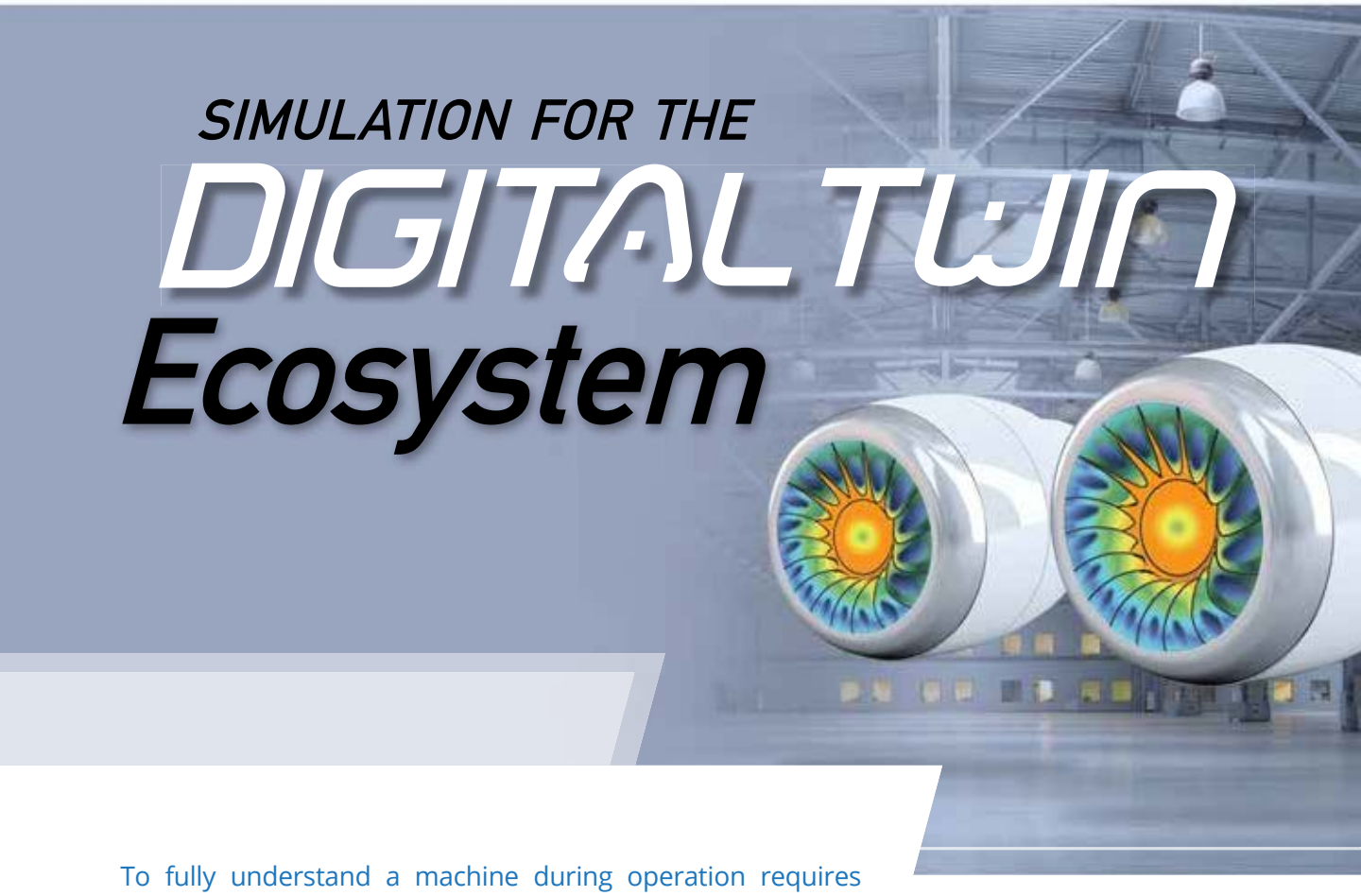
SIMULATION FOR THE DIGITAL TWIN Ecosystem



To fully understand a machine during operation requires connecting the full-featured virtual model to actual operational data from the machine; the virtual model is then called a digital twin. Simulation is a valuable tool for companies creating digital twins, as it allows them to accurately predict how the machine might perform and how changes will affect it during its lifetime. ANSYS has a full suite of tools to enable a digital twin to deliver accurate, insightful and reliable results that can have a real impact on operation — improving output, decreasing downtime and extending longevity. By understanding real-world product behavior using simulation, the next-generation product can be significantly improved while reducing its time to market.

By **Sameer Kher**, Director of Systems and Digital Twins, ANSYS

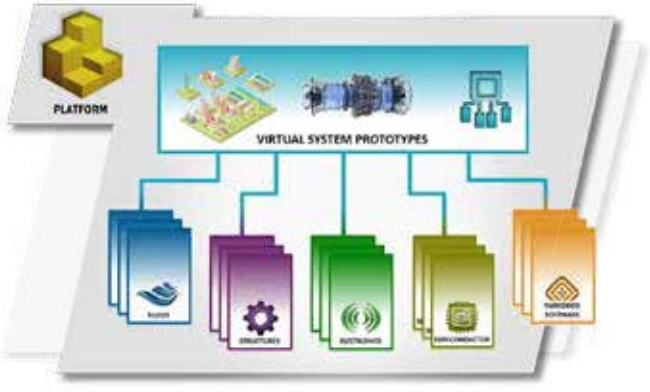
Digital Twin — Web Page
ansys.com/digital-twin

Tens of thousands of high-value machines are currently hard at work around the world generating electrical power, manufacturing automobiles, transporting people and goods, producing oil and gas, supplying clean water, picking orders for consumers and businesses, and performing many other vital functions. Most of these machines were designed using physics simulation to optimize structural, fluid flow, electromagnetic, thermal and other physical properties. However, as assets age and are modified, few are operating under the conditions envisioned when they were designed. Until recently, the people responsible for keeping these assets running at maximum efficiency had no way to understand the effects of operational and environmental changes on asset performance. Is the machine headed for a breakdown that could cost tens of thousands of dollars per hour in lost production? Is it being run at suboptimal conditions that will reduce its life over the long run? Are there opportunities to improve its performance

> “When incorporated in a digital twin, engineering simulation helps companies analyze and optimize the performance of products in real-world operating conditions.”

by making changes to its operating conditions or upgrading its capabilities?

For many high-value assets, such as jet engines, companies have been using sensors to collect data for many years. However, these data are not always collected in real time, and the vast amount of data has made it difficult to extract actionable insights. The Internet of Things (IoT) makes it possible for the first time to use sensors to capture data from these assets to understand and optimize their performance instantaneously. By combining this operational data with other information on how the machine works — including maintenance records, PLM information and simulation results — together with analytics and machine learning to form an ecosystem, a fully featured model called a digital twin can be built. Using a digital twin, it is possible to diagnose complicated problems that involve interactions of multiple subsystem and factors. Simulation is critical to a digital twin as it supplies answers to questions like “What if we change this?” and “Why did that happen?” and “How do we improve the design?”

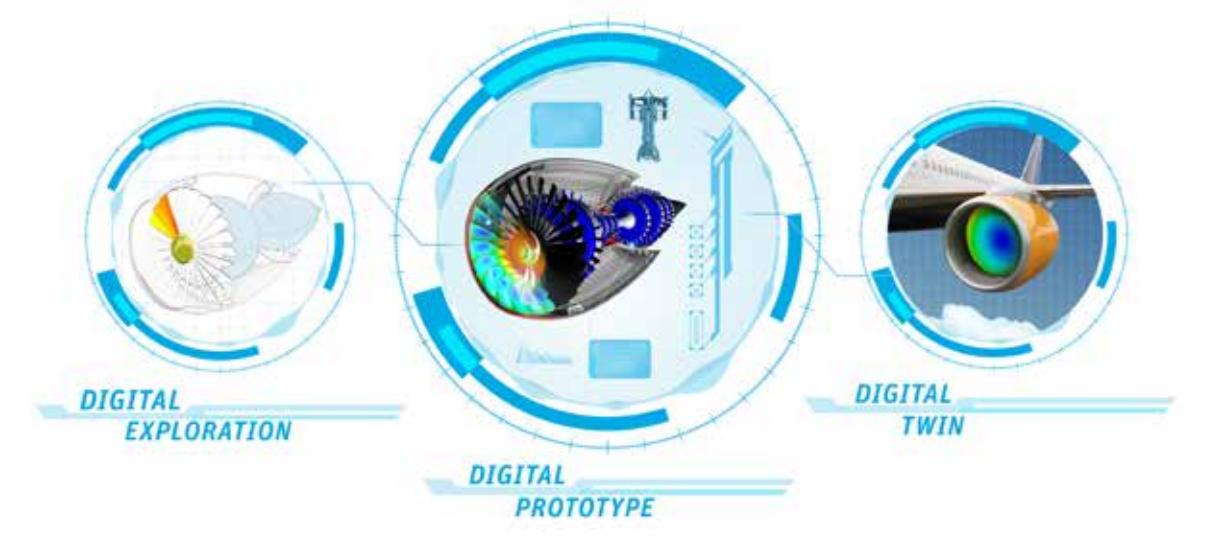


^ ANSYS enables a simulation-based digital twin — from comprehensive component-level design and simulation to complete systems simulation.

SYSTEMS-LEVEL SUPPORT

The ANSYS Simplorer system-level modeling tool makes it possible to build digital twins that accurately describe complicated interactions between components, subassemblies and subsystems. The subsystems in the model can be defined to the desired level of

PERVASIVE ENGINEERING SIMULATION



fidelity ranging from high-level behavioral models to detailed physics-based simulation models. The subsystems and components of system-level models often consist of reduced-order models—compact representations of 3-D physics-based models—that accurately represent the physics while providing results in much less time.

PHYSICS-BASED SIMULATION

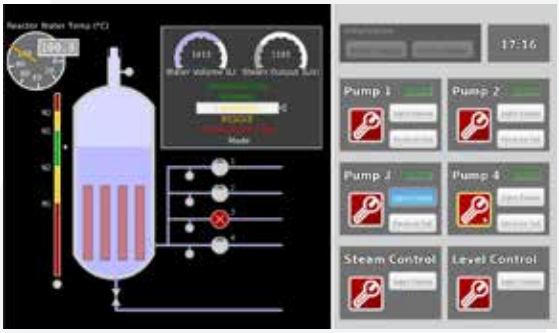
The full potential of the digital twin concept is realized by using physics-based models that can duplicate the operation of complex assets in enough detail to fully understand their performance, even when facing never-before-seen conditions. The digital twin often contains a simulation model that duplicates the operation of the asset and can diagnose unforeseen situations by analyzing the basic physics to predict how the asset will perform. It should include a simulation model that has been developed to duplicate the current condition of the product or process, such as by incorporating wear or modifications into the simulation model. The data from sensors connected to the product or process are used to provide real-time boundary conditions for the digital twin. The digital twin results can be calibrated based on the operation of the actual asset.

CONTROL SYSTEMS

ANSYS SCADE can control the digital twin and develop a human–machine interface (HMI) using the same control software and HMI used on the real physical asset. An engineer can then virtually test different scenarios or operating conditions on the digital twin to see how it will perform using the same interface as that employed to control the physical asset.

COMPLETE TECHNOLOGY PLATFORM

ANSYS provides a sophisticated platform to improve the digital twin experience that integrates many different simulation tools. One of the key tools is the ANSYS Engineering Knowledge Manager (EKM), which greatly simplifies the process of connecting multiple digital twins to the IoT. For example, if there are 100 individual implementations of a particular asset, EKM can store a digital twin of each asset that reflects the



^ Human–machine interface for a chemical processing asset developed using ANSYS SCADE

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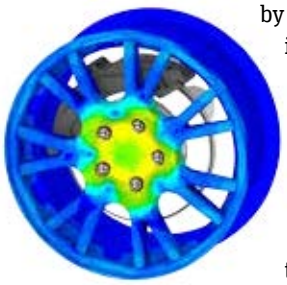
"ANSYS is the only company with a full suite of simulation solutions that span platform, depth and breadth of trusted physics, and systems functionality."

differences between them (such as their age and operating conditions) and then connect incoming data from a particular asset with the associated digital twin. The ANSYS simulation technology platform also includes ANSYS DesignXplorer to explore numerous conditions or geometric variables and quickly evaluate a wide range of operating conditions, helping engineers determine the conditions that deliver the best performance. Engineers can use DesignXplorer offline to come up with the best possible solution to a challenge before implementing it in the operating asset.



^ **Physics-based simulation provides insight into the digital twin, such as stress on a wheel.**

INTEGRATING THE DIGITAL TWIN ECOSYSTEM

The ANSYS simulation platform is already proven to work in tandem with a wide range of popular IoT platforms such as PTC's ThingWorx® and General Electric's Predix®. For example, ANSYS worked with PTC to demonstrate how a simulation model of an operating pump can help diagnose and solve operating problems faster than the usual trial-and-error approach.

Simulation has long been used to improve the design of nearly every physical product or process by evaluating complex physics that are impossible to fully understand through physical testing. ANSYS is the only company with a full suite of simulation solutions that include platform, depth and breadth of trusted physics capabilities, and systems functionality. ANSYS simulation solutions help engineers move to the next level of insight through digital twins. When incorporated in a digital twin, engineering simulation helps companies analyze and optimize the performance of products in real-world operating conditions and make confident predictions about future performance to improve product operation and productivity, and reduce the cost and risk of unplanned downtime. ^