



Nurturing Digital Twins: How to Build Virtual Instances of Physical Assets to Boost Performance

Assess your readiness, define and communicate a vision, set common data management rules and build in flexibility for intelligence.

What is a digital twin?

A digital twin is a replica, described by data, of physical assets, processes and systems that helps organizations understand, predict and optimize their performance. A digital twin combines design and engineering details with operating data and analytics about anything from a single part to multiple interconnected systems to an entire manufacturing plant.

This is more than a generic model of a type of asset. It is unique to the device it describes, combines multiple data sources for different types of data (such as the temperature, vibration and power consumed by a device) and applies intelligence (in the form of rules, logic, algorithms and predictions) to that

data. This allows organizations to simulate the behavior of the device, process or system and monitor, diagnose and control them. It can even enable them to develop new features to increase their value.

A digital twin at work

Mapping performance and status of a compressor improves performance, cuts downtime.

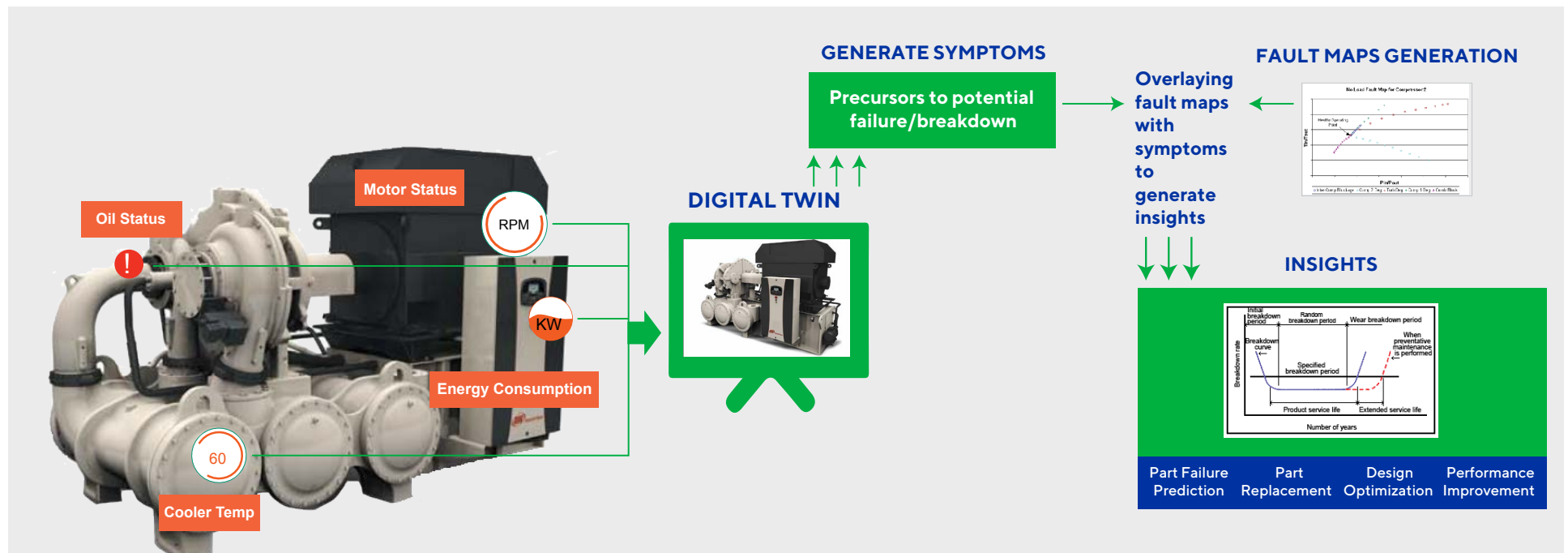


Figure 1

Business benefits of digital twins boost efficiencies, sales and services

Digital field services:

- I **Real-time machine data in augmented view for field technicians** to increase efficiency and productivity.
- I **Remote SME collaboration** – optimize SME bandwidth and utilization.
- I **Combine with wearables for hands-free operations** – increase employee safety.

Smart operations:

- I **Give engineers information on potential failures of IoT-connected products** to prevent unplanned downtime and improve product performance.
- I **Employ a smart record**, versus manual entry of asset maintenance records, by using digital twin instances to improve accuracy and maintenance schedules.

Digital twin of an aircraft

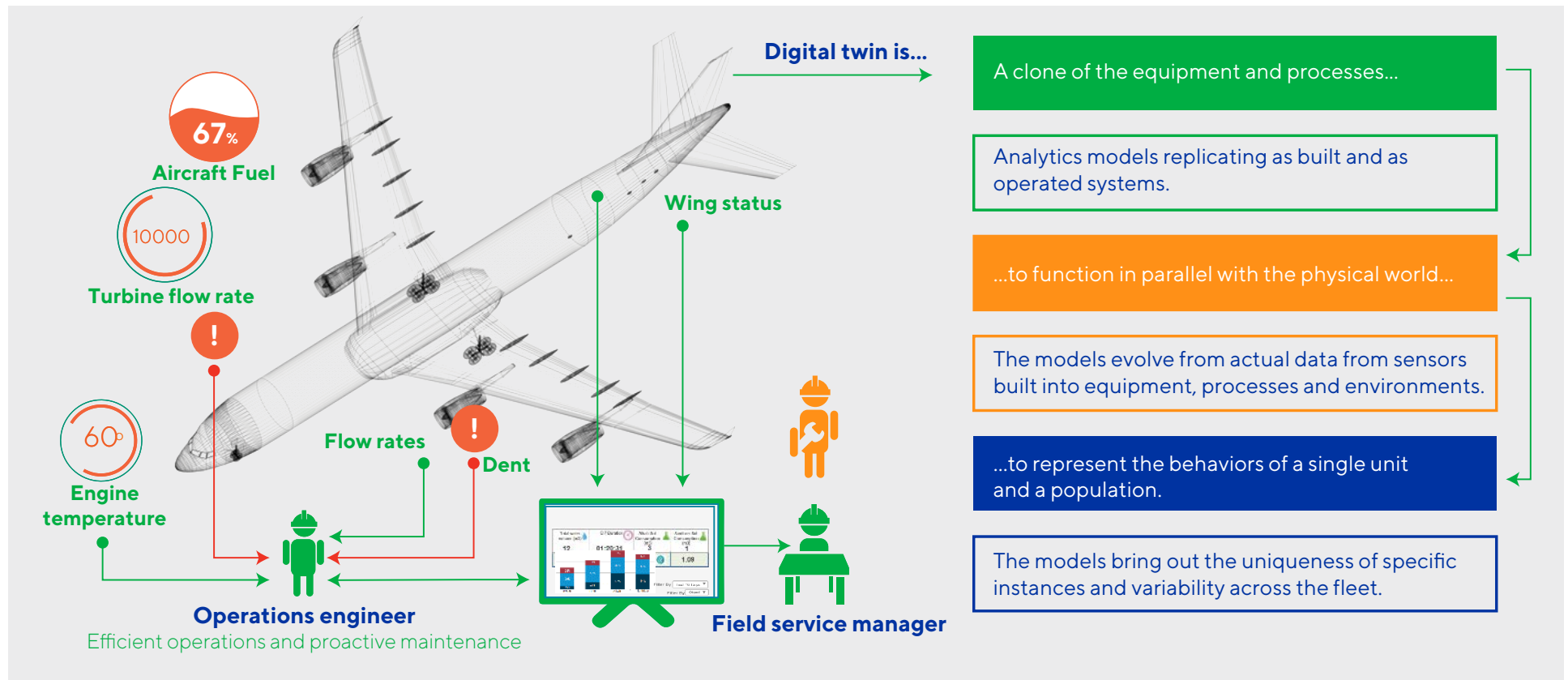


Figure 2

- I **Conduct smart inspection using AR/VR** with digitized instructions for engineers to increase process efficiency and productivity.
- I **Increase the output and yield of manufacturing equipment** to reduce waste and increase profits.
- I **Optimize the efficiency and energy use of production equipment** to reduce costs and help assure compliance with environmental standards.
- I **Better understand the performance of new production equipment and processes** to improve planning and succeed at meeting delivery and quality commitments to customers.

Engineering and product development:

- I **Generate “what-if” scenarios using stochastic simulations** in which variables such as product usage or environmental conditions change randomly (like in the real world) to predict which variations might cause a failure. This can prevent costly product quality issues as well as reduce time-to-market for new products.
- I **Predict the performance and durability of new products** to allow improvements and refinements before they reach the market, increasing sales and customer satisfaction.

Driving growth with digital twins

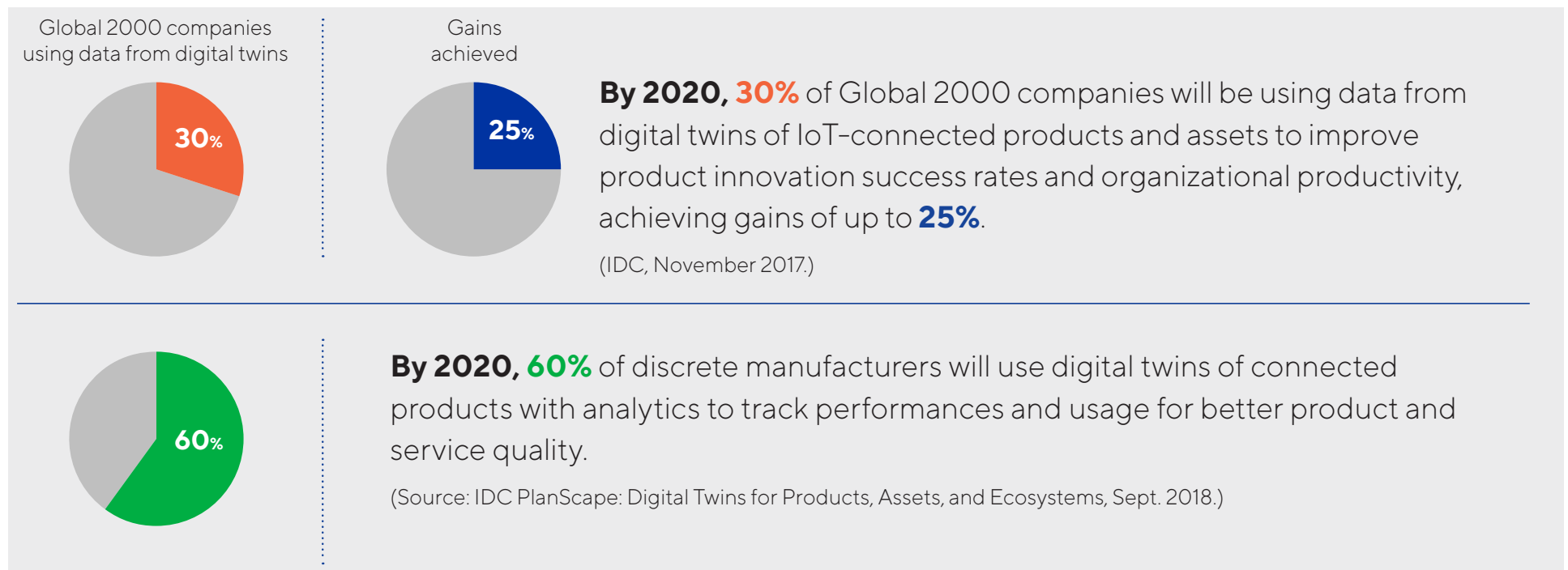


Figure 3

Three key digital twin requirements

1 Organizational readiness

This means assessing the maturity of your technology, processes, governance and staff for finding, gathering, validating and analyzing all the data needed for your digital twins. This includes your ability to combine

data from multiple sources such as field measurements, quality inspection reports and customer feedback. A well-defined process ensures that the data is generated and stored at the source and can be easily and quickly shared across organizational boundaries. The higher the level of maturity, the better positioned you are to reap the benefits of digital twins.

Metrics to measure organizational maturity

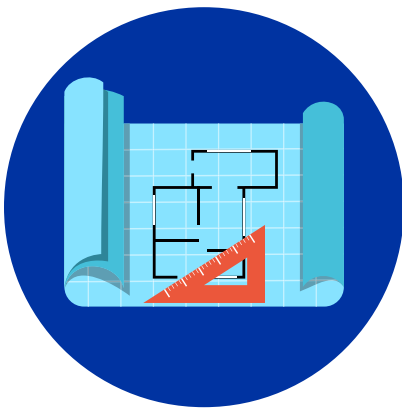
Level	1. Unstructured	2. Repetitive	3. Defined	4. Dynamic	5. Optimal
Process	<ul style="list-style-type: none"> Limited product feedback Isolated M2M applications No intelligence or connectivity 	<ul style="list-style-type: none"> Minimal information sharing Fragmented information Static reports of operational activity Descriptive analytics 	<ul style="list-style-type: none"> Managed services Integrated analytical data model Localized intelligence Diagnostic analytics 	<ul style="list-style-type: none"> Smart decision-making Harvest of knowledge and insights Real-time analytical data processing Predictive/prescriptive analytics 	<ul style="list-style-type: none"> Integration into corporate processes Application of machine learning to create predictive models Cognitive analytics
Technology	<ul style="list-style-type: none"> Siloed sensors Data unavailability 	<ul style="list-style-type: none"> Connected devices Data localized 	<ul style="list-style-type: none"> Software tunable assets Secured remote management 	<ul style="list-style-type: none"> Self-optimization Interaction with ecosystem 	<ul style="list-style-type: none"> Converged technology Real-time infrastructure
Governance	<ul style="list-style-type: none"> Decision-making is ad hoc Minimal or no strategic planning taking place 	<ul style="list-style-type: none"> Managed Near-term focused and limited in scope to key initiatives 	<ul style="list-style-type: none"> Process-driven Longer-term focused; created in response to specific events or immediate conditions 	<ul style="list-style-type: none"> Policy-driven Long-term focused; taking advantage of enterprise synergies and coordinated efforts 	<ul style="list-style-type: none"> Value-oriented Strategy iterates rapidly in response to competitive opportunities and threats
People	<ul style="list-style-type: none"> Ad hoc people management 	<ul style="list-style-type: none"> Policies developed for capability improvement 	<ul style="list-style-type: none"> Standardized people management across organization 	<ul style="list-style-type: none"> Quantitative goals for people management in place 	<ul style="list-style-type: none"> Continuous focus on improving individual competence and workforce motivation

Figure 4

2 Build your foundation

- Define the concept.** Make sure all stakeholders understand that a digital twin is an evolving digital profile of physical assets that captures both historical and real-time data, and communicate the monetary value of the digital twins this data enables. Define who owns the various types of data and has the authority to share it. Tackling these challenges up front helps ensure your digital twin strategy gets the support it needs and is focused on your most urgent business needs.
- Design your data management.** Design and implement a comprehensive approach to collect, manage and manipulate the data you need for your digital twins. Close integration among partners and suppliers is essential to ensure the digital twin accurately mirrors the physical devices, systems or processes. This may require integration among multiple data sources as well as proprietary sensors and networks on the devices. As the physical products evolve, managing the design data across the value chain becomes more challenging.
- Choose the right level of detail.** You need a digital twin that is simple enough to implement and use, but with sufficient detail to deliver meaningful insights. Different objects and business challenges will require different types and amounts of current and historical data. Consider starting with a basic model and add other inputs and analytics as needed, designing in flexibility so the models don't become obsolete.

Convince suppliers and other partners to move to 3-D, rather than 2-D, models and drawings.



3 Tap best practices

- Get buy-in across the value chain to ensure real-time gathering of information from, and sharing of information with, everyone involved in the design, manufacturing, maintenance and use of a product or associated process.
- Work with all value chain partners to understand the trade-offs they face in the design process, the ways in which a product or process can fail, and the types of data and analytics required to model these. Match those data and analytic needs against the organization's capabilities and create an action plan to fill the gaps.
- Future-proof your data and analytic tools, especially for long-lived assets such as industrial machinery and buildings. Look for support for open data and network standards. For proprietary tools, insist vendors guarantee data compatibility with future upgrades.
- Create, communicate and evolve standard processes for changing the data gathered to produce digital twins, the 3-D models that represent them and the associated analytics. This reduces the delay and overhead of adapting to future needs.

Different needs, different digital twins

Measured variables depend on the purpose of the digital twins, such as for vehicle tires.

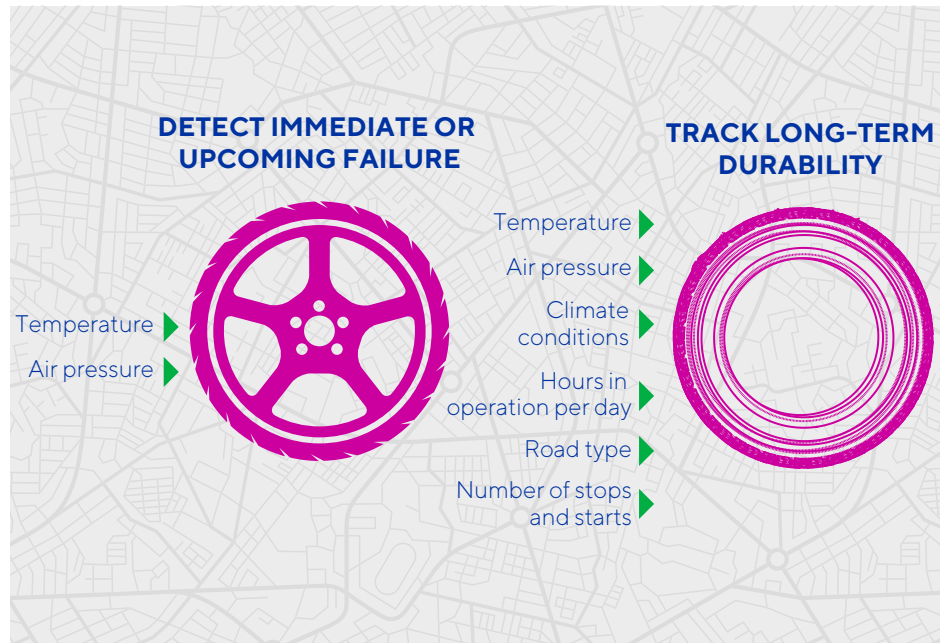


Figure 5

Data needs across the value chain for a gearbox digital twin

What combination of readings has been a predictor of failure or excessive wear?

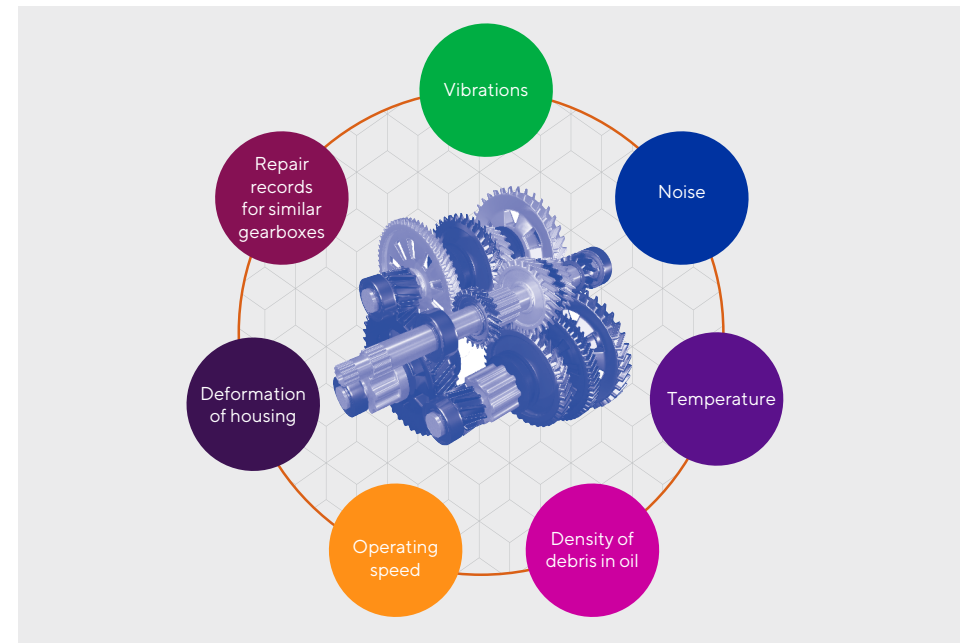


Figure 6

Overcoming five common digital twin roadblocks

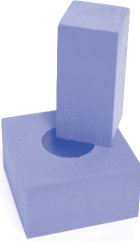




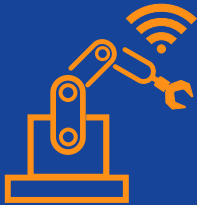
	Pitfall	Solution
	<p>Trying to use the same software and data management tools and model for digital twins of assets that need different amounts, types and degrees of detail of information.</p>	<p>Carefully define the current and future requirements for each digital twin before choosing your modeling software and data management tools.</p>
	<p>Taking a “big bang” approach that risks high costs, delays and failure to deliver benefits quickly enough.</p>	<p>Identify the most critical assets, and the data required to create digital twins of them. Create those digital twins first to gain experience and prove value to business sponsors.</p>
	<p>Poor quality data due to manual input and duplication from multiple source systems.</p>	<p>Create, enforce and continually adapt standard data collection processes, including the use of standard templates. Use data de-duplication to reduce the incident of redundant data that can skew analytics and increase data-handling costs.</p>
<p>404 ERROR</p>  <p>PAGE NOT FOUND</p>	<p>Lack of common communication standards hampers data-gathering from IoT devices.</p>	<p>Investigate and utilize, perhaps with the help of a service provider, emerging common IoT communication standards.</p>
	<p>User skepticism and resistance limits use of and value from digital twins.</p>	<p>Provide ongoing, high-quality training and documentation to ensure users understand need for, value of and best practices for using digital twins.</p>

Figure 7

The digital twin payoff

Digital twins can be implemented on many levels – for equipment, site locations, or even whole enterprises, for example. Key value-impact measures should be measured and analyzed before and after implementation, as a basis for building a solid business case to scale up the use of digital twins to deliver greater business value.



EQUIPMENT

Increased:

Availability
Uptime
Productivity
Cycle Time
Overall
Equipment
Effectiveness
Mean Time
Between Failures
Lead Time

Reduced:

Downtime
Equipment Failure
Rate

SITE

Increased:

Resource Utilization
Compliance
Rates
Capacity Utilization
Planned Hours of
Work vs. Actual
Situation

Reduced:

Plant Downtime
Percentage
Reduction in
Defect Rates
Labor as a
Percentage of Cost

ENTERPRISE

Increased:

Revenue Growth
Monthly Sales
Net Profit
Earnings Before
Interest, Tax,
Depreciation and
Amortization
Customer
Satisfaction
Environmental
Compliance
Employee
Satisfaction
Sales Volume

Reduced:

Attrition

Figure 8

Next steps

Digital twins can provide unprecedented insights into the status and performance of the devices and processes that power modern business. But like any new technology, they require a shared vision of the costs and benefits, standardized processes to ensure a high-quality supply of raw data, and the flexibility to add new data types and analyses to meet changing business needs.

We recommend starting your digital twin work small, focusing on your most critical assets, and conducting an up-front analysis of your tools and processes in key areas such as data management. As you build your family of digital twins, make sure to future-proof your software and models so they can evolve to meet future needs.



Learn More

For more information about how we are partnering with companies to connect intelligence to their physical world, visit www.cognizant.com/iot.

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Cognizant

World Headquarters

500 Frank W. Burr Blvd.
Teaneck, NJ 07666 USA
Phone: +1 201 801 0233
Fax: +1 201 801 0243
Toll Free: +1 888 937 3277

European Headquarters

1 Kingdom Street
Paddington Central
London W2 6BD England
Phone: +44 (0) 20 7297 7600
Fax: +44 (0) 20 7121 0102

India Operations Headquarters

#5/535 Old Mahabalipuram Road
Okkiyam Pettai, Thoraipakkam
Chennai, 600 096 India
Phone: +91 (0) 44 4209 6000
Fax: +91 (0) 44 4209 6060

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