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Digital twins can provide a virtual view of products, processes, and operations, as well as the impact of various internal and external factors on performance.

Digital Twins — Transforming Supply Chains and Operations

March 2022

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Introduction

Executives and leaders who build technology products or manage infrastructure and operations across manufacturing and other asset-heavy industries realize they can no longer operate in silos. They understand that the fast pace of technology means there are new and innovative solutions they can use to get a detailed understanding of how their products, supply chain, and operations perform in various conditions.

AT A GLANCE

KEY TAKEAWAYS

Creating a truly modern digital twin infrastructure requires a clear understanding of an organization's current maturity.

The need to become resilient and lead in the market is also forcing leaders to reexamine their siloed approach to dealing with IT, operations technology (OT), customers, supply chain, and other forces. Instead, leaders need to initiate programs and infuse connectivity, scale, and simulation technologies such as digital thread and digital twins into their operations so that they can monitor minute details that enable them to predict different parameters of their business. Digital twins are a digital representation of a physical product, process, or operations (such as a smart factory) that is monitored continuously.

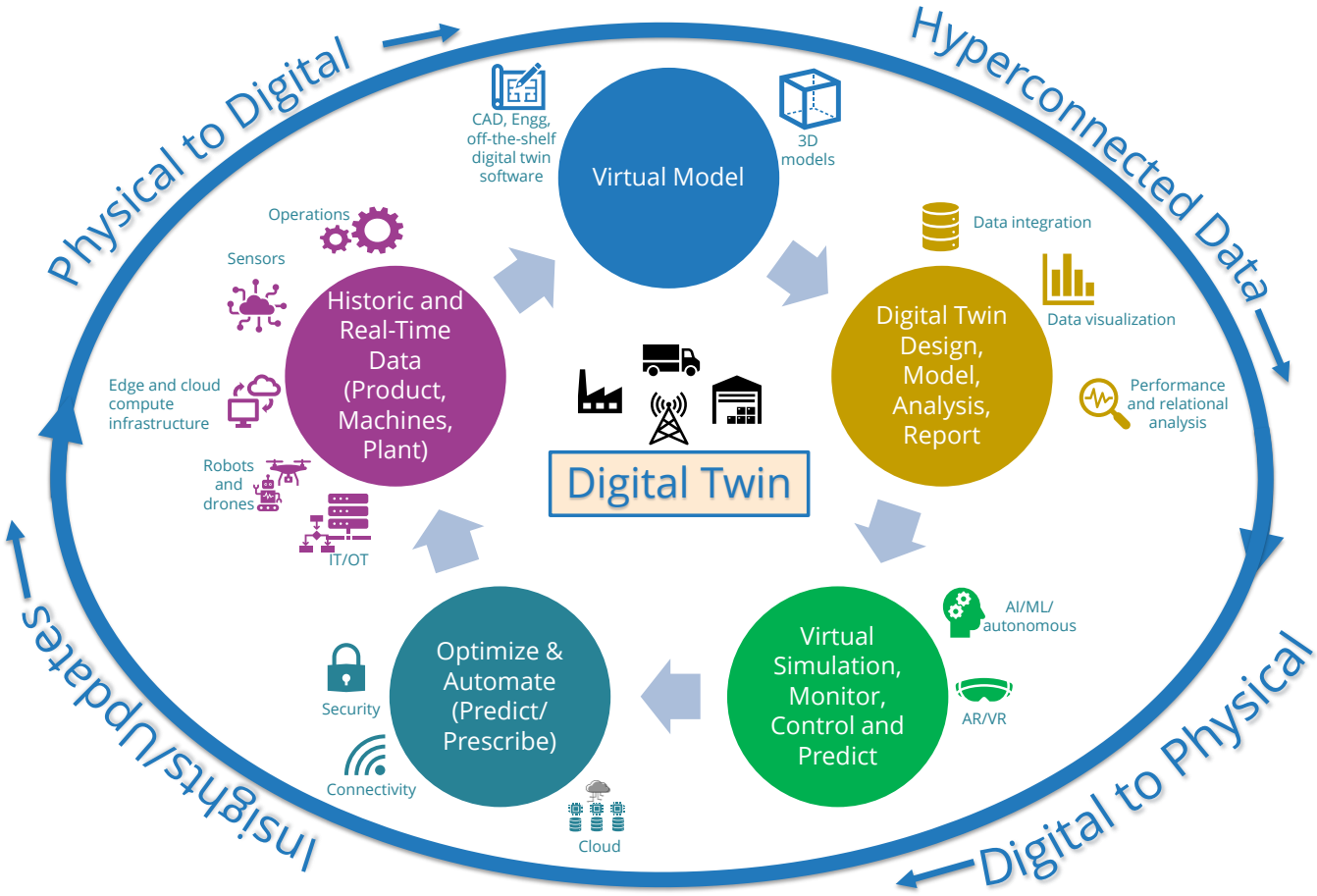
In a recent global customer survey, IDC's February 2022 *Future Enterprise Resiliency and Spending Survey, Wave 1,* 47.7% of respondents listed "improving operational efficiency" as one of their top 3 business priorities. They also indicated that due to investments in digital technologies in 2020, they saw an improvement of 22% in operational efficiency. Other business metrics saw improvements too. Customer satisfaction (24%), profits (18%), and revenue (17%) all grew while time to market was reduced (21%).

Achieving resiliency requires tools that can map product, processes, or operations data constantly and in real time while understanding their implications in real-life situations. This data comes from sources such as IoT sensors within the product or on the shop floor, weather data, traffic data, and electromagnetic data. This data must be grounded in human-centric design to build better products and experiences for customers. This requires additional technology elements such as artificial intelligence (AI), analytics, and augmented reality and virtual reality (AR/VR) to enable immersive experiences. Resiliency necessitates an investment in digital twins to enable customers to get a virtual view of their products, processes, and operations, as well as the impact of various internal and external factors on their performance. The insight gained from digital twins can help correct any product or operations inefficiencies, improving financial performance, getting better products to market faster, and thus enabling resilient supply chain and operations and increasing customer satisfaction. In addition, by leveraging this insight, customers can also redefine their business models and meet their sustainability goals. Those customers that don't invest will stand to leave money on the table.

Digital Twins Innovate the Product Value Chain and Modernize and Optimize Infrastructure and Operations

A digital twin entails the digital creation of a physical product or operation by leveraging historical and real-time data from on-premises and third-party sources. The intent is to examine the impact of events and stimuli on the performance of these products/operations and constantly improve them. The first step is the creation of detailed digital product drawings that represent the process and every step in the life cycle from the component stage to the final product as seen in Figure 1.

FIGURE 1: ***The Digital Twin***



Source: IDC, 2022

For operations, it can include detailed digital drawings of the manufacturing shop floor, a telecom tower with various components, or a bridge with details about its foundation, beams, girders, cables, and other parts. Such digital simulations, in combination with machine learning models, can understand how the product behaves in different conditions or how it operates when integrated with other products or systems. For infrastructure and operations, it can help understand, in real time, the current health and performance of the overall system as well as subsystems. The idea of digital twins is not new. However, their promise is enabled and augmented by digital technologies that include sensors,

AR/VR equipment, digital thread, robots, and drones that are always connected and generate data that can be analyzed to predict in real time the actions needed to avoid degradation in product performance or operations. In addition, the evolution of cloud (edge infrastructure, connectivity technology such as 5G, storage, and simulation/modeling software) is fueling increased use cases and opportunities. When designed and implemented in the right manner, a digital twin solution can enable seamless virtual interaction.

Best Practices Approach

For any digital twin program, it is critical to first identify internal process and operational challenges related to its products, processes, or infrastructure. Traditional approaches mandated a siloed model where a new technology implementation or process change was finalized without examining the impact on adjacent infrastructure or other ecosystem entities. For example, if the product team noticed problems related to a product function/feature, the team would work on a software or hardware update without gauging its effect on other software programs that work with the product. If the product was part of a larger machine, the update could result in a production shutdown and negative financial and CSAT/CX implications. To summarize, it is critical to understand that adding digital twin data to the decision-making process enables highly accurate operations status and performance visibility that has a direct correlation to revenue assurance. Once the inefficiencies are identified, business problems and resulting transformation outcomes can be defined. After a business outcome is defined based on the challenges, a digital twin solution program that focuses on the changes needed for the organization's people, processes, and technology should be outlined as follows:

- **People.** The company must define the skills required to deploy and run a digital twin program. It might have the required talent, or it may need to work with a services partner with the requisite industry and process expertise that can provide the relevant scalable skills and technology . The internal talent will have to learn the required technology and new ways of working with it; they will also have to closely collaborate with other business units and services/technology providers.
- **Processes.** Traditional workflows will make way for automated, data-driven, and intelligent workflows that will use AI/ML and various automation technologies. This change will infuse speed and accuracy while providing customers with real-time insight into their operations and product performance. In addition, a digital twin solution that is interacting with the real product, process, or operations infrastructure provides the ability to predict any impending degradation, which in turn enables relevant stakeholders to take corrective action before it fails.
- **Technology.** This refers to the various technology ecosystem and services partners that perform functions such as remotely accessing, monitoring, and maintaining infrastructure. Other partners could include companies that fly drones to inspect bridges, oil and gas pipelines, telecommunications towers, and so forth.

Digital Twin Maturity

Creating a truly modern digital twin infrastructure requires a clear understanding of an organization's current maturity. This means knowing where an enterprise sits in terms of the integrated building blocks of such an infrastructure and what it needs to reach a mature and optimized digital twin state. Identifying the elements of a mature and optimized state helps a business understand the budget, effort, and timeline to get there. The journey will be different for each company. Most will dream big and start small with a multiphase approach to avoid disrupting their operations. Once benefits from the first phase are realized, enterprises can unlock value and invest the savings/additional budgets into subsequent phases. A few customers might have sufficient budgets to carry out their digital twin transformation in fewer phases.

Figure 2 shows IDC's digital twin maturity index and what capability and competency needs to be built to reach the optimized state.

FIGURE 2: ***Digital Twin Maturity Index***

Source: IDC, 2022

Benefits

There are many benefits to implementing and creating mature digital twin infrastructure. Some of these include:

» **Operational:**

- Integrating disconnected systems and understanding linkages and interdependencies between systems (Experiment and ensure that everything works before actually investing in product or infrastructure changes. This can lead to an internal or external ecosystem approach where different digital twins talk to each other.)
- Enabling the ability to predict and prescribe changes to reduce or eliminate infrastructure downtime and improve performance and productivity
- Providing better insight into product or equipment with real-time monitoring
- Creating efficient supply chains
- Performing predictive maintenance by addressing problems before they occur
- Using a closed-loop digital twin facilitates real-time product performance field data to be applied in real time and continuously to product design/engineering and manufacturing teams
- Having a digital twin that simulates processes at the shop floor, oil rig, telecommunication infrastructure, and other similar environments and ensures optimal layout, processes, and control systems (From the IIoT data that is generated and fed back to the digital twin, further optimization can be achieved.)

» **Business and financial:**

- Reducing costs related to product defects and machine downtime
- Improving go-to-market capability and reducing product defects to improve customer experience and satisfaction
- Increasing in-market share due to improved product quality

Industry Examples

In Table 1, we see some examples of how digital twin investments meet a customer's need to modernize their operations by first creating a virtual mock-up of their infrastructure and creating a simulated "performance model."

TABLE 1: ***Digital Twin Maturity Index***

Industry	Customer Aspirations	Strategy/Execution Initiatives	Technology Required		Outcomes
Manufacturing	• Increase productivity • Reduce operations cost • Increase asset availability • Improve worker safety • Improve changeover scheduling times • Improve remote access and control • Reduce environmental Impact • Create a single version of the truth • Provide flexible manufacturing	• Offer one single version of truth data related to all assets and processes • Virtual 3D reality model replica of production line • Link information of all assets, vendor product/documentation • Model and simulate production line • Simulate impending adverse impact on production line and predict/prescribe plan for downtime and demand fluctuations • Conduct what-if scenario analysis • Build connected infrastructure/workplace • Leverage automation to "sense and respond" in real-time production line performance, and build virtual ability to make the infrastructure resilient • Integrate solution with supply chain	• Industrial IoT	• Digital twin • Historic and real-time big data infrastructure and solutions for visualization and prescriptive/predictive analysis/actions • Edge/cloud infrastructure • Analytics • AR/VR/MR • Robotics/drones/satellite technology • Software engineering • AI/ML • Digitize documents/drawings • RFID tracking • Remote access monitoring and management • Digital workforce enablement	• Improved Reliability of Infrastructure • Reduced CAPEX/OPEX • Improve productivity and reduce wastage • Reduce training costs • Improved Availability of production line • Increase safety and productivity – Reduce expansion and infrastructure cost • Improve Implementation Times • Improve timeliness and availability of spares
Telecom	• Increase network asset availability • Reduce site monitoring and troubleshooting • Optimize capex and opex • Build AI/ML capabilities for network management • Customize service offerings and communication • Create service innovation and improve customer experience	• Build connected infrastructure • Create digital abstract (3D) of the wired and wireless network assets (e.g., RAN, edge, core/DC, optical transport) and customers • Map data related to all physical assets to digital assets and customers • Offer continuous feedback system across these assets to improve data quality • Provide modeling and simulation of the network through what-if analysis	• Software-defined networking • Enterprise IoT/ telco IoT		• Improved network performance with improved visibility • Reduce network downtime, improve trouble shooting and QoS • Reduce costs related to obtaining and validating towers • Increase safety of the network assets through simulations • Reduce both CAPEX and OPEX • Availability of Telecom inventory through efficient management • Service innovation, customization for the customer and deliver superior experience
Energy and utilities	• Increase uptime and build resiliency into operations • Manage complex operating models • Manage different customer preferences to reduce churn • Build infrastructure to manage sustainability agendas • Predict and avoid any cyberthreat to operations/infrastructure • Build scalable operations • Modernize infrastructure through digital investments	• Build connected infrastructure • Create digital abstract (3D) of the wired and wireless network assets (e.g., RAN, edge, core/DC, optical transport) and customers • Map data related to all physical assets to digital assets and customers • Offer continuous feedback system across these assets to improve data quality • Provide modeling and simulation of the network through what-if analysis	• Digital Meters		• Reduce outage by detecting changes to infrastructure • Increase grid capacity • Integrate renewables sources • Forecast demand • Forecast impact of predicted weather changes • Increase asset life • Improve safety • Reduce CAPEX/OPEX

Source: IDC, 2022

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- **IBM's digital twin maturity model:** Digital twins range from the simple to the sophisticated. To use them effectively means placing a range of requirements on the people and processes within an organization with which they must successfully interlock if they are going to deliver the expected business benefits. The digital twin maturity model provides a useful tool with which organizations can map out where they are today and where they would like to be in order to benefit from digital twin solutions. When combined with the identified use cases needed to drive business value, the results of a digital twin maturity model assessment can form the basis of an implementation road map or even a wider digital twin program.

- **The digital thread:** Fundamentally, digital twins are driven by data, and different digital twins will consume very different data sets to meet their diverse requirements. This leads to the possibility of digital twin projects becoming derailed by a big data integration and cleansing activity that costs more and takes longer than foreseen. Rather than seeing each digital twin solution as requiring all source data to be pre-integrated and loaded into a data warehouse or data lake ready to be queried, it can be beneficial to take a more loosely coupled approach in which the required data often remains in its source system (or a read-only replica) and connected through the concept of a digital thread.

  A digital thread allows multiple data sets to be linked together so that they can be queried and return correlated data, typically regarding an asset or process. This is very distinct from the data lake approach that creates copies of data. The digital thread is based on a single source of truth for a given piece of data to eliminate redundancy and inconsistency for greater accuracy and access. This approach can help establish a closed loop across multiple processes and systems from design through operation and service of a physical entity.

  Very simplistically, the digital thread provides a very lightweight way to connect data sets without the heavy lifting of a large data integration project. A domain-specific ontology can also help provide context to the data describing a piece of equipment and its meaning and place in the organization. Put all of this together, and include the use of modern, automated tools to process, analyze, and interrogate data, and you have a metaphorical platform that provides coherent access to an enterprise's disparate data sets and a common surface on which digital twin solutions can be built and executed. This is what makes digital twin solutions scalable, extendable, and repeatable. Without such an approach, there is a significant risk that the digital twin solution stack will become expensive to operate and maintain.

- **Digital twin business value:** Establishing a digital twin in an enterprise will essentially involve a strategic road map of value-based use cases. Key to realizing a rapid business value from the digital twins may be summarized as follows:

  - Taking a user-centric approach by gaining consensus, prioritizing, identifying organizational benefits, and managing change across the enterprise
  - Implementing minimum viable product (MVP) to realize value quick and magnifying benefits at scale
  - Focusing on the right data by leveraging AI, ML, and analytics to find parameters and KPI that matter
  - Designing for scale by using a use case selection approach based on the ability to deliver outcomes and be operational at scale

Challenges

- **For customers:** Implementing a digital twins program is not without its challenges. The following could act as impediments in the execution process if the appropriate budgets and processes are not in place prior to starting any new initiative:
  - **Security breach.** As any digital twins implementation gets initiated or more advanced, a lot of customer IP, process data, and operations gets connected to the network. To avoid any compromised products or operations, it is important to implement extremely robust security infrastructure.
  - **Technology selection and asset obsolescence.** Executing a digital twins program is a long-term commitment. Some assets (subassembly, assets, devices) could become obsolete. Make sure that appropriate technology is selected so it can continue supporting any obsolete products.
  - **Legacy infrastructure.** Some or part of the organization's IT and engineering infrastructure could be old. There may be areas that need upgrading and relevant investment before embarking on any digital twins initiative.
  - **Talent.** Specific expertise is required to successfully implement and run a digital twins program. Businesses will have to invest in hiring, training, and retaining workers with the right skills. These workers could be internal or sourced from external partners. In addition, existing talent will require change management training so that they can learn new processes/technology and adjust to new roles.
  - **Proof-of-concept purgatory.** Sometimes initiatives get stuck in this phase. Organizations should be mindful of scaling any digital twins program without too much delay if they are to realize its true potential.
  - **Siloed approach.** Customers should avoid starting isolated digital twin activities that do not take the overall infrastructure into consideration. It is important to envision and execute a continuous process that includes design strategy, implementation, and operation, which will result in the ability to predict outcomes.
- **For IBM:** In addition to assisting their customers to manage the above-mentioned challenges, IBM must ensure that it addresses and understands the following challenges that could be presented as it embarks on partnering with its customers to transform their supply chain and operations:
  - **Understand the competition.** Competitors could be other consulting or technology vendors that may leverage a tier 2 provider to execute. It is important to clearly articulate the value of IBM's experience, talent, partnerships, and global infrastructure.
  - **Confirm customer leadership buy-in**. Make sure that there is buy-in from the customer's leadership and they are invested in these transformation initiatives. This will help IBM mitigate any resistance arising out of certain leaders'/managers' concerns related to loss of control and position within the company.
  - **Check on budgets.** Ascertain whether the customer has the required budgets and help decision makers and influencers with the required justification to secure these budgets.
  - **Ensure internal customer collaboration.** It is very important that various internal customer stakeholders work together toward transformation operations and the supply chain. The commitment to internal partnership and collaboration must happen at the beginning. IBM must ensure this if it wants to avoid any internal customer conflict that may likely jeopardize the transformation initiatives.

Conclusion

IDC believes that an organization needs to envision both a short-term and a long-term digital twin strategy to modernize its supply chain (i.e., product development and operations) while positively influencing customer experience, revenue, and the bottom line. In addition to the CIO and CTO, this discussion needs to include other C-level leaders as well as business and operations stakeholders. It is critical to first discuss potential operational and execution issues before finalizing any required capability (technology, skills, partnerships). Adopting a partnership approach will enable the business to get to its desired state faster and more efficiently as well as establish marketplaces where customers can buy some of these digital twin services as APIs.

About the Analyst

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