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The Promise of the Digital Twin

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ISG WHITE PAPER

INTRODUCTION

A digital twin uses first principal and statistical models, design information and external drivers to generate near real-time product information.

A power plant manager receives a notification to change a certain tube in the boiler during the next planned outage. An online store automatically sends an email mentioning ski clothing on sale to a new customer who just purchased a pair of skis. A freight train driver notices on the dashboard screen that his speed is automatically changed to save fuel based on the railway profile.

What do these three stories have in common? They each show people operating on insights created by a virtual replica of their asset. This virtual replica is called a digital twin. It uses first principal and statistical models, design information and external drivers to generate near real-time product information such as remaining life time, distance to optimal operations and geographical position.

This ISG white paper explores the concept of the digital twin and its potential to offer data-driven insights that enhance products and services, drive predictive maintenance and field service management to provide greater value to the end customer.

The Opportunities for Digital Twin

The digital twin relies on three requirements that have been made possible through technology in recent years:

- **Profusion of operational data:** Globally, about 30 billion "things" are already connected. This number is expected to reach 50 billion by 2020. These connections generate and store data from mechanical assets, ranging from temperature, pressure and position, and from human activity trackers that gather data about exercise, food, weight and sleep.
- **Cloud computing and connectivity:** To derive insights from the data, complex analytics must be applied. This requires storage and computing power available in the cloud. Additionally, insights generated by a digital twin need to be consumable by people and organizations far from the physical asset, which the cloud also enables.
- **Controls:** Insights are typically interpreted and applied by a human operator. However, when an asset uses a digital twin to optimize operations, it can automatically change operating parameters using control systems and actuators. For the actuator to react fast enough, part of the computation needs to be done in the control system. Modern control systems can run algorithms that solve constrained optimization problems and change set-points every 40 milliseconds.

Leveraging these new technologies, a digital twin can provide significant enhancements in the following areas.

Service/Product Offering: from Standardization to Extreme Customization

Since the beginning of the first Industrial Revolution, standardization has been a key means to reducing operational costs and product price. As Henry Ford said in 1909, "Any customer can have a car painted any color he wants so long as it is black."

By combining behavioral, social, environmental and other data, companies can now create a digital twin of a product that allows them to gain insight into customer behavior and sentiment – and customize products accordingly. This information and the resulting customization tremendously increase the chance of sales.

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For example, Dell Inc. creates 12,000 different versions of emails (in English alone) that it sends to different customers at different times in different circumstances. The communications are created depending on the interest customers have displayed in different types of Dell products as proven by data from the products' digital twins.

Maintenance: From Schedule-based or Condition-based to Predictive

Historically, maintenance events have been planned based on equipment running hours or on the distance travelled by a vehicle as defined by equipment manufacturers or legislation. For example, a car would have to be inspected every two years or every 30,000 kilometers. Additionally, the driver would receive an alert that he or she needs to get the car inspected in the case of lack of oil or the motor reaching a certain temperature. This is what manufacturers call condition-based maintenance.

Predictive maintenance triggers inspection of equipment only when it is required. This means it drastically reduces the cost of maintenance, the number of spare parts needed on hand and the likelihood of unplanned outages. For example, when Airbus unveiled the flight operations and maintenance exchanger (FOMAX) program on the Airbus A320 family of aircraft, it claimed to capture 24,000 data points (or 100 percent of the available data) and transmit that data to the ground-based operations and maintenance teams. Thanks to powerful algorithms, the ground teams created a digital twin that enables the company to predict faults and order components or systems that need to be replaced before they cause in-service interruption.

Depending on the industry, reducing unplanned downtime has a significant monetary impact. For example, a leading auto manufacturer estimates that unplanned downtime in a factory can cost as much as $20,000 per minute. Some solution providers claim that using predictive maintenance can **reduce such downtime by as much as 48 percent**.

Operations: From Empirical or Design-based to Automatically Optimized

Operations of physical assets have usually been conducted by trained humans supported by static operating manuals. Highly skilled train drivers know how to adapt train speed to reduce gasoline consumption, for example, and power plant operators know the optimal sequence of events to minimize the time for load change. However, humans can master only so many numbers of controlling parameters, and the aging workforce makes it difficult to find highly skilled operators.

The digital twin creates the visibility and insight that operations leaders need to implement actions that will improve asset performance and lower operation cost. And it can be done at nearly real-time, or even automatically. For example, model predictive controls (MPCs) can use ambient temperature, solar radiation forecast occupancy, energy use patterns and electricity prices to dynamically adjust heating in a building. A power plant boiler optimization software can evaluate more than 40 parameters and tune combustion to lower sulfur oxide emissions or improve heat rate in near real time. The resulting improvement figures are impressive. Power plant operators using a digital twin to optimize operations observed a two percent increase of megawatt (MW) production with up to three percent improved fuel efficiency.

Field Service Management: from Static Instructions and Trainings to Real-time Contextual Information

Field service management is a crucial part of any after-sales business. This is usually the last mile to reach the end user and help him or her repair a device or upgrade a component. The technician needs to have the right tooling and skills to perform the tasks efficiently. Historically, field service inspectors received a standard theoretical and practical training and were sent to the customer with a static document called "Field Services Instructions" (FSIs).

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Thanks to digital twin capabilities, the end-user environment can be fully replicated three-dimensionally, enabling the use of virtual reality (VR) for realistic immersive experiences during trainings. By linking technical documentation to 3D models and image recognition, the static FSIs can be replaced by over-layered instructions accessible from mobile devices; this is augmented reality (AR).

For example, the nuclear energy industry uses VR to help technicians limit their exposure to radiation. A virtual environment that replicates the plant where technicians can practice safely is a crucial part of the training curriculum. Similarly, operators in the water treatment industry can use special glasses with AR capability to monitor facilities in real time. The glasses display technical and operational data laid over the physical asset.

Additionally, AR and VR are used extensively in manufacturing in the following ways:

- To better perceive complex assembling operations
- To demonstrate inspection orders and results that will simplify the maintenance of manufacturing equipment
- To provide remote expert support during inspection.

Challenges to Implementation

Successfully implementing a digital twin requires addressing five key technical, provider governance, organizational and cultural challenges:

1. **Systems integration**. Operating a digital twin requires several layers to be tightly integrated. For example, AR may need to be integrated into at least five technical layers to provide the end user with a high-performing, insightful and reliable experience. These five layers include the end-user device, connectivity, operational data application, technical data application and the cloud / platform layer.

2. **Service Provider Management**. Enterprises need to effectively manage the multiple solution and service providers responsible for the various layers of technology making up the digital twin solution. This is the only way to ensure a consistent and structured way for an end-to-end service to properly function.

3. **Cloud adoption**. Organizations need to be prepared to answer the following questions regarding cloud computing:
   - Which deployment option to adopt: private / virtual private, public or hybrid?
   - Which cloud service delivery model to use: Software as a Service (SaaS), Platform as a Service (PaaS) or Infrastructure as a Service (IaaS)?
   - How to evaluate and select the right supplier?
   - What is the total cost of ownership (TCO)?
4. **Advanced analytics**. The adoption of advanced analytics is paramount to the success of a digital twin program. The questions are less about technology than transformation:
   - How to recruit people with new skills such as data scientists?
   - How to bring together operation technology (OT) and information technology (IT)?
   - How to combine laboratory development for innovation requests and the factory mode of working for industrialization?
5. **Enterprise Agility / DevOps**. With the adoption of the digital twin, traditional manufacturers are competing with pure software providers that have agility in their DNA (with the ability to deliver as many as several thousand productive software changes in a day). Bridging traditional new product introduction (NPI) methodologies with DevOps continuous delivery techniques is a matter of survival. To do this, a team must:
   - Develop a framework to increase enterprise agility
   - Design a target operating model (TOM) that enables agility
   - Understand the impact on external sourcing and adapt processes accordingly
   - Create a roadmap to de-risk the deployment of the TOM while preparing and supporting the human resources during the transformation

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Conclusion

Building digital twin capabilities is an opportunity to increase internal productivity, improve commercialization channels and provide greater value to the end customer. Many successful corporations across industries are already embracing it as a competitive differentiator. The technology needed to create the digital twin has matured and is available; now it is up to enterprises to manage the necessary organizational and cultural changes to facilitate this important component of digital transformation.

ABOUT THE AUTHOR

THE PROMISE OF THE DIGITAL TWIN

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Sébastien has 20 years of IT and digital experience with various leadership positions. During his career, he worked for software providers and global industrial companies in France and Switzerland, for which he led several digital transformation programs. Sébastien holds a masters degree in applied mathematics from both the French National Institute of Applied Sciences and Toulouse University and he received further business and leadership training at GE's Crotonville leadership institute. At ISG, Sébastien leads customer engagements in DACH and his a member the Engineering Services practice. In addition, he is engaged in product lifecycle management (PLM), Internet of Things (IoT), Industry 4.0 and digitalization topics. He has wide ranging industry experience in power generation, manufacturing and supply chain where he led multiple large digital transformation programs. His work for ISG clients has led to significant improvements on key metrics such as productivity, product introduction lead time and cost of ownership.

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