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Data Quality for Effective Digital Twins in Oil and Gas

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Keywords

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Summary

To be responsive in these dynamic and somewhat chaotic times, oil and gas companies need systems that provide real-time visibility and flexibility. A digital twin, by definition, replicates attributes of a physical asset. Digital twins enable oil and gas companies to respond with fact-based decision support for the industry's challenges, which can be particularly helpful considering the added adverse impact of the COVID-19 pandemic.

Effective digital twins need high-quality data in real time for common applications like predictive maintenance and optimizing the operational performance of equipment. An intelligent asset inspection program becomes an imperative for success.

A digital twin needs data which is used for analytics, prediction, and automation. For a useful twin, the data must be of high quality, verified, and referenced. To operate in real time, the digital twin requires that existing data and models are current with the latest status and changes of the assets.

Predictive maintenance using data from a particular piece of equipment has been a key driver for adopting digital twins. Many organizations have expanded the scope to include improved operational performance of the equipment to augment the control systems. As the scope of a digital twin expands, it requires additional data from multiple sources. Managing the digital twin models and data quality becomes an imperative for success.

Once a digital twin of a physical asset has been deployed, it is vital to keep it current to be effective for real-time decision support. The twins need to be updated and re-verified frequently enough to qualify as real-time. An intelligent asset inspection program provides a foundation for successful digital twins and overall digital transformation in the oil and gas industry.

Chaos Pervades the Oil and Gas Industry

Imbalances between supply and demand occur periodically in the oil and gas industry as geopolitical events, adoption of green energy sources, and other market forces cause either price decline (as with the current pandemic) or price spikes as have occurred in the past. To limit the spread of the virus, countries implemented social distancing and shut down businesses. This led to vastly reduced travel by car, truck, or plane. Currently, the combination of reduced global demand for oil and over-production has dramatically reduced the price of oil. COVID-19 accelerated issues in the oil and gas industry.

Reduced demand due to the COVID-19 pandemic combined with over-supply by the producers are driving chaos across the oil and gas industry.

The combination of the recent excess production of oil combined with the pandemic became a "perfect storm" showing the need for digital transformation to manage risk and achieve sustainability. Real-time visibility, responsiveness and flexibility have become critical to business survival during these extremely dynamic conditions.

Digital Twins Provide Decision Support to Respond to Events

Today, roughly 63 percent of the oil field assets are past the halfway point of their expected lifetimes. This adds stress on knowing the precise status of your equipment. Digital twins enable oil and gas companies to respond with fact-based decision support for the industry's challenges including production imbalances, rapid changes in global economic conditions like with the COVID-19 pandemic, and equipment reliability issues. To be responsive in these dynamic and somewhat chaotic times, oil and gas companies need systems with real-time visibility and flexibility provided with digital twins.

Impediments to Digital Transformation

Several issues impede successful digital transformations in the oil and gas industry and thus realization of the associated benefits. Many operators and independent exploration and production (E&P) firms have confronted challenges developing effective digital strategies. A broad scope and "big data" approach require deep domain skills in multiple applications and complex systems integration. This approach evolves into a comprehensive custom project with extensive data management, data quality, and integration issues. By the time a custom digital transformation is implemented, internal system changes (applications and business processes) and external market dynamics require further changes – with delayed completion.

Data Management Issues

To deliver the promise of digital transformation with digital twins, automation and other digital tools, the data used for analytics, prediction and automation needs to be of high quality, verified, and referenced. Unfortunately, many companies are finding that their existing and historical data is hard to find, requiring users to spend excessive time locating the right information needed for their day-to-day work. In addition, the data they can access suffers from quality issues that degrade the usefulness of analytics. Companies are tackling the problem by appointing senior-level (chief data officer, data scientists, etc.) with the responsibility to create a usable data ecosystem.

Good data quality and management provide a foundation for digital twins that can be trusted and used for effective consensus building and decision support.

Data Management for Digital Twins

Critical components of a digital twin – often glossed over – involve comprehensive data management in four areas:

- **Data ingestion** of historical data from multiple data storage locations and data bases.
- **Data acquisition** through a variety of sources including an intelligent asset inspection program
- **Data storage** and management to preserve the time-stamped data
- **Robust analytics** to extract information for decision support

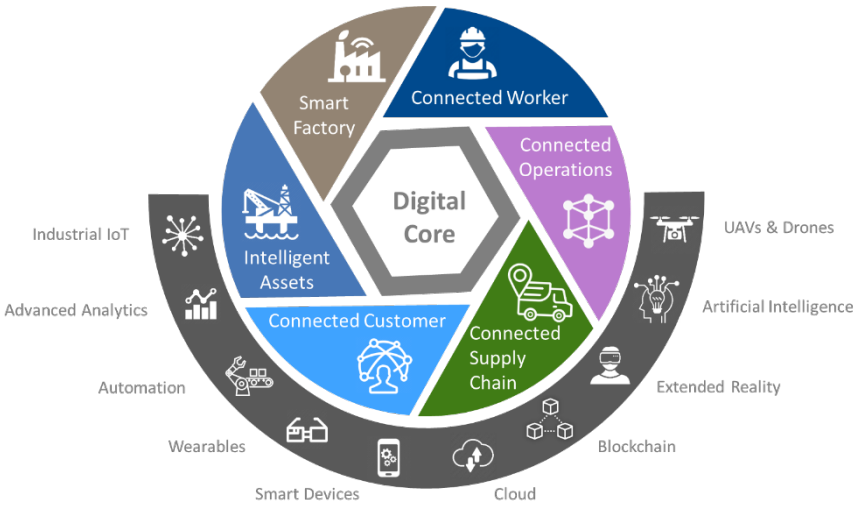
Analytics plays two roles here. The first involves the algorithms or models that provide insights to the ongoing operations and related business processes. The second, and often less recognized role, involves data formats and integration from the various components of the enterprise. Some obvious issues include unit of measurement (metric or English) and synchronizing the time stamps.

Real-time Data Drives Digital Twin

Digital twins, by definition, replicate attributes of a physical asset. Sometimes this involves simulated data for training and what-if analysis. Usually, real-time data is incorporated to monitor the condition of an asset for predictive maintenance, optimizing operational performance, or managing perturbations. These digital models put additional pressure on the need for real-time data for analytics and associated insights for real-time decision support.

Existing Sources for Real-time Data

A real-time digital twin requires existing data and models to be updated continuously with the changes in the assets and the associated decision support systems. The volume of data generated in the oil and gas industry is measured in petabytes and growing. The data needs to be verified, classified, organized, and then presented to the right stakeholders at the right time in the right format to feed the digital twins.



Data from a Variety of Sources Enables Multiple Categories of Digital Twins
Source: TCS

New Types of Real-time Data

How recent qualifies as real-time? This depends on the application and type of decisions being supported. In general, adoption of digital twins has quickened the pace and generated a demand for more timely data. Manual data collection is too slow and error prone. Studies made in the 1980s to explain the need for barcode readers showed that paper forms and manual data entry generated transactions with a 10 percent error rate. This low data quality renders a digital twin useless for decision support. Automated data acquisition is needed to keep the data current and of high quality. This includes inspections that are performed through various acquisition channels such as drones, fixed wing aircraft, satellites, video capture, Internet of Things (IoT) sensors, and SCADA systems. This is in addition to the usual oilfield data like seismic, well logs, reservoir performance, and more. To provide useful decision support, integration with operational technology (OT) is needed to provide quantifiable and actionable results.

TCS Business 4.0 Model

Tata Consultancy Services (TCS) recently briefed ARC on its capabilities related to Business 4.0 and digital twins. This includes capabilities to provide digital twins with the needed real-time data, data quality, and systems integration.

The TCS Business 4.0 model – when applied to the oil and gas industry - includes these themes:

- **Purpose driven**: Focus on the basics. What is the core purpose of company and the project? What is the root of what is being accomplished?

- **Resilient**: Be capable to respond to both the expected and unexpected. What comes next for known industry trends like peak demand? How can the business become more robust to help mitigate unknown business dynamics like the recent pandemic? The ability to survive a hit involves both primary and secondary effects.

- **Adaptable**: Change happens and often requires modification of existing or creating new systems and business processes. Drive agile methods as deeply into your organization as possible. Secure borderless workplaces to deliver regardless of location. The current situation has a future that cannot be predicted. Avoid rigidity – a strength can transform into a weakness - and strive for flexibility.

According to the company, the TCS Business 4.0 enterprise builds on a strong ecosystem of software and platforms that enables information integration with actionable output to the right entity in the right context at the right time for more effective and responsive decision making. Data democratization is a foundation for a TCS Business 4.0 approach with integration, distribution, and availability across the enterprise. For example, digital twins of assets allow simulations for potential changes and upgrades and operational monitoring of existing assets.

Scope of Digital Twins

Predictive maintenance (PdM) has been a key driver for the adoption of digital twins. Typically, a performance twin starts with predictive maintenance because of the obvious and significant economic benefit and very short payback period for preventing unplanned downtime and the associated lost

revenue. Here, a digital twin monitors the condition of an individual machine. Many have expanded in scope to include improved operational performance of the equipment. The process control system continues to control the process, which involves multiple pieces of equipment. The performance twin for a machine augments the control system by focusing on the proper functioning of a piece of equipment.

Types of Digital Twins

For asset management, two general types of digital twins have emerged – one for projects during plant design and build, and another for performance during operate and maintain by the asset owner/operators.

*A **project digital twin** simulates the construction sequence using a 3D or 4D model. It improves the schedule and helps avoid errors in the design and build of equipment, plant, or infrastructure.*

*A **performance digital twin** uses real-time data and analytics to optimize the effectiveness of the resources deployed for operations and maintenance.*

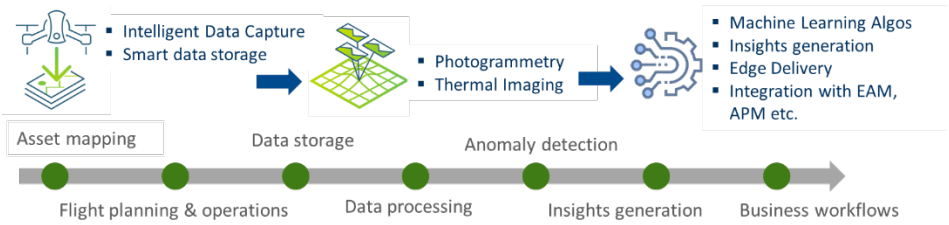
Data Sources and Analytics Expand

As the scope of a digital twin expands, it requires more data, which often comes from multiple sources. The analytic processes start to incorporate more data with increased diversity from various parts of the business. The effect becomes an integration of these parts into a new whole – the digital twin.

Asset Inspection Program

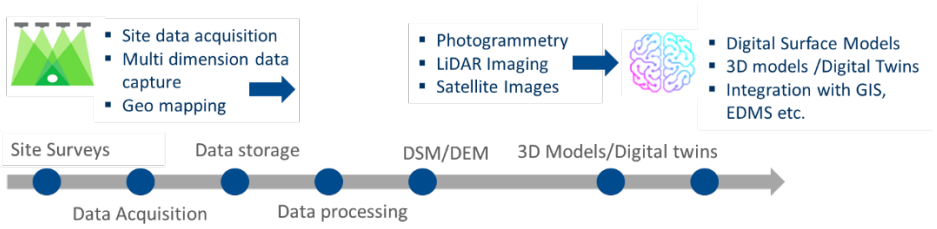
An intelligent asset inspection program becomes an imperative for success. The operational status of a modern asset uses input from multiple sources of data including aerial surveillance data, sub-surface surveillance data, remote sensing, SCADA and other inputs like manual or visual inspections. This input data comes from different sources/companies. In addition, integration between the OT and back office IT is usually required. These models determine how physical assets perform both in real time and under various conditions for what-if simulations.

Once a "digital twin" of a physical asset has been created, it is vital to keep it current with changes to how the asset operates. To be useful for both real-time monitoring and simulation, the status of the asset needs to be accurate and up to date. The business process for engineering changes needs to include the digital twin. Inspections to keep the model current provide additional information regarding operational changes.



Workflow for an Intelligent Asset Inspection Program
Source: TCS

An asset inspection program provides data and a business process to maintain digital twins. The program also supports planned upgrades and maintenance schedules. A framework for acquisition, processing, updating, maintaining, and reporting the complex set of data enables effective integration and use of the acquired data. When combined with intelligent asset inspection, digital twins help optimize performance and extend asset life.



End-to-end Service Maps the Whole Plant, Including Managing the Lifecycle of the 3D Models for Critical Assets to Enable Digital Twins and Context-aware Solutions
Source: TCS

Conclusion

A digital twin of a tank farm with the crude oil inventory and available storage is an example of a useful tool for responding to the current oil glut and low prices exacerbated by the COVID-19 pandemic. This type of digital twin covers a broader scope beyond a single piece of equipment. The deployment is best done as part of an intelligent asset inspection system to manage data and keep the model current.

For a digital enterprise, the digital twin and associated data have a significant value delivered through business processes and decision support. To remain valuable to the enterprise, digital twins need to be updated and re-verified frequently enough to qualify as real-time for effective decision support.

The path to become a data-driven, digital- or a Business 4.0-based company is built on the accessibility of verified, good quality, and current data. An

automated intelligent asset inspection program is a foundational aspect for successful digital transformation in the oil and gas industry.

TCS Business 4.0 is a trademark of Tata Consultancy Services.

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