WHITEPAPER

What CEOs need to know about Digital Twins

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Executive Summary:

A digital twin is broadly defined as a digital replica of a physical object or process. Its value comes from using living data to help understand the behavior of the system or "state-of-work" in the following ways:

- What could happen in the long-term FUTURE? (via Design applications that help determine the boundaries of the operating envelope)
- What could happen in the near-term FUTURE? (via Planning & Simulation applications that help model different scenarios within the operating envelope)
- What is happening NOW? (via Monitoring applications)

By helping understand the above states at the highest levels of the business system, a digital twin of the enterprise offers strategic value by helping the CEO steer the company through today's highly dynamic environment. Furthermore, digital twins offer the potential to rethink and find new ways of working and not just simply replicate the current way of doing business.

Introduction

A 2019 Gartner Research survey revealed that 75% of organizations implementing Internet of Things (IoT) already use digital twins or plan to within a year[1]. This has come a long way since the concept of the "digital twin" came into vogue in 2002. While adoption continues to accelerate, it's relevance to the CEO agenda has been unclear to date.

This is largely because the evolution of digital twins has been a bottom-up phenomenon, starting from the physical objects in the value chain. Not surprisingly, the most commonly-held view of a digital twin is an ultrarealistic, 3D model of physical objects such as products, assets, places, and people. In contrast, the abstract nature of logical constructs such as process flows have been slower to gain acceptance as digital twins (and even in these cases, most digital twin projects have been at lower-level processes.)

But from a top-down perspective, the ultimate logical construct is obvious: the digital twin of the "money machine" representing the enterprise or value chain. In support of this end-state vision, this whitepaper captures what CEOs need to know about digital twins via the following insights:

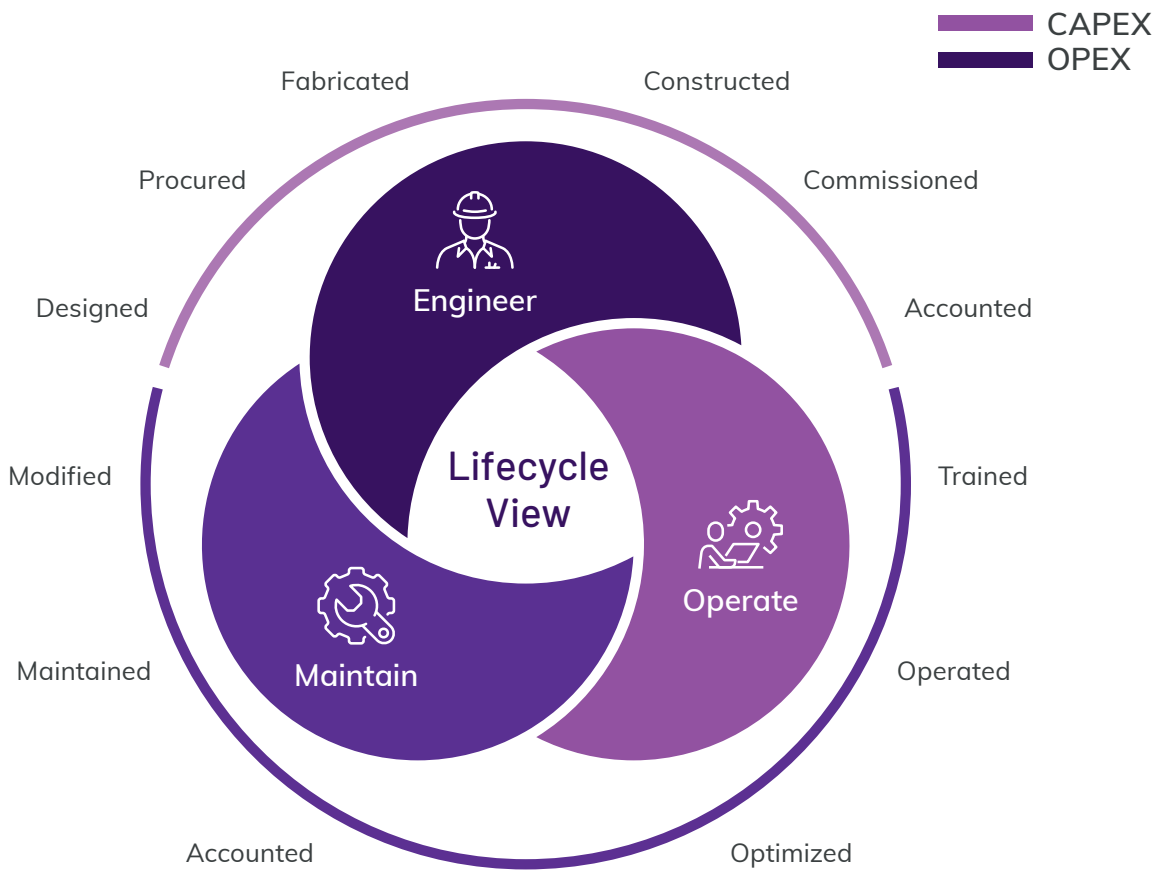
- **To capture maximum value for the business, the vision for digital twin should take an end-to-end lifecycle view** that integrates the Design & Build (CAPEX) side with Operate & Maintain (OPEX) side.
- **Since work is specific to a worker, that unique perspective is key to any meaningful discussion on digital twins.** It is natural to have different views and expectations of digital twin throughout the organization. However, they must converge towards a holistic and unified vision.
- Enabled by new technology advances, digital twins are rapidly maturing within functional silos. But these **bottom-up efforts will fail to converge towards an integrated digital twin of the business without a clear vision and priorities from the top-down.**
- Digital twins are living data models. **Creating and maintaining digital twins to extract the maximum captive value requires an information architecture that enables access to living data generated across the lifecycle.**
- **Time is the new currency.** Data growth is exponential but time remains constant. Only by creating **the right user experience (right information, right assistance, right time, right people, right device, right place, etc.)** can problem solvers in the organization be empowered to extract the maximum value potential.
- Digital twins present **an opportunity to find new ways of working and rethink how people collaborate and engage with these information models to create value for the business** – and not view digital twins as simply as automating the current way of doing business.

INSIGHT: To capture maximum value for the business, the vision for digital twin should take an end-to-end lifecycle view that integrates the Design & Build (CAPEX) side with Operate & Maintain (OPEX) side (and back to Design via refurbishment or eventually to be decommissioned).

The inception of the digital twin begins with Engineering, which takes it through the stages of design, procurement, and construction through to commissioning and handover to Operations. At this point, the "Design Twin" transitions to the "Operations Twin" where the processes are staffed and trained, operations continuously improved and optimized. All throughout, costs are diligently accounted for including the maintenance as well as the ongoing modifications of the assets.

Ultimately, digital twins accelerate digital transformation by:

- Creating value through data and maximizing the opportunities to impact both CAPEX and OPEX via a lifecycle approach.
- Revealing inefficiencies or the "value leaks" throughout the entire "money machine".
- Providing innovative insights to design not only smarter assets and processes, but also think about how to design competitive advantage into the business model itself from the outset.

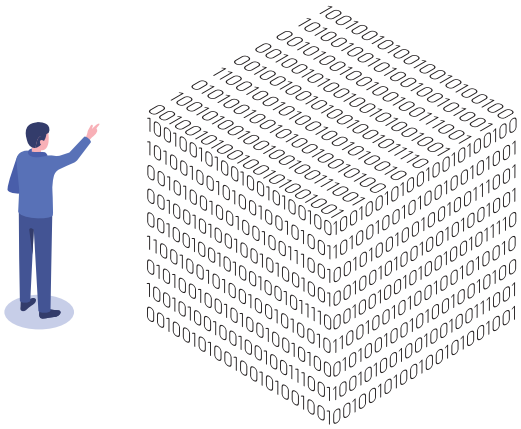


INSIGHT: Since work is specific to a worker, that unique perspective is key to any meaningful discussion on digital twins. It is natural to have different views and expectations of digital twin throughout the organization. However, they must converge towards a holistic and unified vision.

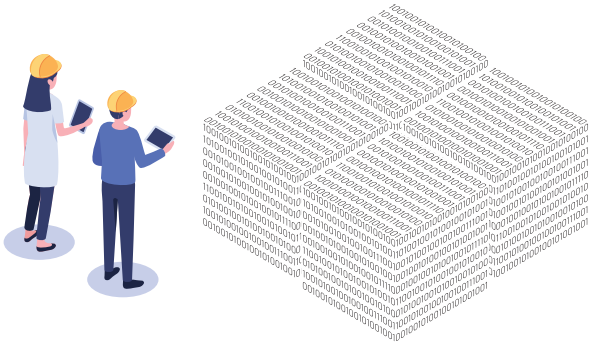
Because digital twins are digital representations of work, it must be noted that work is often specific or unique to the person doing it. In the example illustrated below, the digital representations of work at the C-level will be different from the work done by middle management or the lower-level workers within the organization hierarchy.

As such, the strategies, priorities, methods and enabling technologies used to create and deploy digital twins will be different at various levels. This is one of main reasons why organizations are finding it difficult to bring it all together as part of their digital transformation journey and roadmap.

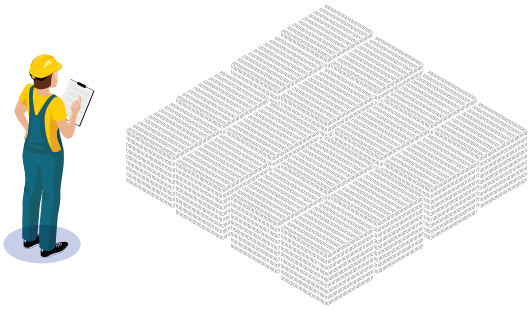
C-Level Perspective:
Digital Twin of the Business

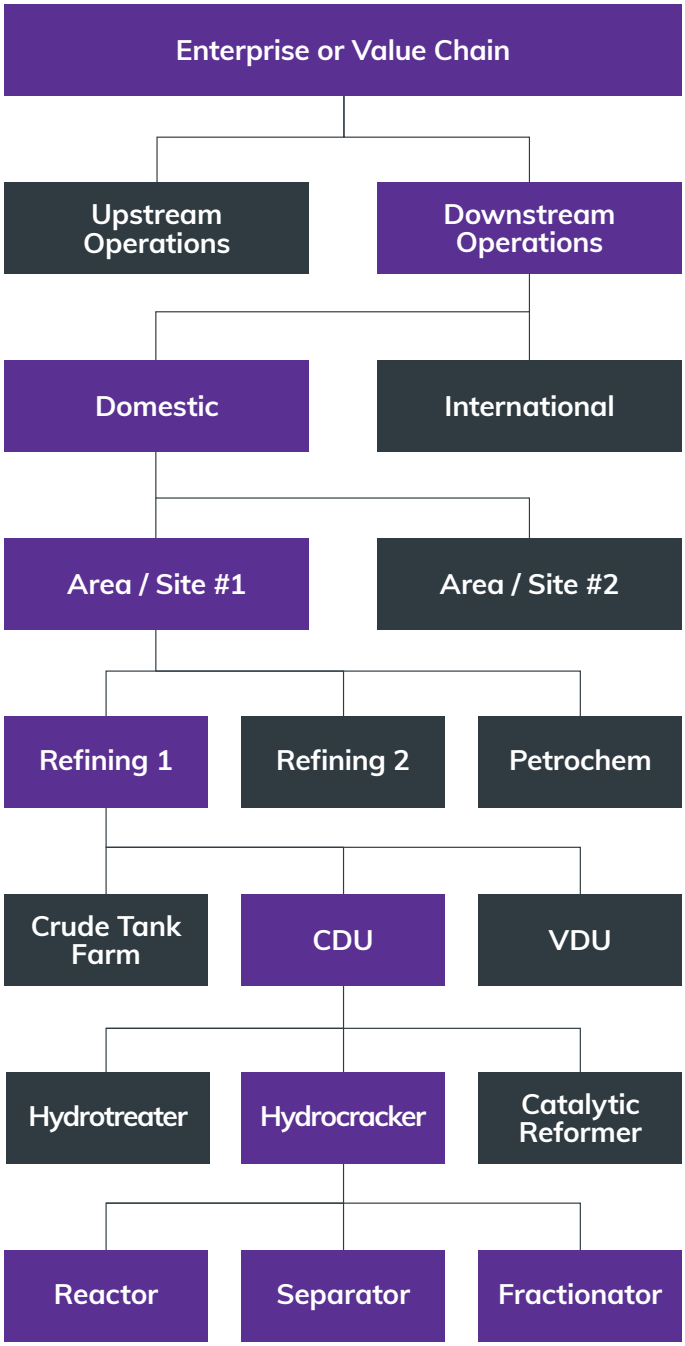


Mid-Level Perspective:
Digital Twin of Processes



Field-Level Perspective:
Digital Twin of Assets



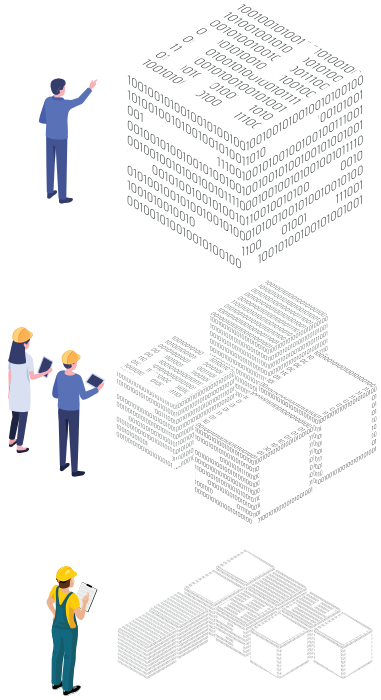


INSIGHT: Enabled by new technology advances, digital twins are rapidly maturing within functional silos. But these bottom-up efforts will fail to converge towards an integrated digital twin of the business without a clear vision and priorities from the top-down.

According to Gartner Research[1] , 24% of oil and gas companies (surveyed in mid-2018) said they had either already implemented digital twins or would within 12 months. The survey also found that 75% of organizations expect to have widespread adoption of digital twins by mid-2021. In other words, there is already a lot of grass-roots activity to exploit technology advances and improve on existing digital twins.

But without a cohesive vision and technical architecture, different stakeholders will close the gaps in their digital twin projects with an ad-hoc approach to technology selection and standards.

Oil & Gas and Mining & Metals industries are breaking new ground in driving a top-down vision and successfully demonstrating the value and feasibility of digital twins for their business. Their insights and lessons learned, with respect to people and culture, processes and policies, and technology, are invaluable for other companies looking to accelerate the digital transformation journey.



Typical Digital Gaps:

- Suboptimal decisions due to Insufficient fidelity of model
- Context not intuitive nor easy to understand
- Delays in synchronization, different cadence
- Different formats, misaligned KPIs
- Data in silos, disconnects
- No data or not available in digital format
- Etc.

New Digital Enablers:

- Cloud
- Artificial Intelligence
- Virtualization
- Internet of Things
- Edge Computing
- Extended Reality
- Workflow Mgmt.
- Blockchain
- Etc.

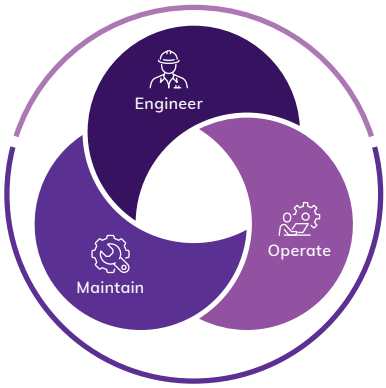
INSIGHT: Digital twins are living data models. Creating and maintaining digital twins to extract the maximum captive value requires an information architecture that enables access to living data generated across the lifecycle.

By acting as a "virtual hub" for information integration, digital twins offer a way of facilitating work between different disciplines and across silos through all phases across the lifecycle. A virtual information hub will have to be built. This would involve integrating with a variety of data sources and apps across the IT and OT systems landscape, as illustrated below:

Digital twins don't just provide insights into specific parts or components. By integrating disparate data sources, the potential arises to gain an overall view into various interconnected processes and operations.

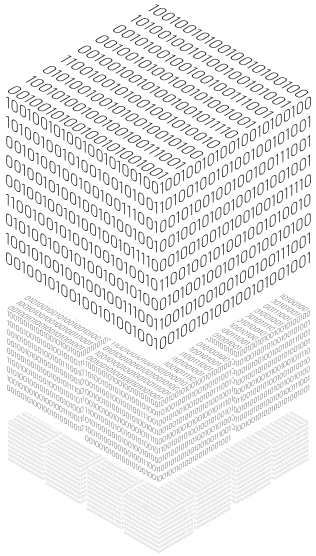
Digital twins can leverage real-time data to optimize performance, reduce downtime and simulate the impact of situations that may arise.

The data sources for these digital twins are what drives the present and future-state of the industry. As a knowledge repository of these data sources and with sophisticated analysis, the now living digital twin can predict and preempt any challenges that could arise or potentials that could be realized in the industrial complex.



Data Sources for Living Digital Twins:

- Engineering & Design Systems
- Process Simulation Systems
- Product Data Management Systems (PLM)
- Project Management Systems
- Procurement Systems
- Operator Training & Simulation Systems
- ERP / Finance Systems
- Asset Management Systems (EAM)
- Supply Chain Planning Systems
- Trading & Customer Mgmt. Systems
- Operations Management Systems
- Real-Time Optimization Systems
- Automation Systems (DCS, PLC)
- Etc.



INSIGHT: Time is the new currency. Data growth is exponential but time remains constant. Only by creating the right user experience (right information, right assistance, right time, right people, right device, right place, etc.) can problem-solvers in the organization be empowered to extract the maximum value potential.

Ensuring access and ease-of-use of the system is paramount in industrial operations. Users must be assured that all lifecycle data is available and they can get to it quickly, easily and catered to their preferences.

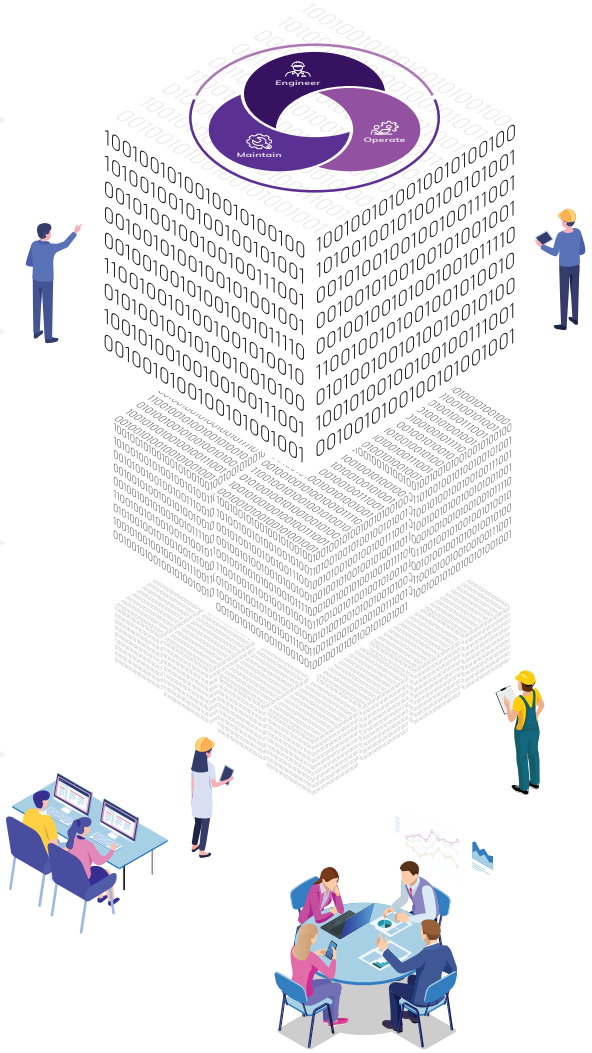
In other words, the requisite Information Management architecture to sustain living digital twins must enable the following user experience scenarios:

Can I provide visibility for supply chain partners without forcing everyone to use the same platform?

Can I access information across the lifecycle from anywhere (cloud and edge)?

Can I follow the digital thread (drill down, up, across) to get the full context?

Can I get predictive visibility and take actions based on future value-driven behaviors?



Can I accelerate learning across asset and fleet history to improve design?

Do I have the rights to author and maintain information for the lifetime of the asset?

Is the system smart enough to learn and help me manage by exception?

Am I making data-driven decisions for continuous improvement and innovation?

INSIGHT: As digital twins evolve from low fidelity to high fidelity models, it also means more of the work is gradually being codified into software. This presents an opportunity to find new ways of working and rethink how people collaborate and engage with these information models to create value – and not view digital twins as simply as automating the current way of doing business.

Industrial organizations are slowly but surely progressing towards autonomous operations, driven by the need for competitive advantage in terms of:

- **Speed:** e.g. the need to embed intelligence to quickly respond to opportunity and risk
- **Scale:** e.g. the use of artificial intelligence to process millions of real-time data streams
- **Smart:** e.g. the use of drones to capture data in ways that humans could not
- **Cost:** e.g. manual and/or repetitive tasks that is not necessarily the best use of human capabilities

None of this is a new endeavor – over the last 200 years, we have been steadily replacing muscles with machines. And now, more recently with software, minds are also starting to be replaced by machines. As we contemplate the future of the industrial worker, we continually challenge ourselves by asking, "What do humans do best? Can we find the right balance with technology in defining the future of work?" In a sense, Industry 4.0 represents the 4th time we've asked these fundamental questions since the first industrial revolution.

At every stage, we've seen that humans excel at problem solving and adaptation. We're wired to sense and respond to changing conditions. Humans can create, improvise, imagine, deal with ambiguity, interpret emotions, and even behave irrationally if that serves our desires and purposes. And with that same spirit we will define a new world of work – again.

And with the right guidance from the top-down, the digital twin vision for the business can offer both a practical means to create value in the near-term as well as help adapt to the changing future of work for the long-term.

1. Gartner.com; Gartner survey reveals digital twins are entering mainstream use, 2019