KONGSBERG

Advanced Digital Twins with AI and Simulation in Heavy-Asset Industries

Executive summary

Advanced digital twin technology, enhanced with integrated simulation and AI capabilities, is transforming industrial operations. Moving beyond static digital replicas, advanced digital twins create dynamic, interactive environments where work is virtualised, collaboration is seamless, and decision-making is informed by data.

At the heart of this transformation is the Industrial Work Surface (IWS)—a solution that goes beyond traditional digital twins to virtualise tasks, integrate AI-driven automation, and enable real-time simulation of complex systems. By breaking down silos and optimising workflows, IWS empowers organisations to improve efficiencies, enhance safety, and drive sustainable operations.

This whitepaper explores how advanced digital twin solutions are connecting human expertise with innovative technology, offering a scalable and adaptable foundation for operational resilience. As industries evolve to meet the challenges of today, the integration of AI, simulation, and digital work environments will be essential for developing smarter, safer, and more agile industrial ecosystems.

Key capabilities of the IWS

- IWS allows organisations to overcome physical limitations, facilitating remote collaboration, digital process implementation, and AI-enhanced task optimisation.
- AI automation enhances efficiency by managing repetitive tasks, reducing human workload, and improving accuracy and safety.
- Organisations can test various operational strategies in a secure digital environment, optimising efficiency through real-time simulations and predictive analytics with look-ahead and what-if models before executing them in the real world.
- Enhanced safety and regulatory compliance: By deploying robust data-driven risk assessment, IWS improves operational safety, decreases incidents, and ensures compliance with regulations.

What is the Industrial Work Surface?

The Industrial Work Surface (IWS) is an advanced digital twin environment that enables industries to virtualise work, integrate AI-driven automation, and optimise real-world operations. Unlike traditional digital twins, which primarily model physical assets, IWS provides an orchestration layer that connects data, processes, and human decision-making.

Agentic AI in the Industrial Work Surface

The use of Agentic AI in heavy-asset industries is enhancing operational efficiency by merging human expertise with intelligent automation. These AI-driven agents execute tasks and collaborate with humans, boosting productivity while reducing complexity.

The heart of the IWS is the Asset Copilot, an intuitive AI-powered interface that links users to the digital twin environment. Utilising natural language processing and multimodal interactions, the Asset Copilot revolutionises how industrial teams interact with asset data, offering enhanced operational intelligence.

The Asset Copilot acts as an intelligent orchestrator that enables smooth communication between users and AI agents tailored for specific tasks. Whether it's processing real-time operational data, analysing complex datasets, optimising workflows, or conducting contextual simulations, the Asset Copilot serves as a reliable digital partner. It enhances situational awareness and accelerates decision-making.

Users can interact with the system naturally through text, voice, images, video, or interactive workspaces. This eliminates technical barriers, enabling professionals to concentrate on high-value strategic tasks. Such seamless interaction creates a more intuitive, responsive, and proactive industrial work environment, where AI enhances human expertise.

Use cases

Virtual shift handovers

Agentic AI can autonomously synthesise operational data from the Industrial Work Surface (IWS), such as plant or asset performance, maintenance activities, and anomalies. It presents clear and actionable briefings to incoming teams.

The AI functions as a "virtual supervisor," capturing key operational events, risks, and incomplete tasks during a shift. It personalises the handover according to the team member's role—be it operator, engineer, or HSE manager—ensuring that the next team receives tailored insights.

Additionally, the AI allows you to review trends and outliers and predicts coming potential events/anomalies. For example, it may alert you that "compressor X is trending toward high vibration."

Event autonomous investigation

When an unplanned event occurs, such as a process upset or equipment failure, agents can autonomously analyse historical and real-time data from the digital twin to reconstruct a timeline of contributing factors.

The agent functions like a digital forensic investigator, retrieving sensor logs, past maintenance records, operator actions, and environmental conditions. It provides hypotheses for root causes, suggests potential mitigations, and can even simulate "what-if" scenarios, such as how the situation might have changed if setpoints had been adjusted earlier.

Equipment health check

AI agents autonomously monitor equipment such as pumps, compressors, and turbines through the Industrial Work Surface. They continuously analyse key performance indicators (KPIs), sensor data, and degradation models.

These agents provide real-time health diagnostics, such as "Pump #104 is operating at 92% efficiency with a risk of cavitation detected." They also recommend actions, which may include rerouting flow or planning maintenance.

Additionally, the agent can schedule maintenance tickets or autonomously alert the maintenance crew.

Safe work practices

Agentic AI enhances safety by verifying job plans against safety protocols in real-time.

For instance, when workers plan maintenance on live equipment, the AI checks for compliance with lockout/tagout procedures, ensures that the correct personal protective equipment (PPE) is used and verifies the necessary permits to work (PTW). Additionally, the AI can alert users to any non-compliance issues, such as "Scaffold erected without required anchor points, according to digital twin inspection."

Conversational querying: Simple and multi-faceted questions

AI agents embedded in the digital twin allow users to pose both simple and complex operational questions in natural language and receive immediate, data-driven responses. This eliminates the need to sift through multiple SCADA screens, spreadsheets, or engineering databases.

Multi-faceted query:
"Show me all the pumps that have been operating against X parameters in the last 7 days."

The agent correlates operational data (sensor logs, PI historians) with asset metadata (pump types, specs), filters by the requested parameters (e.g., flow, vibration, temperature), and returns actionable insights, like:

"5 pumps operating above recommended vibration limits; 2 showing reduced flow rates. Would you like me to recommend next steps?"

Consequence simulation:
"Show me the consequence of these parameter changes."

The AI agent interacts with the simulation engines inside the digital twin and shows predicted effects, e.g., "Raising discharge pressure by 10% will increase pump seal wear rate and energy consumption by 8%, with risk of cavitation."

Why it matters:

- Reduces cognitive load on engineers and operators.
- Saves time (no need to browse through siloed systems).
- Helps less-experienced workers quickly make informed decisions.
- Brings simulation + AI + real-time data into a single, conversational interface.

Aligning with sustainability to drive profitability

As global attention on decarbonisation grows, businesses in heavy-asset industries are under increasing pressure to reduce emissions, improve resource efficiency, and adopt sustainable operational practices.

Industry 5.0 supports these objectives by utilising AI, digital twins, and simulators to facilitate more sustainable decision-making.

How the Industrial Work Surface drives sustainability

Energy efficiency and resource optimisation
The Industrial Work Surface is a powerful tool for Shell's Energy Nominators. It lets them quickly calculate a plant's energy consumption with just a few clicks. The best part is that it can simulate energy consumption for any operational scenario in minutes. This increases efficiency and accuracy, freeing operators from manual processes and streamlining the workflow.

Through the Industrial Work Surface technology, the Shell team achieves:

- Improved nominations accuracy
- Increased efficiency, and a simplified process
- Close to fully automated workflows
- Elimination of up to 85% of manual work
- Less over- and under-estimation of demand from the grid

Emission reduction and decarbonisation
Organisations within numerous industries view Emissions Management as a critical concern that requires understanding and action. The Industrial Work Surface enables these organisations to track assets, processes, and facilities to gain comprehensive oversight of their emissions. This holistic view—driven by seamless data integration and AI-driven insights—empowers businesses to make better-informed decisions for a greener future.

Competitor landscape

The tech-driven energy transition: Moving beyond the traditional digital twin

Oscar Abbink and Judson Jacobs, S&P Global

As the oil and gas industry progresses toward a low-carbon future, there is increasing pressure to manage its legacy and new-build asset base in the most efficient and effective manner. Emerging digital platforms (including "digital twins") that integrate data and asset models and workflows are well positioned to support these objectives—if they can overcome organisational challenges to achieve widespread and sustained uptake.

S&P Global defines a digital twin as a virtual, holistic, dynamic, and detailed representation of a physical asset (e.g., an offshore platform) or a process (e.g., oil and gas separation) that is continuously updated to represent the actual state. Digital twins differ from other digital integration platform concepts and earlier digital model representations due to their higher levels of data integration, up-to-date and detailed asset models, and larger amounts of ingested data. New digital technology enables all of these capabilities.

The sophistication of the applications, combined with broad data integration capabilities, are key elements that help define digital twin implementations.

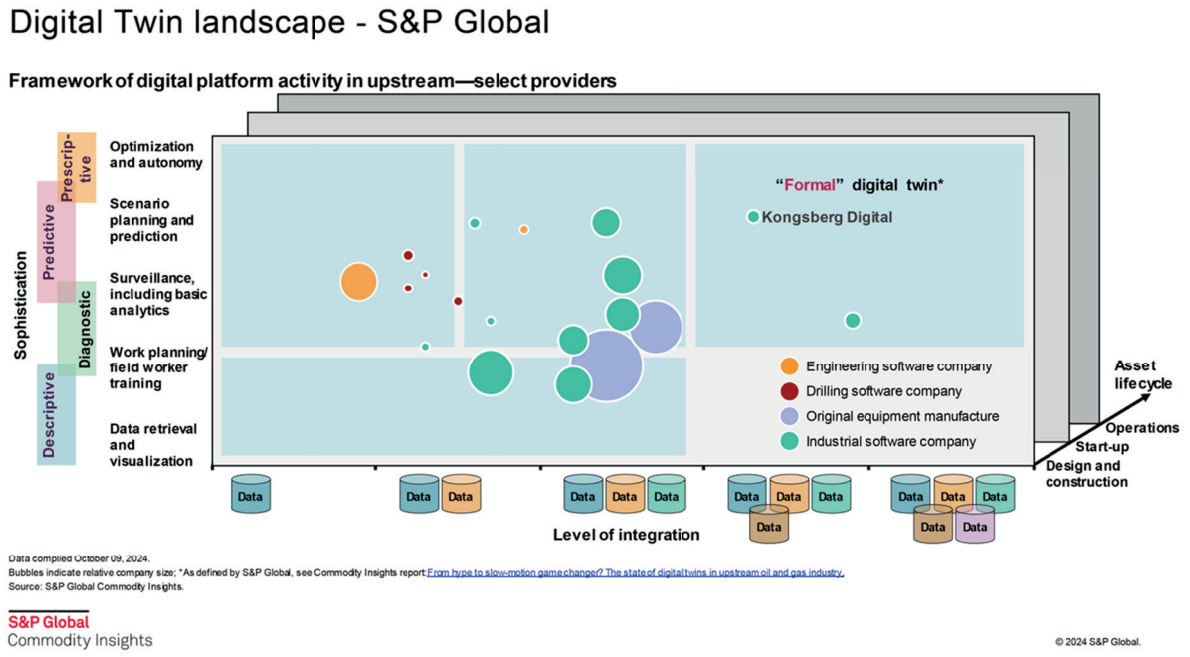
Case studies featuring digital twin deployments across the industry reveal a range of opportunities. For example, digital twins have been shown to help optimise workforce utilisation in the field and make maintenance practices more effective. They have also helped accelerate remote operations while making progress toward semi-autonomous operations over the longer term.

S&P Global analysis indicates that effectively executing these opportunities can result in efficiency improvements related to well and facility performance of 3% to 12% (with outliers exceeding 30%) and overall asset GHG emissions reductions of 10% to 30%.

As the energy landscape evolves, the interconnection of energy value chains becomes more apparent. By incorporating renewable energy sources, exploring liquefied natural gas (LNG), carbon capture, utilisation, and storage (CCUS), and utilising the potential of hydrogen, new opportunities and difficulties arise.

To effectively handle and improve these interconnected energy systems, organisations must use advanced technology and best practices. Digitalisation, with its ability to bring diverse elements together, plays a crucial role in managing and optimising interconnected energy systems. The utilisation of advanced analytics, artificial intelligence (AI), and other emerging technologies acts as the glue that enables effective integration across various energy value chains.

These are the first steps toward achieving intelligent operations, which can lead to next-generation performance.



Conclusion and call to action

Industries are currently at a critical turning point. To remain competitive in an increasingly complex world, organisations must adopt advanced digital twin solutions that integrate AI, simulation, and real-time analytics such as the Industrial Work Surface (IWS). These technologies are becoming increasingly mature with seamless integration of on-premise and cloud-based assets, ensuring scalability, security and leveraging complex IT/OT data with LLM and AI agents.

The IWS represents a significant advancement in digital twin technology, offering an intelligent environment for achieving operational excellence in asset-intensive industries like energy, oil & gas, continuous process manufacturing, and many others. By bridging the gap between human expertise and AI-driven automation, IWS enables industries to adapt, optimise, and reach their sustainability goals.

Next steps for organisations

- Assess your readiness for adopting IWS and advanced digital twin solutions.
- Identify key areas for implementation based on operational challenges and goals.
- Engage with industry experts and technology providers to explore tailored solutions.
- Pilot and scale digital initiatives with a focus on long-term ROI.

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