WHITE PAPER

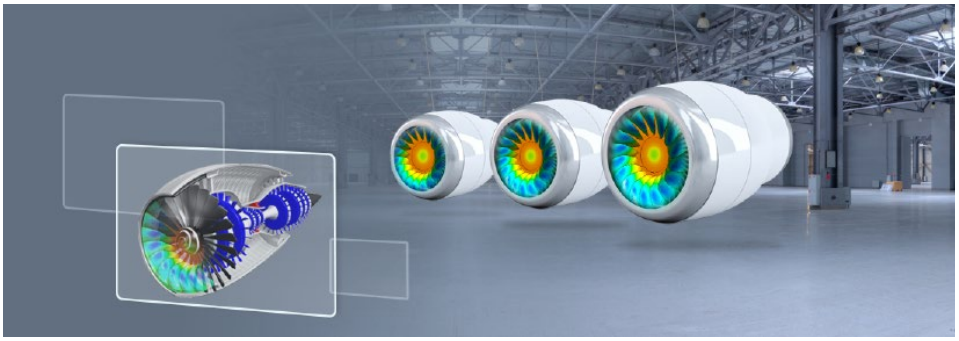
Digital Twins: Making the Vision Achievable

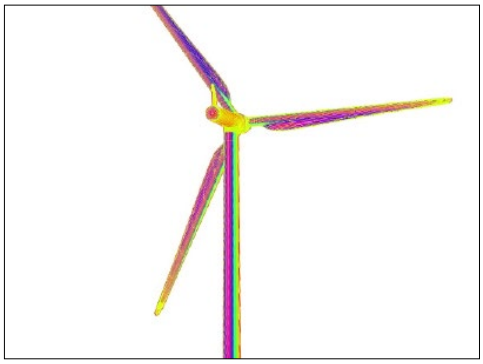
Few business concepts are generating the buzz of digital twins — product replicas that can help target performance issues and allow for true predictive maintenance. While the benefits are obvious, companies have struggled with how to achieve this vision. But now there is a practical solution.

One of the newest and most exciting frontiers in simulation is the concept of digital twins. By using product-mounted sensors, companies can collect operating data from the field in real time, and use that information to create an exact replica of the working product in a controlled virtual space. By studying how the simulated product model performs under real-world conditions, companies can flag any performance issues, schedule predictive maintenance, reduce downtime and minimize warranty expenses. While this is an attractive proposition, most businesses have been challenged to implement this best practice within their own operations due to the specialized expertise and cross-functional partnerships required. What's needed is a straightforward, best-in-class solution for creating, validating and deploying digital twins. The good news? That solution is here.

Modeling a Working Product: The Benefits Are Obvious

For decades, engineers have leveraged simulation to develop innovative, high-performing products in a virtual design space. By applying a range of physical forces and operating parameters to their three-dimensional product designs, engineers have been able to launch products with a high degree of confidence that they will perform as expected under real-world conditions. Once a visionary idea, today simulation-driven product development is a best practice applied every day, in every industry, by all types of companies. Not only has simulation supported game-changing innovations, it has also saved enormous amounts of time, money and other resources for the world's product development teams.





What's been missing historically is a closed-loop approach that ensures simulation remains a competitive advantage once products are launched into the field. Imagining the benefits to be gained by monitoring product performance over time — and empowered by advances in smart connected product capabilities — many leading businesses have begun to explore the concept of the "digital twin."

What exactly is a digital twin? It is a simulated model of an actual working product in the field, informed by sensors mounted on the product that gather and feed back real-time, real-world operating data. By studying the digital twin under actual working conditions, for the first time companies can see the product in action, over time, when subjected to the physical environment. This allows the product development team to close the loop on its initial simulations. Engineers can make more informed choices for future designs and make their simulations even more accurate.

Even more important, for the first time digital twins enable true predictive maintenance. Instead of over-servicing or over-maintaining products to avoid costly downtime, repairs or replacement, companies can act "just in time" to address any product performance issues. They can accurately visualize exactly when and where maintenance is needed, instead of making blind guesses and safe bets.

Asset Management: Gain a Competitive Edge

As competition increases and customers demand higher levels of service, businesses are challenged to protect their traditional margins. In this tough environment, asset management is emerging as a key capability. By strategically maintaining their existing capital assets via predictive maintenance and repair, companies can avoid costly downtime, lost customers, warranty expenses and other liabilities. They can also minimize the need for new capital investments as they optimize the lifetime performance of their working products.

The time and cost savings are substantial. Via digital twins, enterprises of all sizes and types can eliminate unnecessary maintenance, bring an end to product downtime, reduce repairs and minimize warranty expenses. Enabled by the rise of smart connected product technology — which allows durable, competitively priced sensors to be mounted on working products — digital twins represent an idea whose time has clearly arrived.

/ An Ambitious Vision...With Practical Challenges

There's no doubt that digital twins have the potential to revolutionize the field of product maintenance and repair. In industries like energy generation, oil and gas recovery, defense and aerospace — where products are subjected to harsh and difficult-to-predict conditions — digital twins have obvious benefits. But also consider the millions of industrial pumps and heating/ventilation/cooling systems in operation today, all around the world. Digital twins have the power to affect the reliable, cost-effective operation of all these machines, creating an enormous economic impact. Despite the well-justified excitement about digital twins, today this concept is still being pioneered by a handful of early adopters.

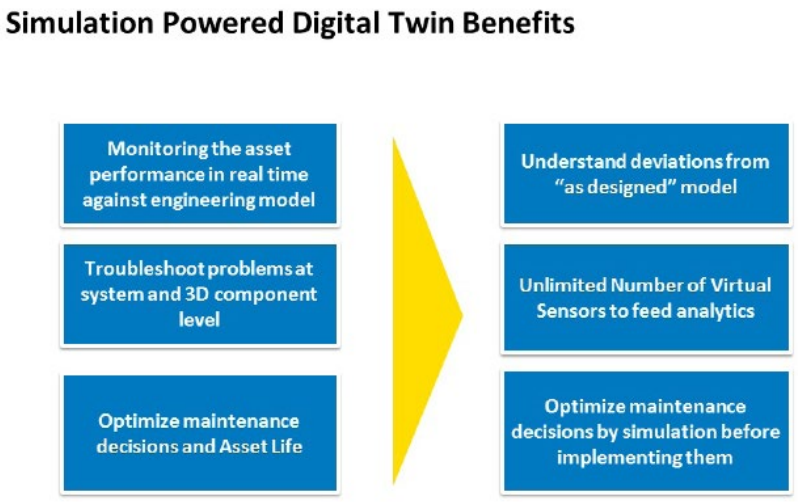
Why aren't more enterprises implementing this obvious best practice? The answer is that most businesses lack the dedicated resources to create a simulated product model, verify the model, deploy the model by connecting it to actual working products, then analyze the collected information. Because this process typically involves multiple functions and multiple technology platforms, the majority of companies are intimidated by the practical challenges of implementing the concept of digital twins within their own operations.

Bridging the Gap Between Engineering and Operations

One of the key disconnects in most companies lies between engineering and operations. Too often, product developers throw a design "over the wall" for installation and maintenance by the operations team — and never gain the valuable insights that are delivered over the lifetime of the product system. Conversely, the operations team often fails to fully benefit from the technical expertise of the engineering function. Digital twins bridge this gap, creating a closed-loop process in which product development is continuously improved and lifetime product operations are strategically mined for useful insights.

Needed: An Accessible, Straightforward Solution

To realize the potential of digital twins in millions of worldwide applications, what is needed is an easy-to-implement, straightforward solution. Developed by an industry leader in simulation technology — and based on a technology platform that is easily integrated across business functions — this solution would place digital twins within reach of many companies that are overwhelmed by the challenges today. By making this advanced operations practice accessible, such a solution could increase the profitability and competitiveness of any organization with significant maintenance, repair and warranty expenses.



The ideal solution for leveraging digital twins should be:

- Developed by an industry leader in simulation
- Built on an agnostic technology platform that integrates with many third-party tools and systems
- Intuitive and easy for many employees to learn
- Cost-effective, especially when compared to custom coding and homegrown solutions
- Fast to implement, so that return on investment can be accelerated
- Capable of managing the entire life cycle, from twin creation to everyday management

While many companies have embarked on a digital twin initiative by writing their own software code and relying on a loosely connected web of commercially available simulation software, a solution designed specifically for this purpose would save time and money, while substantially lowering the risk involved in any new initiative. Instead of re-inventing the wheel, businesses of every type could benefit from a simulation software solution that's customized to this task — whether they are currently using simulation in their engineering function or not.

Build, Validate, Deploy: A Three-Step Process

Leveraging the concept of digital twins may seem daunting, but in fact this process involves three straightforward steps: build a digital model of the product system, verify the model, then implement it by connecting it to the physical product in the field.

For businesses relying on engineering simulation to design products, the first two steps have likely already been accomplished by the product development team, as engineers iterated on their designs to achieve an optimal performance level. For companies new to simulation, a comprehensive digital twin solution would walk them through this process, led by the engineering team.

Engineers supporting the digital twin initiative would first build the three-dimensional product model, then verify and optimize its performance by applying multiple physical forces — replicating the real world in which the product system will operate. They would re-use models and data from the original product development process, saving time and money, while also forging a closer relationship between the engineering and operations teams.

ANSYS Twin Builder: Delivering Value at Every Stage

By utilizing the specialized capabilities of ANSYS Twin Builder to support their digital twin initiative, businesses can realize strategic benefits at every step:

- *Build. The typical company can reduce the time involved in creating an accurate multiphysics-based product model by 2X via ANSYS Twin Builder, when compared to manual methods.*
- *Verify. As engineers utilize ANSYS Twin Builder to verify and optimize their product model, they can expect to achieve up to a 25 percent improvement in product performance.*
- *Deploy. All-new capabilities in ANSYS Twin Builder represent the first software solution designed to automate the connection of a digital twin to a working product. Once the connection is made, maintenance costs can be reduced by up to 20 percent over the product's lifetime.*

In deploying the digital twin, an ideal solution would be built on an agnostic technology platform that seamlessly integrates with smart connected sensors mounted on the product — as well as third-party technology systems and tools that the organization already owns. The solution thus provides unequalled insight into the product in the form of a potentially very large number of virtual sensors that can be attached to the simulation model. Through easy-to-follow workflows, this complex process would be simplified so that many different employees in the business could be closely involved in the digital twin initiative.

With data captured by the sensors, the model would then be continuously updated as time passes and conditions change. Insights gained from the digital twin would inform future product development efforts, while also enabling the operations function to optimize lifetime maintenance and repair for working product systems.

/ Finally, True Predictive Maintenance

Businesses have always tried to capitalize on the value of predictive maintenance, but the truth is that the technology just has not existed to fulfill this vision until recently. Lacking the ability to see inside their working product systems — and analyze the real physical effects of vibration, wear and other stresses — companies have tended to hedge their bets, over-maintaining their capital assets. While cost- and time-intensive, this practice at least reduced the likelihood of unplanned downtime and unhappy customers.

With the advent of digital twins, this problem has been solved. Now companies can actually visualize and study exactly what is happening inside their most critical product systems, via a three-dimensional virtual model that is subjected to the same environmental conditions as the working product. With this ability, businesses can leverage true predictive maintenance to address performance issues only when needed, without over- or under-investing their critical resources.

Clearly, the opportunity is here for more and more enterprises to experience the benefits of digital twins. With a new simulation solution on the horizon for building, verifying and deploying digital twins, the future looks bright indeed.

Proven Results: GE Digital Foundry Europe

What kinds of benefits can be realized via the deployment of a digital twin? GE Digital Foundry Europe recently used the capabilities of ANSYS Twin Builder, combined with the GE Predix analytics platform, to create and study a digital twin of the yaw system of an offshore wind turbine. By analyzing the effects of temperature on motor coils, GE operations managers were able to maximize motor life, identify performance issues such as overheating, and optimize the predictive maintenance schedule. This approach represented a significant time and cost savings when compared to continuous human oversight and frequent physical inspections.

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