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Five Digital Twin Strategies For Industrial Facilities

AUGUST 2019

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OPERATIONAL EXCELLENCE

Five Digital Twin Strategies For Industrial Facilities

A Verdantix survey of 284 managers responsible for operational excellence found that digital twin solutions are viewed as the most significant innovation for the next two years. Thirty-five per cent of the respondents 'strongly agree' that digital twins will transform operational excellence over the next five years. To turn these aspirations into reality, firms need to follow one of five digital twin strategies. Descriptive and informative digital twin strategies are a good fit for operations leaders seeking to leverage existing IT systems without incurring significant additional costs or project risk. The predictive digital twin strategy is suitable for organizations with a robust asset management strategy and investments in APM software. Comprehensive and transformative digital twin strategies are most appropriate for new-build facilities where IoT technologies can be embedded into assets and processes assume digital twin capabilities. No matter which of the digital twin strategies a firm pursues, the project team needs to focus on ROI not just the exciting new technology.

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ORGANIZATIONS MENTIONED

Fluor, Jacobs, South Australian Water Corporation

CUSTOMERS ENVISION A BRIGHT FUTURE FOR DIGITAL TWINS

This report forms one in a series covering the development and adoption of digital twin technologies for industrial facilities (see Verdantix Smart Innovators: Digital Twins For Industrial Facilities). Since 2017, a wide range of industrial software vendors have pitched the concept of digital twins which simulate the performance of industrial facilities using real-time data pulled from sensors, mobile devices and other IT systems. This report helps potential buyers in operations and IT roles to understand the current state of thinking about digital twin projects. Verdantix defines digital twins for industrial facilities as:

> *A digital model of an industrial facility which replicates the facility's systems and simulates its performance using real-time and periodic data to enhance operational decision-making for that facility.*

To better understand how potential customers perceive this new technology Verdantix conducted a survey of 284 operations, engineering and maintenance managers (see Verdantix Operational Excellence Survey 2019: Budgets, Priorities & Tech Preferences). We heard that digital twin technology:

- **Tops the list of digital innovations for operational excellence in 2020 and 2021.** Comparing nine different digital innovations, 94% of the 284 survey respondents flagged digital twins as either 'very significant' or 'significant' for their firm's operational excellence initiative in the next two years (see Figure 1). This is a surprisingly aspirational response given the idea of building digital twins for industrial facilities is a recently-conceived idea. Interestingly, only 64% of the respondents consider 3D visualization of asset performance is 'very significant' or 'significant'.

- **Offers transformational potential for operational excellence in the next five years.** Asked to consider the potential of digital twin simulations over the next five years, 35% of the 284 respondents 'strongly agree' that they will transform operational excellence and a further 54% stated they 'agree' with this idea (see Figure 2). These responses provide further evidence that the applicability of digital twin solutions to resolving operational excellence challenges has taken root in the operations, engineering and maintenance community.

Asset Management Realities Determine Which Of Five Digital Twin Strategies Will Work

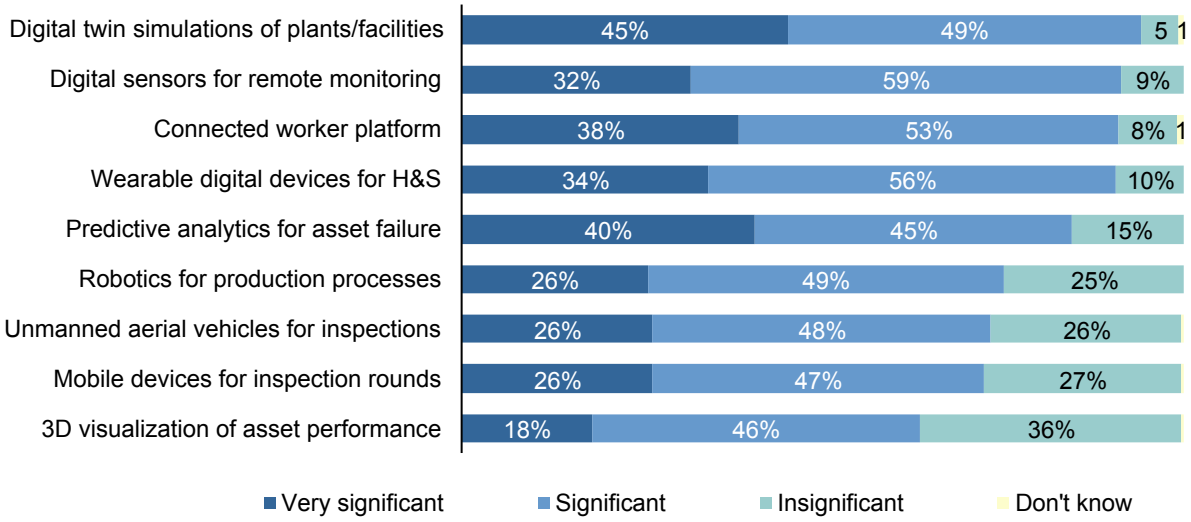
Digital twins have only recently been pitched as a technology with relevance to operational excellence, but customers already show high levels of awareness. Since there is no 'one size fits all' digital twin technology, customers should craft a digital twin strategy framed by their business objectives, the maturity of their approach to asset management, the requirements and constraints of each industrial facility. Customers will succeed by understanding that:

- **Descriptive digital twin strategies address tactical problems at existing facilities.** At the most simple level, some customers consider that a visual replica of interconnected assets at a facility with an information overlay constitutes a digital twin. For example, a digital 3D image of an offshore oil rig with padlock icons that represent pending or signed off permits to work. Another example is a digital 2D piping and instrumentation diagram (P&ID) which includes asset information. Whilst these descriptive (Level 1) digital twins may seem simplistic, P&IDs for a water treatment firm such as the South Australian Water Corporation include dozens of technical definitions for line types, hazard levels, fittings, equipment, chemicals, pipe materials, service fluids, level sensors and flow meters.

FIGURE 1

Digital Twins Top The Priority List For Innovations In 2020 And 2021

"In the next 2 years, how significant will the following digital innovations be for your firm's operational excellence initiatives?"



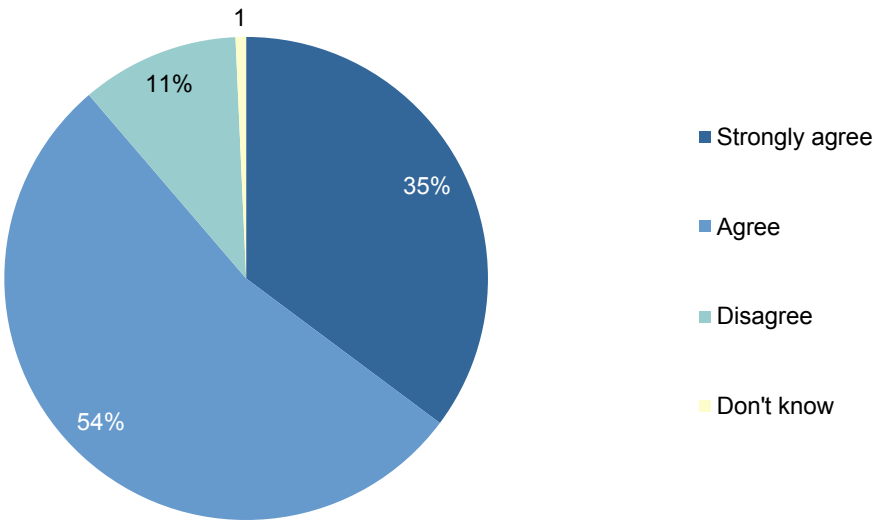
Source: Verdantix

n = 284

FIGURE 2

Digital Twins Have Transformative Potential Over The Next Five Years

"Do you agree that digital twin simulations will transform your firm's approach to operational excellence in the next five years?"



Source: Verdantix

n = 284

Producing a digital version of the P&ID with at least some real-time data is a great place to get started with a digital twin strategy for existing assets. This strategy can also exploit home-built asset information systems. These 'descriptive' digital twins are inexpensive to implement and enhance existing processes without disrupting work routines.

- **Informative digital twin plans leverage asset health monitoring investments.**
  For customers who can invest in IT systems integration, shaping an informative (Level 2) digital twin strategy is a good start point. Many organizations have existing investments in historians, mobile forms for operator rounds, maintenance databases, monitors on safety critical equipment and OEM-installed sensors. Operations managers should identify these existing data sources and generate more value from them with a focused systems integration project. The objective should be to provide better real-time asset health monitoring to save money on maintenance work and reduce unplanned events. Due to budget constraints, informative digital twin strategies do not typically involve flashy 3D visualizations as data can be effectively presented in a dashboard format. Power users run analysis in spreadsheets or corporate BI tools. This strategy doesn't impact existing processes or decision-making.

- **Predictive digital twin deployments enhance process excellence.**
  Firms with more mature asset management strategies and robust asset information systems should develop a digital twin strategy tied into an enterprise roll out of asset performance management (APM) software (see Verdantix Smart Innovators: Asset Performance Management Software). The predictive (Level 3) digital twin strategy leverages the existing capabilities of APM software to predict equipment failure based on data from sensors and operator rounds. By visualizing this real-time asset health information – ideally in a 3D view of the facility – and proposing remedies to avoid unplanned events, the digital twin will change how engineering and maintenance decisions are made. Consequently, the 'predictive' digital twin strategy will only succeed when industrial facilities are managed for a defined purpose. It also assumes prior investment in IT systems integration to flow data into the APM software. Predictive digital twin strategies can be implemented at existing sites as well as new build facilities.

- **Comprehensive digital twin strategies optimize performance with real-time simulations.**
  The big promise of digital twins is the ability to simulate in real-time the actual performance of physical assets. Achieving a realistic simulation implies there is a granular digital model of the facility based on thousands of data sources, a library of asset-level standard operating models, and sufficient computing power to generate insights in close to real-time. Delivering this type of 'comprehensive' (Level 4) digital twin strategy requires a custom-built information architecture which cannot be achieved as an overlay on top of existing IT systems. To deliver on close to real-time analytics and what-if scenario modelling, these digital twin models need access to bursts of cloud-based computing resources. Due to the complexity of the digital twin model, the algorithms used to perform calculations that predict equipment failure are designed from the ground up using physics-based principles. For existing facilities, the comprehensive digital twin strategy can only be applied to a specific asset class with very similar characteristics such as power stations with Combined Cycle Gas Turbines. The Level 4 strategy will be applied more frequently to new build industrial sites which exploit Industry 4.0 design principles.

- **Transformative digital twin projects will only work for entirely new industrial facilities.**
  Firms building new industrial facilities have the opportunity to incorporate a digital twin strategy into the entire engineering, procurement and contracting (EPC) process. According to this approach, a design/ build firm such as Fluor or Jacobs creates a digital twin simulation of the plant, identifies how alternative designs would generate better performance using the digital twin, then constructs the plant with digital twin technologies embedded in assets. For instance, this would imply site-wide communications infrastructure capable of supporting Internet of Things (IoT) data flows, a cyber-security framework

enabling use of cloud computing for digital twin calculations and equipment-attached sensors providing granular insight into asset health. The transformative (Level 5) digital twin strategy is only applicable to new build facilities as it requires an information architecture embedded across all assets. This strategy opens the door to the use of powerful analytics to predict failures, prescribe optimal maintenance strategies and automate remedies. The comms infrastructure makes it possible to deploy location tracking for worker safety and augmented reality technical support. Pursuing the 'transformative' digital twin strategy requires EPC workflows to migrate from document-centric to digital-centric.

Customers Should Focus On ROI To Make Savvy Investments In Digital Twin Projects

Since digital twins are a concept not a discrete category of technology, there is no 'one size fits all' digital twin application comparable to, for example, Customer Relationship Management software. Instead, potential users of digital twins need to diagnose their ability to implement one of five different digital twin strategies based on the realities of their asset management strategies. There is a high level of expectation around the potential of digital twin strategies to improve operational excellence, so senior managers in engineering, operations and IT should figure out how to get started. As with any technology investment, the project team should:

- **Co-create a vision for their digital twin strategy to achieve.**
  High levels of enthusiasm for digital twin technology solutions risk translating into projects without a well-defined purpose. Since digital twins are not a discrete software application, project teams need to sit down with software suppliers and subject matter experts at IT consulting firms to shape the vision and objectives for the digital twin project. This could range from tactical aims such as enhancing safety in relation to maintenance work at an existing chemical plant (Level 1) to building a fleet of offshore wind turbines with best in class performance and uptime (Level 5). The vision needs to detail the usage scenarios for the information captured in the digital twin model and the desired business outcomes. The scope of the project should reflect these requirements as sensors do not need to be deployed veerywh

- **Detail hardware, software and IT consulting costs to implement the project.**
  The costs of digital twin projects will vary enormously. Descriptive (Level 1) and informative (Level 2) projects for a single site should cost between $250,000 and $500,000 as they leverage existing asset information systems and don't require widespread user training and process change management. Predictive (Level 3) and comprehensive (Level 4) digital twin strategies will require far larger investments as they involve overhauling the asset management strategy, paying for APM software, and deploying communications infrastructure and sensor networks. Transformative (Level 5) digital twin strategies will be funded as part of a large capital project and will run into multiple millions of dollars for a large site such as a new build oil refinery or LNG terminal.

- **Quantify the full range of hoped-for business benefits.**
  All digital twin vendors incorporate screenshots and video clips of their 3D visual user interface in their product marketing. This has accelerated customer interest in digital twins but also risks positioning the technology as a 'shiny new toy'. Project teams need to overcome this perception by performing an assessment of how their digital twin strategy will meet business objectives and deliver benefits. For example, how does a Predictive (Level 3) digital twin strategy deliver operational improvements above and beyond just deploying APM software? With few case studies available, building the business case for digital twin enhancements will require original thinking. Both vendors and consultants need to provide the ROI calculation framework to help customers' project teams grab budget from the COO and CIO.

- **Identify risks to project success across IT and change management.**
  Whilst purists may consider strategies below Level 4 as not delivering on the full vision of the digital twin concept, more sophisticated deployments carry the biggest risk of failure. Comprehensive and transformative digital twin strategies push the boundaries of Industry 4.0 business strategies on multiple dimensions. Project teams may be developing the first ever digital twin information architecture for a natural gas pipeline or offshore platform in the North Sea. These sophisticated digital twin strategies also pose risks in terms of changes to processes and work routines. By contrast, descriptive (Level 1) and informative (Level 2) digital twin strategies have lower levels of IT integration and process redesign complexity. Customers may well find that the risk profile of the more ambitious strategies is a bad fit for their IT project management skill set. Starting with less risky projects might make more sense.

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