creation of a supply chain digital twin in three phases.

1. Observe. In this phase a twin acquires and aggregates data. Hence, data sources and types should be clearly identified. There are five main streams of data to consider: environmental, operational, financial, those pertaining to human interactions and DT-generated feedback loops. Data from simulation models can also be used depending on the context of the DT application. IoT and Cloud platforms are primary facilitators that help teams accomplish this stage.

2. Think. Processing the data described above to learn and perform analytics triggers the Think phase. The DT uses optimization, AI, simulation and other analytical tools in this phase to dynamically assess various what-if scenarios and highlight alternative optimal actions.

3. Communicate and execute. Based on the findings in the previous phase, twins can now generate actionable insights. These insights are communicated to users through various visualization tools such as dashboards and mobile apps. After evaluating users' responses, the DT executes relevant actions and stores the responses as a new data source to be used in future analyses. Storing the actions in this way creates a feedback loop that enables the twin to learn from experience, share it with other DTs, and continuously enhance its ability to learn.

Be clear on your objectives

The definition of a digital twin and what the technology is expected to deliver vary from company to company depending on the supply chain context. Hence, to get the most out of the technology, companies need to identify which business outcomes they want to improve. And, of course, these assessments should not be clouded by the misconceptions described in this article. It is then possible to decide where to start—a critically important step.

Ideally, digital twins should be part of an overarching supply chain digitalization strategy, one that uses DT technology to help orchestrate the strategy. However, this is a broader topic, and companies that have yet to start their supply chain digital transformation journey, or are in its early stages, should not be deterred from using DTs to enhance the efficiency of their supply chains. ∞