

# Smart Innovators: Digital Twins For Industrial Facilities

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# Smart Innovators: Digital Twins For Industrial Facilities

In this report we provide an overview of digital twin solutions for industrial facilities and applications. We outline the dynamic operational framework of a digital twin and break down the functionalities underpinning each of the five distinct sophistication levels of digital twins. Speaking with 22 suppliers, we find that the digital twin supplier landscape is convoluted, and only a handful of suppliers are able to offer all the functionality required to create, sustain and operationalize a digital twin. Following a customer-centric approach, we detail the use cases and value propositions digital twins offer across a project's life cycle. We highlight the functionality – in terms of depth of simulations, analytics and data management – required to embark on a digital twin project, considering business objectives as well as the maturity of the organization in terms of asset management.

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## ORGANIZATIONS MENTIONED

ABB, ACCIONA, Ada Mode, Akselos, Al-Khobar 1 seawater reverse osmosis (SWRO) plant, Altair, Ansys, AnyLogic, ARMS Reliability, AspenTech, Asset Performance Technologies (APT), Atos, Autodesk, AVEVA, Avingtrans, Baker Hughes, Bentley Systems, C3.ai, Cognite, Competitive Power Ventures (CPV), COMSOL, COSMI Group, Cosmo

Tech, Dassault Systèmes, DNV, Emerson, Enablon, Endress +Hauser, ENGIE, ENGIE Lab CRIGEN, E.ON, Flow Simulator, Flutura, FutureOn, GE Aviation, GE Digital, Genesis, Hargrove, Hatch, Hayward Tyler, Hexagon, Hitachi ABB Power Grids, Honeywell, IBM, Innogy, Interaptix, Itaipresse Gauss, Itus Digital, James Fisher Asset Information Services, Kongsberg Digital, Lamprell, Lanner, MathWorks, MaxGrip, McDermott, Nyhamna Gas Plant, Oman Refineries & Petrochemicals Company (ORPIC), OptiPlant, OrbitMI, OSIsoft, PAS Global, Process Systems Enterprise (PSE), PTC, Renault, Rockwell Automation, Royal HaskoningDHV Digital (Royal HDHV Digital), SAP, Seequent, Senseye, Shell, ShookIoT, Siemens, SRO Solutions, Technip Energies, The Cohesive Companies, Uptake, Wood, Woodward, Worley, Yokogawa.

# Not All Industrial Digital Twins Are Built Equal

This report is aimed at strategy executives in firms offering industrial digital twin solutions, as well as engineering, operations, maintenance and safety executives in industrial firms looking to understand the supplier landscape and to begin or continue their digital twin journey. So what exactly are digital twins? Many definitions for digital twins have already been given – and these will continue to evolve as digital twin implementations for industrial facilities mature (see [Verdantix Smart Innovators: Digital Twins For Industrial Facilities](#)). The Verdantix definition of a digital twin for an industrial facility is:

*An evolving digital model of an industrial facility which replicates the facility's assets, processes and systems and simulates its performance using real-time and periodic data to enhance engineering and operational decision-making.*

This definition encompasses all the different types of digital twin offerings from various providers. To gain an in-depth understanding of the market and current offerings of digital twins for industrial facilities, Verdantix carried out interviews, obtained briefings and watched demos from the following 22 suppliers: ABB, Ada Mode, Akselos, Altair, Ansys, AspenTech, AVEVA, Bentley Systems, Cognite, Cosmo Tech, Emerson, Flutura, GE Digital, Hexagon, Hitachi ABB Power Grids, Honeywell, Itus Digital, Kongsberg Digital, MathWorks, Process Systems Enterprise (PSE), Royal HaskoningDHV Digital (Royal HDHV Digital – including Lanner) and Senseye. Suppliers who were contacted and only provided details of product offerings through email correspondence, or who did not respond, were: AnyLogic, Autodesk, C3.ai, COMSOL, Dassault Systèmes, DNV, FutureOn, IBM, PTC, Rockwell Automation and SAP. In this section, we outline the dynamic operational framework of a digital twin, break down the functionality underpinning each of the five distinct sophistication levels, and illustrate the make-up of the supplier landscape.

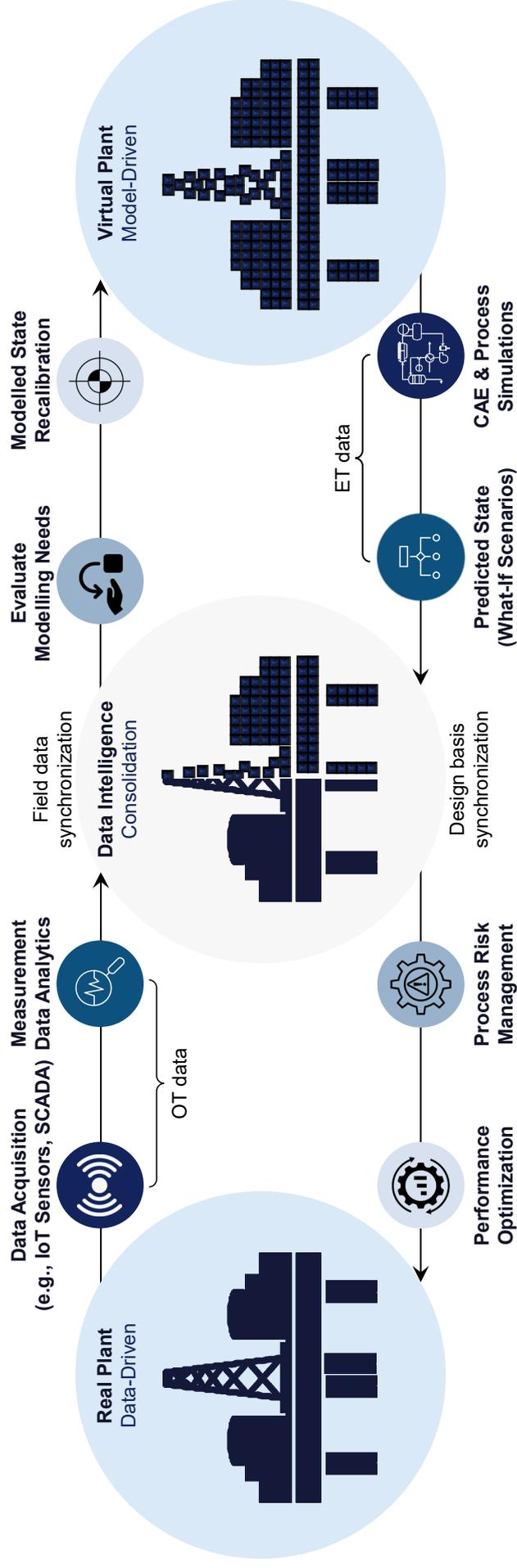
## Dynamic Digital Twins Mandate Real-Time OT, IT and ET Data Exchange

A digital twin is a digital version of a real-world asset or process, and as such, simulation and field measurement data need to synchronize through a dynamic exchange of information technology (IT), operational technology (OT) and engineering technology (ET) data (see **Figure 1**). This data transfer facilitates:

- **Consolidation of field measurements and simulations for actionable insights.**  
Digital twins can provide a dynamic consolidated view of operations by aggregating and contextualizing data from field sources, engineering simulations and complex systems such as cyber-physical systems (CPSs). Cognite worked with Yokogawa, a Japanese multinational electrical engineering firm, to build an operational digital twin of Yokogawa's Kofu plant. Cognite combined time series, equipment, historical events, and instruction manual data with a photogrammetry-enabled 3D model. Using the digital twin, Yokogawa's field workers were able to efficiently search for and locate equipment, as well as to plan remote operations and improve off-site planning (see [Verdantix Cognite Offers A Platform To Springboard Digital Twin Creation For Asset Heavy Industries](#)).
- **Dynamic recalibration of models and evaluation of simulation demands.**  
Synchronizing the status of a real facility with a virtual one should be done in a seamless way, with minimal user input. Following the motto of 'all models are wrong, but some are useful', it is recommended that digital twin users validate their simulations with field data to ensure that models are up to date and close to the real-world asset. As asset and process-level physics-based simulations can be computationally very costly, it is extremely important to be able to use field measurement data analytics to dictate what simulations are required and at which fidelity level. Both Altair and Emerson offer users the ability to adjust model fidelity to meet the asset or process needs.

FIGURE 1

## Operational Framework Of A Dynamic Digital Twin Of An Industrial Plant



Source: Verdantix

- **Real-time view of process safety risks and operations.**

In most organizations, digital twins live separately from risk models. While historical data can be valuable to predict when process failure might occur, real-time updated field measurement and simulation information can assist with live risk assessments, reflecting actual conditions and future operation scenarios. Innogy and Shell are collaborating with Akselos, a Swiss-based digital twin simulation software provider, to monitor the integrity of wind turbines, vessels and other assets. Akselos integrates real-time data from sensors, along with machine learning (ML) and big data analytics, to enable risk-based and reliability-centred maintenance strategies (see [Verdantix Green Quadrant Operational Risk Management Software 2019](#)).

## Digital Twins Connect Up To Six Different Categories Of Data

The dynamic operational framework of a digital twin is based on a comprehensive network of information exchange. Digital twins help industrial facility stakeholders generate new insights by integrating disparate datasets and organizing all information, from asset to process-level. The technology requires a large amount of data from various (and potentially siloed) sources and industrial systems (see **Figure 2**). Digital twins bring together:

- **Design and geospatial data about the industrial facility.**

As a digital twin is a virtual representation of an industrial facility, the infrastructure plans, as well as the equipment and instrumentation plans, are needed to build the digital replica. Drawings such as computer-aided designs (CADs), piping and instrumentation diagrams (P&IDs) and process flow diagrams (PFDs), as well as geolocation data of workers and assets, need to be consolidated. Various software suppliers offer design tools, such as Autodesk (AutoCAD), AVEVA (E3D), Bentley Systems (OpenPlant) and Hexagon (Intergraph). However, many firms are still using paper-based processes. To accelerate their digital twin journeys, Bentley Systems has developed ML functionality to digitize and label physical P&IDs and isometric drawings.

- **Existing asset information and libraries.**

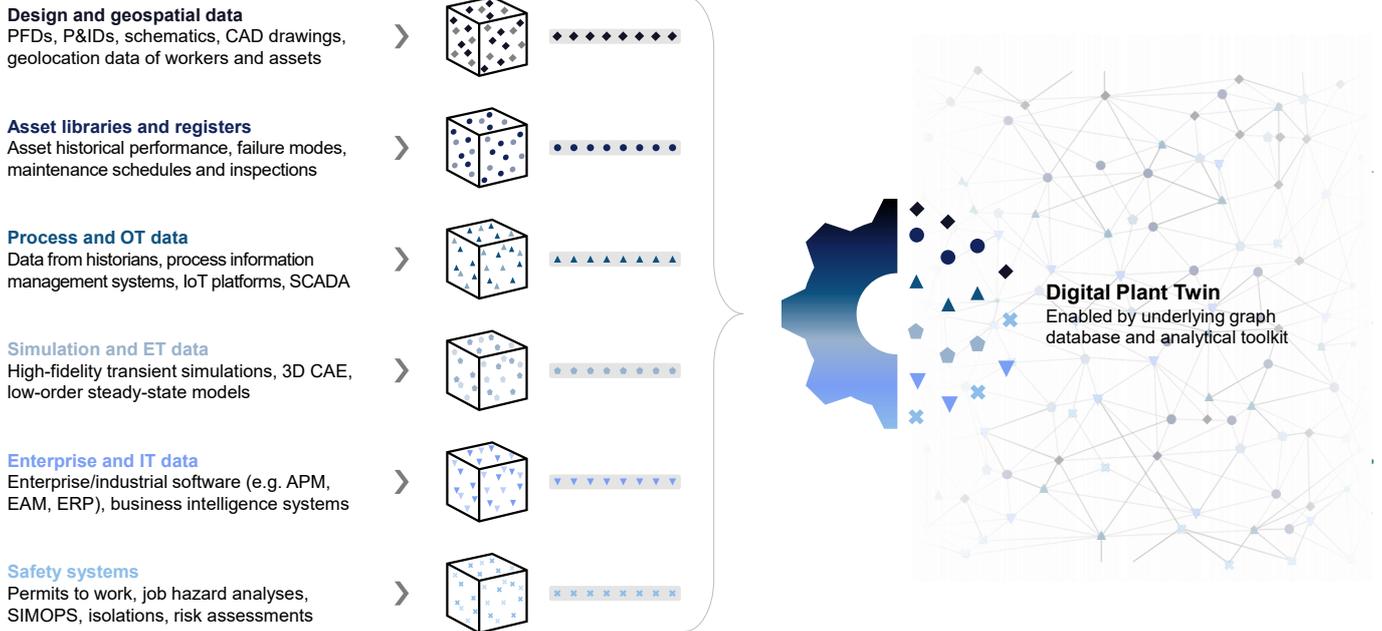
Asset registers and libraries are the building blocks of an asset management strategy for any industrial firm, and are also the building blocks of a digital twin. These registers and libraries include information about the location, condition and owner of an asset, as well as its status, procurement date, price and depreciation. Asset libraries can also include asset strategy information, such as failure mode and effects analyses (FMEAs) and failure codes, as well as original equipment manufacturer (OEM) maintenance recommendations. Asset strategy libraries are crucial for asset performance management (APM) and for estimating the remaining useful life (RUL) of assets. To meet these demands, Uptake acquired Asset Performance Technologies (APT) in 2018; AVEVA acquired MaxGrip in 2019; and Baker Hughes signed to acquire ARMS Reliability in February 2021.

- **Operational plant data from sensors, IoT platforms, SCADA and historians.**

Digital twins need an up-to-date status of what is happening with the asset or process in the real world. Of the 259 executives interviewed in the most recent Verdantix global corporate survey, 57% stated that digital sensors would be 'very significant' for their firm's operational excellence initiatives over the next two years (the highest of the ten digital innovations options provided in the survey) (see [Verdantix Global Corporate Survey 2020: Operational Excellence Budgets, Priorities & Tech Preferences](#)). Seamless communication between hardware and software is therefore crucial. To strengthen this convergence of OT and IT, AVEVA acquired the industrial data platform provider OSIsoft in August 2020, and will exploit this to bolster its digital twin offering. Uptake recently acquired Canadian-based ShookIOT, an industrial Internet of Things (IIoT) solutions provider, while Senseye launched Senseye Ready, a partner ecosystem of hardware providers, to ensure compatibility between hardware and Senseye's APM software.

FIGURE 2

## Digital Twin Components And Data Streams



Source: Verdantix

- **Asset and process-level simulation and engineering data.**

Engineering technology data are an intrinsic part of any digital twin – from 3D computer-aided engineering (CAE) and low-order steady-state process modelling, to high-fidelity 3D transient simulations for specific assets. Digital twins receive this information and use it to optimize the plant automation systems in real time or to provide soft-sensor values. PSE uses mathematical and first-principle-based models to predict process parameters that are not measured using physical instrumentation in the plant. Siemens, which acquired PSE in 2019, can readily integrate these models into its plant automation system SIMATIC and simulation platform SIMIT (part of its digital twin proposition).

- **Enterprise and industrial software application data.**

As insightful as digital twins of specific deployed assets may be, a digital twin of a whole industrial facility can be especially powerful, acting as the cornerstone of operations and asset strategies. It is imperative that such a twin brings all enterprise systems and IT data together, linking siloed IT software applications such as enterprise resource planning (ERP) and enterprise asset management (EAM) systems and providing business intelligence (BI) through actionable insights.

- **Information from safety systems and software applications.**

Using digital twins for operational risk management requires connecting safety systems and data with performance and operations data. Enablon’s digital plant strategy entails connecting assets, such as through IoT devices, predictive maintenance and asset management solutions, as well as connecting data from inspections, SIMOPS (simultaneous operations), isolations, risk assessments, change management and worker permits. This helps to facilitate the creation of a plant digital twin that can be harnessed in process safety applications (see [Verdantix Wolters Kluwer Invests To Deliver Enablon Digital Industry 4.0 Success](#)).

## Digital Twin Sophistication Levels Dictate Functionality Requirements

A digital twin is not a monolithic application – rather, it compiles data and integrates digital applications from up to six separate sources. The amount and types of data generated and utilized in a digital twin, as well as the analysis performed on these, dictate the level of its sophistication (see **Figure 3**). Core digital twin functionality comprises:

- **Aggregation of disparately sourced data for building informative digital twins.**

The first step for customers embarking on digital twin projects is to focus on data management and building descriptive digital twins (see [Verdantix Five Digital Twin Strategies For Industrial Facilities](#)). These are usually inexpensive to implement and enhance existing processes without disrupting work routines. To lower the barriers of entry and enable agile deployments, Kongsberg Digital released Kognitwin Unify, a data contextualization engine representing the services that tie data, structures and semantics together, without relying on a master model. Through this, customers can build virtual representations of assets that do not have respective engineering data warehouses in place.

- **Visualization of design and operational data in a single pane of glass view.**

Digital twin customers have a habit of equating digital twin technologies with fancy 3D visualization software applications. While the visualization aspect is very important to digital twins – especially in order to easily identify process and asset-level risks on operations – it is not the be-all and end-all of them. Of the 259 executives interviewed in the Verdantix global corporate survey, only a third of them planned investments in 3D visualization software applications in 2021. Tech suppliers, however, recognize the importance of visual elements in digital twin strategies and are working hard to bolster their visualization capabilities. In October 2021 Bentley Systems invested in FutureOn, a Norway-based visual content provider for the oil and gas industry.

- **Analytics for advanced and predictive asset performance and maintenance strategies.**

Industrial firms are moving away from universal OEM-suggested asset usage guidelines and rigid maintenance schedules, using digital tools to maximize the availability, reliability and performance of their assets. Multiple suppliers offer measurement data analytics to do so (see [Verdantix Green Quadrant: Asset Performance Management Solutions 2020](#)). Digital twins house APM software applications and combine them with enhanced visualizations, as well as with data streams from all available sources, to optimize asset performance and minimize the interventions required. Ada Mode recently helped a client move its 660MW generator to a condition-based maintenance strategy by utilizing historic data derived from plant instrumentation, walkdowns and chemical sampling. The client enabled a 30% reduction in generator maintenance, which costs over £500,000 (\$688,000) per shutdown.

- **Physics-based process simulations as a must-have for comprehensive and autonomous digital twins.**

The use of black box models is OK – as long as they work. However, they raise a critical question as to whether the user can trust them – and trust is higher when there is insight into how the outputs are calculated. This is why physics-based models are an essential element of comprehensive digital twins for design, engineering and process optimization. The Oman Refineries & Petrochemicals Company (ORPIC) used AspenTech's HYSYS and EDR software apps, which utilize physics-driven models, to perform hydraulic analysis and heat exchanger design modelling on a distillation unit, which was degrading due to a high salt concentration in the crude oil. ORPIC was able to optimize the performance of the unit and, at the same time, avoid a costly shutdown.

FIGURE 3

Functionalities Required For Each Digital Twin Sophistication Level

Functionalities		Sophistication Levels							
		Descriptive	Informative	Predictive	Comprehensive	Autonomous			
Visualizations	Interactive schematics	◐	◑	◒	◓	◔			
	Asset tracking and tagging	◐	◑	●	●	●			
	3D model designs	◐	◑	◒	◓	●			
	Workforce geolocation	○	◐	◐	◑	◑			
Measurement Data Analytics	Condition-based	●	●	●	●	●			
	Predictive	○	◑	◒	●	●			
	Prescriptive	○	○	○	◑	●			
Simulations	Equipment and parts	◐	◑	◒	◓	◔			
	Process and production line	○	◑	◒	●	●			
	System and plant	○	○	○	◑	◑			
Data Management	Aggregation	●	●	●	●	●			
	Contextualization	◐	◑	◒	●	●			
	Dashboards & BI tools	◑	●	●	●	●			
Typical Providers Encountered		Ada Mode, AnyLogic, C3.ai, COMSOL, Enablon, FutureOn, Itus Digital, PSE, Senseye, Sphera		Ansys, Autodesk, Cosmo Tech, Flutura		ABB, Cognite, GE Digital, Hexagon		AspenTech, AVEVA, Bentley Systems	

○ won't have ◐ nice to have ◑ could have ◒ should have ● must have

Source: Verdantix

## Introducing The Fragmented Make-Up Of The Digital Twins Supplier Landscape

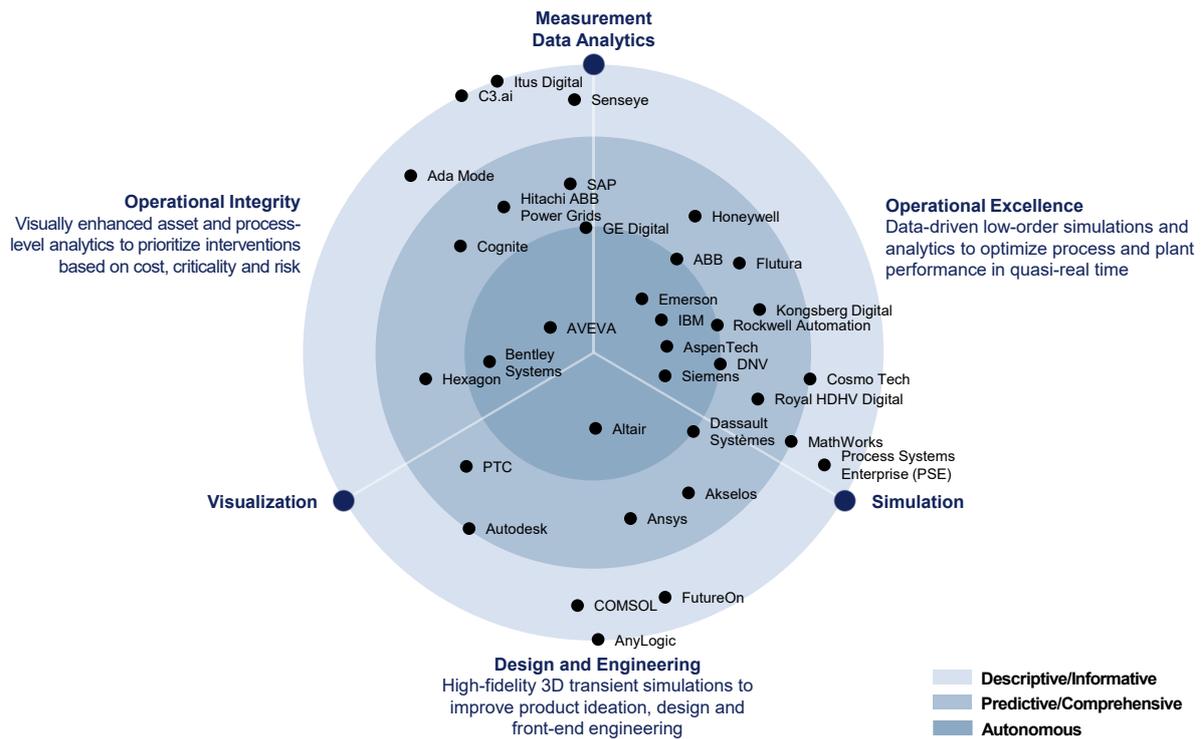
As digital twin offerings are dependent on such a broad swathe of functionalities, digital twins for industrial facilities do not exist as a standalone product category (see [Verdantix Buyer's Guide: Digital Twins For Industrial Facilities](#)). Instead, providers hail from divergent backgrounds, offering packaged products of software applications and positioning these as 'digital twin' solutions (see **Figure 4**). The industrial facility digital twin technology market consists of:

- Only a handful of suppliers able to offer the whole gamut of solutions.**

Only 12 of the 34 digital twin technology suppliers analysed have solutions for data management, analytics, simulation and visualization – the four pillars required to build, sustain and operationalize a digital twin. Instead, most suppliers offer a compilation of point solutions packaged as a 'digital twin' offering, which prevents technology buyers from being able to find solutions that fit their demands. This appears to be a very significant barrier to the uptake of digital twins. In our 2020 global corporate survey, we asked the 259 executives about the factors holding back their investments in digital twin projects. Interestingly, 47% of executives cited the fact that there were only a few suppliers with software capabilities meeting their usage requirements as a 'very significant' barrier. This was the highest proportion of all the six options noted as potentially limiting investment.

FIGURE 4

## Market Landscape Of Digital Twin Technology Providers



Source: Verdantix

- Most suppliers offering solutions for data-driven simulations along with analytics.**

The major market trend at the moment is analytics-focused APM suppliers using low-cost 1D simulations to optimize plant performance in quasi-real time. Process optimization was the third-highest business priority (after worker health and safe operations) for the 259 executives in the Verdantix 2020 global corporate survey, with nine in 10 of them considering it a 'high' or 'medium' priority for their firm to improve on over the next two years. We expect to see more suppliers appearing in this segment of the market over the next few years. Engineering and project management consultancy Royal HaskoningDHV recently launched its digital arm, Royal HDHV Digital, which offers predictive simulation software and services, as well as a simulation software portfolio. The latter was furthered bolstered in 2019 with the acquisition of Lanner.
- Visually enhanced APM and IIoT software suppliers.**

APM software application and IIoT platform providers are visually enhancing their offerings to better communicate insights from asset and process-level analytics. This helps users prioritize interventions based on a consolidated view of cost, criticality and risk. Woodward, a global provider of controllers for industrial markets, worked with PTC to develop a digital twin of its operations. PTC consolidated data from multiple sources, applied predictive analytics and developed role-specific front-end user interfaces (UIs) to increase operations visibility, lower manufacturing costs and improve production quality.
- Specialists in high-fidelity simulation tools complemented by 3D visualizations.**

Digital twin suppliers in this market segment traditionally cater to customers with front-end engineering and design challenges. High-fidelity simulations can support time-insensitive R&D initiatives, from flow assurance to discrete manufacturing. Endress+Hauser uses the Ansys simulation portfolio to model

coupled field problems in process sensor technology and support all phases of the product life cycle. Endress+Hauser runs simulations to evaluate new ideas, understand product behaviour at multiple conditions, reduce the time and money involved in the industrialization phase and safeguard product quality during production.

## Digital Twins Provide Users With Tools To Enhance Facility Design, Operation And Safety

Digital twin technology suppliers can provide digital twins at five different levels of sophistication and offer functionality across four key areas. Of the 259 senior executives interviewed in the Verdantix global corporate survey, 36% of the respondents stated that COVID-19 and the economic recession had driven investments in digital twin simulations of plants/facilities at multiple sites, while 41% stated that these factors had caused their firms to evaluate or trial such solutions. So why are customers investing in digital twin strategies? In this section, we will explore the use cases enabled by digital twin strategies along the project life cycle (from feasibility to decommission), and their value propositions.

## Digital Twins Improve Budgeting And Engineering Of Asset-Intensive Capital Projects

COVID-19-induced digitization acceleration has had a trickle-down effect on digitally mature industrial firms, which are turning to digital twins to tackle the rise in remote and autonomous operations challenges. Capital projects in most industrial sectors have been hit significantly by the economic recession following COVID-19, but a digital twin strategy, implemented in the design phase of a project, can help overcome many hurdles and reduce costs (see **Figure 5**). Specifically, digital twins for capital projects offer:

- **Accurate capital budgeting and estimation of CAPEX and OPEX.**

Using digital twins in the early phases of a capital project can enhance project capital budgeting and mitigate cost overruns. The digital twin offers a single source of trusted information, enables collaboration between multiple disciplines and ultimately enhances the estimation of expenses. The main customers of digital twin technologies for capital projects are engineering, procurement and construction (EPC) firms. With oil prices dropping by more than 30% over the last five years, McDermott started deploying digital twin technology from Dassault Systèmes for its oil and gas projects, to better estimate its capital and operating expenditures (CAPEX and OPEX) and to identify cost-cutting opportunities, in order to remain competitive in the market.

- **Earlier stage feedback and more reliable concept generation and evaluation.**

Bringing in big data analytics, ML capabilities and physics-based simulations assists engineers in developing more reliable designs. Digital twins save effort in expensive corrections and time-consuming reviews by securing contractual and regulatory obligations early on and maintaining a clear record for audits. Genesis, an energy-focused engineering advisory firm and subsidiary of Technip Energies, identified a flow assurance issue using computational fluid dynamics (CFD) on a brownfield pipeline project for a European oil and gas firm, which would have resulted in higher operating line pressures and, potentially, in plant shutdown. Through a cost-benefit analysis, Genesis delivered an economically and technically feasible solution that resulted in over \$350 million of savings.

- **Improved supply chain logistics and reduced production ramp-up time.**

Digital twins can help improve inventory management, optimize supply chain planning and, overall, offer

FIGURE 5

## Digital Twin Use Cases Along The Project Life Cycle



Source: Verdantix

detailed progress tracking and quality control during the procurement and construction phases of new industrial facilities. Hatch was the project EPC firm of a new sulphuric acid plant in the Democratic Republic of the Congo (DRC), worth \$245 million, with manufacturing capacity of 1,400 tonnes per day. To accommodate an accelerated schedule, Hatch used Bentley Systems’s ProjectWise and iTwin products to create a 3D digital twin model of the entire acid plant, to model and analyse structural components, and to establish a connected data environment. Hatch increased return on investment (ROI) by 20%, saved 15% of material requisition costs, finished the project three months earlier than planned, and reduced production ramp-up time from 27 weeks to just one week.

- **Seamless virtual handover between EPCs and owner-operators.**

Digital twins can be used to facilitate compliance by maintaining a clear record for audits, and to streamline handover processes by minimizing time-consuming reviews between the EPC and the owner or operator of the facility. ACCIONA, a Spanish-headquartered construction firm, recently tested and commissioned Saudi Arabia's Al-Khobar 1 seawater reverse osmosis (SWRO) plant remotely, meeting the required cybersecurity standards, using Siemens's virtual commissioning digital twin technology (SIMIT). This allowed ACCIONA to operate the desalination plant's start-up equipment, control systems, water and electrical circuits without putting a large team of engineers on the Saudi site, thereby overcoming COVID-19-induced travel restrictions.

## Digital Twins Boost Performance And Safety Of Operations And Maintenance

Digital twin strategies implemented in the design and engineering phase of a capital project can be pivotal in accelerating time to market and reducing CAPEX costs. Digital twin solutions can also be used during the operational phase of an industrial facility to provide:

- **Remote and unified view of process safety management.**

Digital twins can connect physical assets and workers in a unified manner, harmonizing operations and mitigating risk, by enabling remote plant operations and by positively engaging frontline workers with dedicated workflows. With COVID-19 surging over the last year, technology providers have launched a series of worker-focused solutions that directly link to digital twin platforms. AVEVA, for example, beefed up its connected worker solutions, and is now offering a wider array of digital solutions for worker mobility, safety, efficiency and collaboration (see [Verdantix AVEVA Complements Its Asset-Centric Software Portfolio With Worker-Focused Digital Solutions](#)). In September 2020 GE Digital introduced its Remote Operations for Power Generation software application, for remote and mobile worker access to plant controls.

- **Risk mitigation for transient operational conditions.**

Digital twins provide a dynamic and quasi-real-time view of the current condition of a plant and assets. In this way, they can provide an accurate representation of plant transitions and transient operations, which is when plants are least profitable and most dangerous – especially in the process industries. Emerson offers Mimic, a real-time and dynamic modelling tool of adaptable fidelity (to match the time-scales required) that continuously updates based on live feeds from instruments and equipment. Mimic, in contrast to steady-state modelling tools, can also be used to train plant operators on safe and effective plant operation during malfunctions, abnormal conditions and start-ups/shutdowns.

- **Access to advanced asset maintenance strategies.**

Product complexity has been increasing exponentially, and so has the complexity of predicting the condition of assets at any given time. Asset maintenance processes are becoming even more effective with the advent of simulation-based digital twins, through which engineers can reveal issues that might otherwise be impossible to discover and assess. DNV worked with E.ON, a gas and electricity supplier in the UK with over 23 million customers, to create a digital twin to monitor the asset health and performance of E.ON's fleet of power transformers. E.ON used DNV's Veracity cloud platform to gather and analyse all asset data centrally, and ultimately shift from managing assets in a reactive, time-based manner to managing these in a more preventive, predictive and risk-based way.

- **Virtual environments for inspection, training and field worker enablement.**

Demand for remote training, quality assurance and expert help has been on the rise, with organizations stating that part of their operations will remain remote for the near future. A Canadian-based aerospace firm recently deployed AptixAR, a mixed reality (MR)-enabled platform by Interaptix that compiles digital replicas of a facility's assets to expedite the quality assurance (QA) process through the remote access and inspection of these digital replicas. Using Interaptix's solution, the aerospace firm was able to reduce overall QA time by 90%. In a similar vein, Italpresse Gauss, an Italian manufacturer of high-pressure diecasting machines, selected AVEVA to develop a digital twin technology able to remotely monitor assets and provide operator training through MR simulations.

- **Data-driven asset investment and retirement planning.**

Asset investment planning (AIP) software applications use asset data and information to forecast costs and budget, as well as to test different strategic scenarios and evaluate their impacts on KPIs such as investment costs. Renault, an international car manufacturer, had to renew or update more than 15% of its assets in its manufacturing plants. The firm deployed Cosmo Tech Asset to gain visibility into asset management decision-making and CAPEX constraints. Cosmo Tech created digital twins of the asset management systems of Renault plants and evaluated the impact of different asset management scenarios. With this approach to asset obsolescence management and maintenance, Renault reduced OPEX from €10 million (\$11.7 million) per year down to €2 million (\$2.4 million) and expects to save €5 million (\$5.9 million) of CAPEX per year.

## **Digital Twins Deliver Added Value By Providing Increased Visibility Into Process And Team Performance**

Digital twins in the operational phase of a project have multiple use cases that can enhance the production and maintenance of industrial facilities. They are also the building blocks of industrial plants and can deliver value in multiple ways (see **Figure 6**). Digital twins help organizations by:

- **Improving safety and collaboration by unlocking dark data problems.**

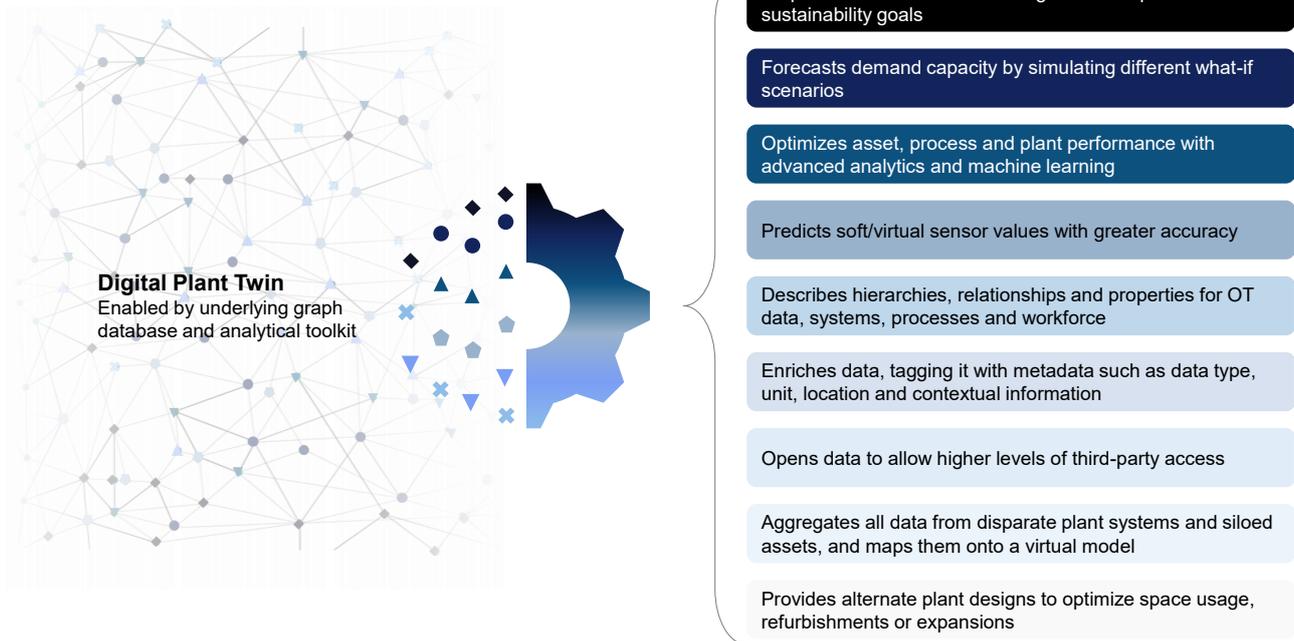
Dark data problems – such as not knowing which assets an industrial plant has, where they are located, or if their condition or performance has changed – are the usual challenges confronting industrial firms. It is not uncommon for process or reliability engineers to spend almost half their time searching for or validating data, before accepting them as sufficiently accurate and trustworthy for critical decisions. By integrating all its systems and data in Kongsberg's Kognitwin platform, Shell's Nyhamna Gas Plant was able to improve the risk assessment of all activities. This represented a big step towards achieving its goal of having zero incidents or leaks and also contributed to a more effective workday for Nyhamna staff, through enhanced collaboration between engineering, maintenance and operations.

- **Forecasting demand capacity through what-if simulations.**

Predictive simulations can be used through digital twins to plan how an organization's operations will evolve over the coming years. Hayward Tyler, an Avingtrans subsidiary and supplier of mission-critical motors and pumps for the oil, gas, nuclear, industrial and chemicals markets, worked with Royal HDHV Digital to use digital twins to double the size of its UK factory. Hayward Tyler built a dynamic virtual factory that provided timely access to actionable information. By further incorporating predictive simulation using Lanner's WITNESS platform, the firm was able to improve demand capacity planning, as well as maximize efficiency and boost profitability by creating a detailed picture of the business processes and resources needed to deliver against future demand.

FIGURE 6

## Value Propositions Of Digital Twins For Industrial Facilities



Source: Verdantix

- **Optimizing production without increasing maintenance costs.**

Dynamic digital twins can help organizations get rid of manual processes and static models. In an effort to streamline and automate operations at its plants, US-headquartered Competitive Power Ventures (CPV), which has ownership interest in 4.2GW of clean generation, adopted GE Digital's operations performance management (OPM) software to create digital twin solutions to improve production capacity, profit margins and demand planning. CPV was able to increase peak power output by 10 times without impacting its maintenance interval and improve the accuracy of its day-ahead capacity predictions by 2%.

- **Enhancing gaps in asset information with virtual sensors.**

Asset simulations can be very extensive and complex, and normally, it is not possible to use these for real-time calculations. However, through reduced-order modelling (mathematical reduction processes), digital twin users can derive less comprehensive but still accurate results of assets, which can be used to monitor asset performance. In collaboration with and enabled by Ansys, SAP launched its SAP Predictive Engineering Insights solution, which combines ML and IoT with engineering simulations and soft-sensor values, in order to enhance operations visibility and reduce downtime. Engineers can use this solution to monitor the operations of hard-to-reach equipment, such as investigating erosion in an electrical submersible pump, stress in a wind turbine yaw motor, or fatigue in a looped pipeline section.

- **Realizing sustainability goals within operations and new design concepts.**

Apart from enhancing safety and optimizing production, digital twins can be used to monitor and reduce the environmental impact of industrial facilities. Environmental risk mitigation was a 'high priority' for 66% of the 259 executives interviewed in the 2020 Verdantix global survey – the highest among the eight operational excellence business priorities. ENGIE Lab CRIGEN, the R&D centre of the French multinational

electric utility firm ENGIE, used Ansys Twin Builder to evaluate new concepts in energy production and create simulated replicas of in-service physical assets. In this way, the firm was able to maximize the efficiency and sustainability of its industrial equipment by enabling engineers to anticipate carbon reduction challenges.

## The Market For Industrial Digital Twins Is Undergoing Fast Development

The plethora of use cases and value propositions offered by digital twin technology is having a direct impact on investments. Verdantix finds that the market for digital twins for industrial facilities is expected to rise from about \$800 million of spend in 2020 to over \$27 billion in 2040 (see [Verdantix Market Size And Forecast: Digital Twins For Industrial Facilities 2020 - 2040](#)). Given these significant market prospects, digital twins are becoming an integral part of the commercial strategy of industrial technology providers. For this study, we spoke to 22 digital twin technology providers and looked at the products and industry coverage of 34 providers (see **Figure 7**). We found out that suppliers are:

- **Boosting their asset and industry-specific portfolios.**

As with APM solutions, digital twin deployments require strong domain knowledge and asset-class expertise (see [Verdantix Buyer's Guide: Digital Twins For Industrial Facilities](#)). Digital twin technology providers are enhancing their industry-specific solutions through partnerships and mergers and acquisitions (M&As). In March 2021 Bentley Systems announced that it was acquiring Seequent, a New Zealand-based modelling software provider for geological and geophysical applications, to boost its simulation proposition for the mining sector. A few weeks earlier, Altair acquired Flow Simulator from GE Aviation, to strengthen its thermal systems modelling capabilities, and Kongsberg Digital signed a partnership agreement with US-based OrbitMI, to add that firm's software applications within maritime intelligence, compliance, vessel tracking and vessel performance to the Maritime Applications of the Kognifai Marketplace.

- **Working with consultants and systems integrators to lower the barriers to entry.**

Close collaboration with consultants and systems integrators can lower the barriers to entry for less digitally mature organizations (see [Verdantix Strategic Focus: The Evolving Landscape Of Digital Twin Implementation Partners](#)). In May 2020 Siemens and Atos started collaborating on digital twin implementations for the pharmaceuticals industry. In mid-2020 AspenTech announced partnerships with EPC firms Hargrove and Wood, while in October 2020 asset management specialists SRO Solutions and James Fisher Asset Information Services kickstarted a digital-twin-centred partnership focused on the maritime and offshore sectors. Interestingly, in January 2021 The Cohesive Companies – Bentley Systems's wholly owned digital integrator business unit – acquired SRO Solutions. Akselos recently announced a new distribution deal with Worley, as well as partnerships with engineering services firms COSMI Group, to expand to the Italian market, and Lamprell, to resell Akselos's technology to its offshore oil and gas customers in the Middle East and North Africa regions.

- **Forging partnerships to offer more holistic and sophisticated digital twin products.**

Digital twin technology providers, especially those without a complete breadth of functionality, will be seeking to partner to extend their functionalities and offer digital twins at higher sophistication levels (see [Verdantix Market Overview: Next Steps For Digital Twins](#)). The market has witnessed multiple such M&As recently. In December 2020 AspenTech acquired US-based OptiPlant, to bolster its product portfolio for owner-operators and EPC firms in the process industries with OptiPlant's AI-driven 3D conceptual plant layouts. A month earlier, Hexagon acquired US-based PAS Global to strengthen its cybersecurity and process safety solutions.

FIGURE 7

**Breadth Of Functionality And Industry Coverage Of 34 Digital Twin Technology Suppliers**

		Breadth Of Functionality	Breadth Of Industry Coverage	Publicly Available Customer Examples
Descriptive/Informative Digital Twins	Ada Mode	●	●	●
	AnyLogic	●	●	●
	C3.ai	●	●	●
	COMSOL	●	●	●
	FutureOn	●	●	●
	Itus Digital	●	●	●
	PSE	●	●	●
	Senseye	●	●	●
Predictive/Comprehensive Digital Twins	Akselos	●	●	●
	Ansys	●	●	●
	Autodesk	●	●	●
	Cognite	●	●	●
	Cosmo Tech	●	●	●
	Flutura	●	●	●
	Hexagon	●	●	●
	Hitachi ABB Power Grids	●	●	○
	Honeywell	●	●	●
	Kongsberg Digital	●	●	●
	MathWorks	●	●	●
	PTC	●	●	●
	Royal HDHV Digital	●	●	●
	SAP	●	●	●
	Autonomous Digital Twins	ABB	●	●
Altair		●	●	●
AspenTech		●	●	●
AVEVA		●	●	●
Bentley Systems		●	●	●
Dassault Systèmes		●	●	●
DNV		●	●	●
Emerson		●	●	●
GE Digital		●	●	●
IBM		●	●	●
Rockwell Automation		●	●	●
Siemens		●	●	●

Breadth of functionality coverage<sup>1</sup>:  
 ○ none ● single segment ● two segments ● three segments ● all segments

Breadth of industry coverage<sup>2</sup>:  
 ○ none ● one to three ● four to six ● seven to nine ● ten or more

Publicly announced customers:  
 ○ none ● one to two ● three to four ● five to seven ● eight or more

Notes:<sup>1</sup>across data management, visualization, analytics and simulation; <sup>2</sup>across oil and gas, chemicals, life sciences, food and beverage and fast-moving consumer goods, original equipment manufacturers, automotive/aerospace/marine, power generation, power transmission and distribution, water, mining and metals, transport, and infrastructure

Source: Verdantix

- **Pushing to raise awareness about the use cases and value propositions of digital twins.**

The most significant factor holding back investments for digital twin solutions is a lack of awareness about their added value – a combined 84% of the 259 executives interviewed in the Verdantix 2020 global corporate survey considered the lack of awareness to be either a ‘very significant’ or ‘significant’ barrier. It is therefore imperative that technology providers invest more in thought leadership initiatives, which are still dawdling – even for larger providers. It is also important to publicize successful digital twin technology deployments, in order to raise awareness and help customers see the pragmatic value digital twins can bring to their operations and facilities.



## VERDANTIX CAPABILITIES

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Through our research activities and independent brand positioning we provide clients with:

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- Confidential advisory services such as commercial due diligence
- Thought leadership studies for brand building and lead generation
- Executive summits, roundtables and webinars
- Advisory workshops to rapidly increase your sector knowledge
- Multi-country and complex customer survey projects
- Marketing campaign support with analysts and content

## VERDANTIX MARKET COVERAGE

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### **Smart Building Technologies**

Focuses on software, intelligent building technologies and consulting services that enable real estate and facilities executives to optimize the value and performance of their building portfolios.

### **ESG & Sustainability**

Focuses on the decisions of investors, tech providers, financial services firms and corporate leaders. Conducting in-depth research on the full range of services and technologies required to succeed with ESG and sustainability strategies.

## WHY VERDANTIX?

Verdantix is an independent research and consulting firm with a focus on innovative technologies that optimize business operations. We have expertise in environment, health, safety, quality, operational risk, as well as smart building technologies.

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