How Digital Technology Can Help the Oil and Gas Industry Achieve a Carbon Neutral Future

By Richard Irwin, solution marketing manager, Bentley Systems

Hydrocarbon producers face mounting pressure to become climate resilient, reduce carbon emissions, and focus on revenue streams from renewables. To alleviate this pressure, power generation organizations need to embrace renewable alternatives, and while some companies have become early adopters, many operators are looking at substantial changes to their business models to accommodate the transition.

There are numerous trends affecting hydrocarbon producers who are still carrying out upstream operations while transitioning into renewable alternatives, and their concerns focus on the type of digital technology solutions that can help them achieve their goals. Specifically, they want to ensure that the skills and knowledge gap is kept to a minimum, overcome challenges managing and optimizing current operations while reducing the environmental impact, and solve the data problem of how to manage and extract value from the vast amount of generated data and to prevent it being inaccessible to everyone.

The Current Situation

One of the main trends concerning the increase in demand for oil and gas is that despite the push toward renewables, demand for reliable and, more importantly, affordable energy will not go away until renewable sources outsource traditional oil and gas, as reliance on it could extend to the next 30 to 50 years. The war in Ukraine has made our reliance on energy sources even more apparent, fueling the need for cheaper alternatives. While capital investments in low- and zero-carbon energy projects have grown quickly, they are still lower than the collective investments in the fossil fuel-based infrastructure. That is because hydrocarbon producers are falling into three different camps:

Carry on as normal. These companies keep producing while demand and prices are still high. It means that they are still at the mercy of downturns and recessions in the coming years, but strong returns will see them through the next 30 years and more. They are smart to capitalize now while the window remains open.

Wholesale swing. The wholesale swing strategy replaces oil and gas production entirely and switches solely to renewable energy resources for a greener approach. The approach appeals to operators who are flexible and smart enough to embrace alternative energy sources before their main and often bigger rivals.

The best of both. A hybrid strategy implies carrying on as normal but cutting back on core activities to reduce carbon emissions and investigating and investing in renewable alternatives, such as carbon capture, energy storage, electrification, hydrogen projects, solar, and offshore

wind. These renewables will eventually replace core oil and gas activities overtime, as it is widely anticipated that growing renewable capacity will displace fossil fuels in the world's energy mix. The transition will be achieved by exploring and acquiring strategic opportunities that are already close to them, such as assets in the North Sea, and by taking digital advancements further in design and operation, such as digital twins and analytics.

Transferable Technology

One way to accelerate the process of transitioning to renewables is through reusing technology and skills from one industry to another. It could be personnel, technology, solutions, or partners applying the same principles of one project to another. One example is the offshore Block Island Wind Farm, one of the first commercial wind farms in the U.S., which began commercial operation in December 2016.

Offshore structures face many more challenges, compared to onshore ones, as they face wind, waves, and currents. Structurally, the turbine foundations require more engineering analysis. For the Block Island project, the structural design was carried out by Keystone Engineering, which had built oil and gas platforms to withstand the force of Hurricane Katrina without being damaged.

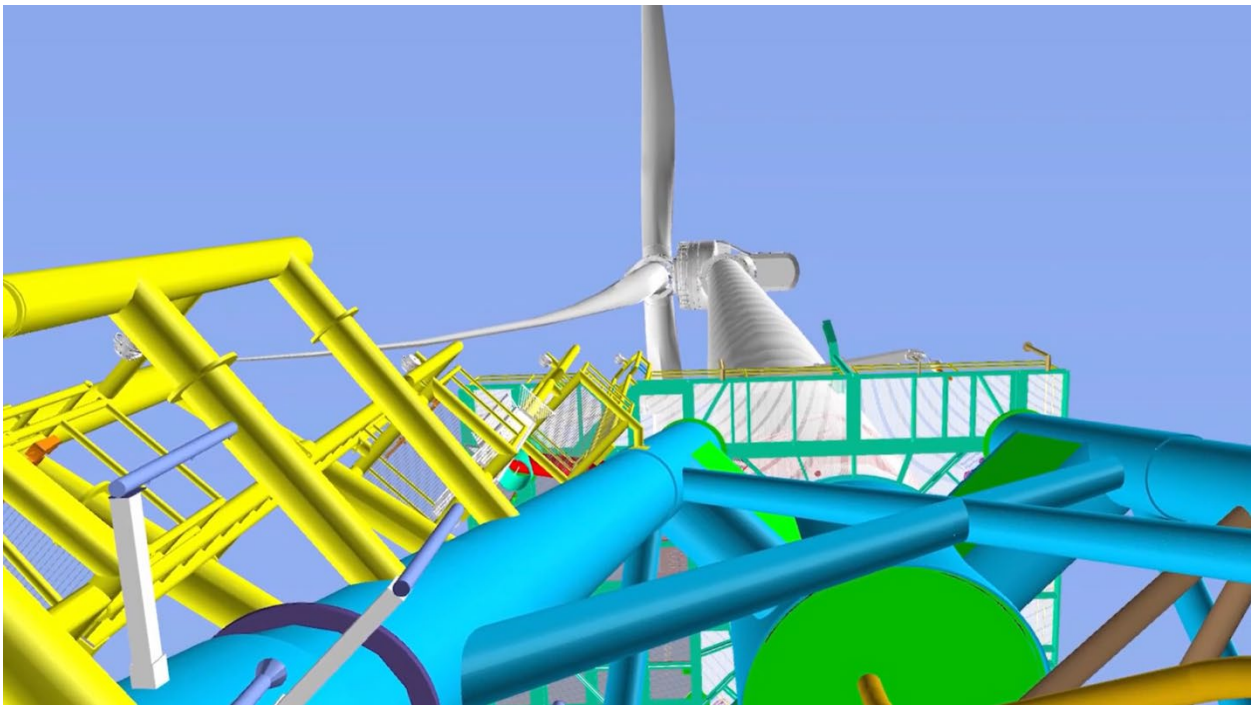

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Image Caption: Keystone Engineering leveraged their knowledge in offshore platforms into offshore wind platforms. *Image courtesy of Keystone Engineering.*

This knowledge and experience they had in the fabrication, construction, and installation of offshore structures gave the firm a key advantage in the design of the Block Island Wind Farm foundation structure by providing a focus on constructability, fabrication efficiency, and reduced installation time. The additional benefits of partnering with Bentley was twofold—both companies had a long history of working together in the offshore oil and gas industry, as well as expertise in structural analysis for wind turbines. Without this, it would have taken the project much longer to complete without the necessary guarantees of success and resilience.

The companies that will gradually make the transition and those that will continue oil and gas production for the next several decades will face even more intense scrutiny from an environmental standpoint and must show that they are making giant strides toward net-zero emissions. There are still many ways of achieving that goal.

Going Digital

One of the main challenges the industry encounters that prevents oil and gas producers from achieving a fully digital solution is the ability to pull together information from many different data silos. It could be engineering data stored in engineering modeling systems, control systems, maintenance and operational data, data historians, and other sources. Siloed data causes bottlenecks as maintenance and operations fail to find the information that they need to fix problems quickly. It takes too long to make accurate decisions when teams spend most of their time trying to find the right information and confirm if it is up to date and reliable. They lack the visibility and access to the right information.

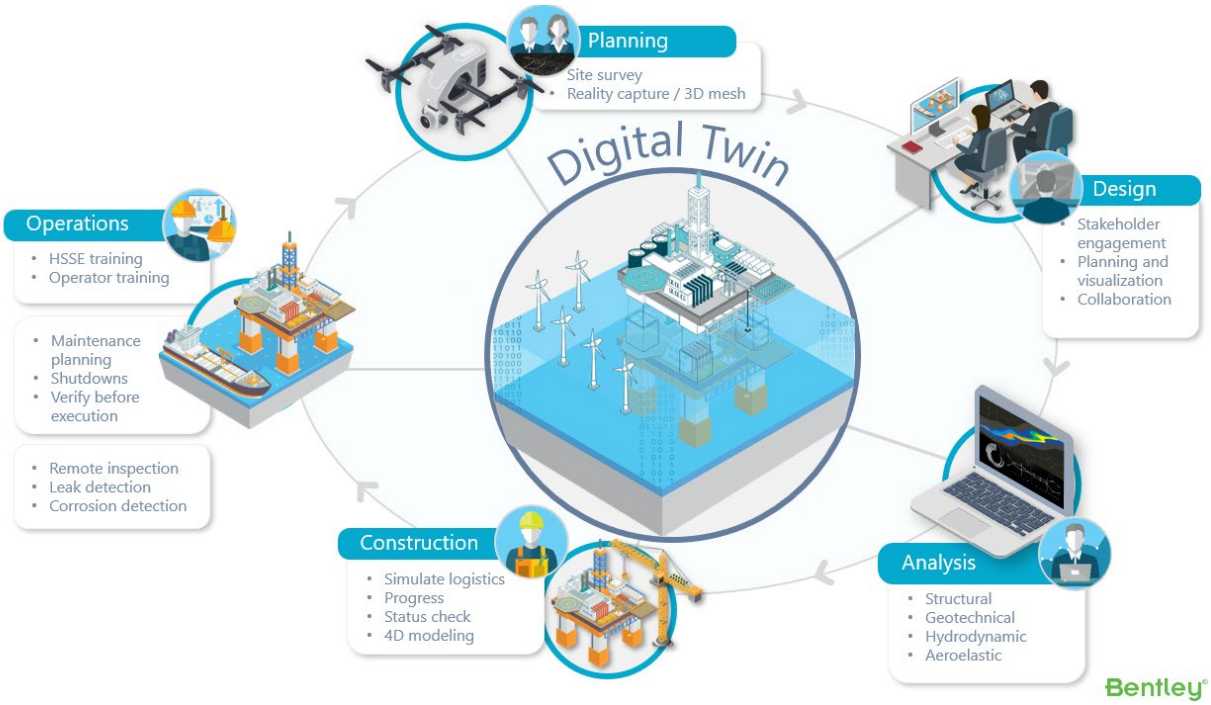

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Image Caption: Going digital means always having access to reliable and up-to-date information from multiple sources across the lifecycle. *Image courtesy of Bentley Systems.*

In addition to pulling together siloed data, there is the question of how the oil and gas industry can calculate the return on investment (ROI) from digital and business transformation solutions, where data attributes and data integration are primary and fundamental deliverables. There is no single answer, as ROI can be calculated in many ways. Recent improvements delivered by a more collaborative supply chain, working with common data and information, has further improved execution performance. Critically, these improvements have facilitated better decision-making, resulting in fundamentally better solutions.

Better solutions are essential if the industry is to meet the immense challenge of "net-zero;" however, these improvements are harder to quantify. What we are seeing is companies demonstrating efficiency improvements through time to find accurate information, trust that information, and avoid offshore visits. Again, these improvements are easy to quantify, but given the focus on safety, they are critical for reducing workforces and developing the flexibility to deploy the best skill sets. Digitization is simply essential to ongoing operations, and imperative for companies to remain competitive and safe.

Incorporating analytics and machine learning techniques to reliability solutions—such as the AssetWise services that Bentley provides—enables the connectivity, interoperability, visibility, and insights that were previously hidden within these data silos. These solutions provide a more holistic view of performance and reliability across operations around the clock, as constant monitoring and reporting can show early indicators of future events or problems. These reliability and analytical solutions can provide a variety of use case to help reduce emissions and achieve the net zero goal.

How to Start a Journey to Net Zero

The rising environmental, social, and governance (ESG) imperative will, to a large extent, define overall producer strategies, as ESG excellence could be viewed as a competitive advantage. Oil and gas companies are increasingly looking to digital solutions like digital twins, data platforms, and other technologies to move beyond monitoring to emission controls, proving that they are taking a step in the right direction. One of the first things that operators can do now, if they haven't already started, to reduce their carbon footprint is to optimize their operations. While optimizing operations is nothing new, the effect on the environment is evident. If everything is running smoothly and as intended, then energy expenditure is minimized.

The first step is to prevent failures that cause equipment to run outside of optimal efficiency, or even cause shutdowns. For instance, pumps not running at their best efficiency not only use more energy, but are also less reliable, both of which lead to a higher level of emissions. Having a robust asset performance management strategy in place is a must. An example of how to establish an asset performance management strategy comes from OQ Upstream, an integrated

energy company that operates and manages dozens of plants, thousands of assets, and over 4,500 kilometers of pipeline across Oman. In their 2022 *Going Digital Awards in Infrastructure* submission, which is a finalist in the Process and Power Generation category, OQ digitized their asset performance management activities. As a result, they could recognize the impact on the reliability growth and the reduction of failures and unplanned downtime, resulting in a growth of asset reliability while significantly reducing functional failures, unplanned work orders, and maintenance costs.

Other ways of optimizing operations are monitoring and managing your assets more effectively. In a recent McKinsey report, they state that, on average, a 10% increase in production efficiency delivers a 4% reduction in emission intensity. The process industry generates a tremendous amount of data, so being able to access, monitor, analyze, and report on this data is crucial for achieving optimal asset performance and emission reporting and control. By having this data at your fingertips, you can ensure that you are operating within governmental and industry guidelines in terms of production, chemical use, flaring, minimized oil in water, and many other factors.

An example of optimizing existing assets more effectively is Cairn Vedanta in India. Using AssetWise 4D Analytics from Bentley, they captured all well integrity and flow assurance data from over 800 onshore and offshore wells. They aggregated data from multiple systems into one solution, and by using analytics, they created a near real-time picture of asset health and performance. They could then identify which wells were performing against cost after stimulation. Having the data helped them to decide whether they should continue, retire, or make changes to the well, resulting in improvements to both emissions reduction and costs. It enabled them to move to a proactive approach toward integrity management to eliminate possible failures or rectify them as soon as possible, creating a more sustainable operation.

The Role of the Digital Twin

These optimization techniques, which are often offered as stand-alone solutions, can now be offered within digital twins. A digital twin is a virtual representation of real-world entities and processes, combining engineering and design data/models, with operational and IT information. Digital twin systems transform businesses by accelerating understanding, supporting optimal decision-making, and enabling effective action.

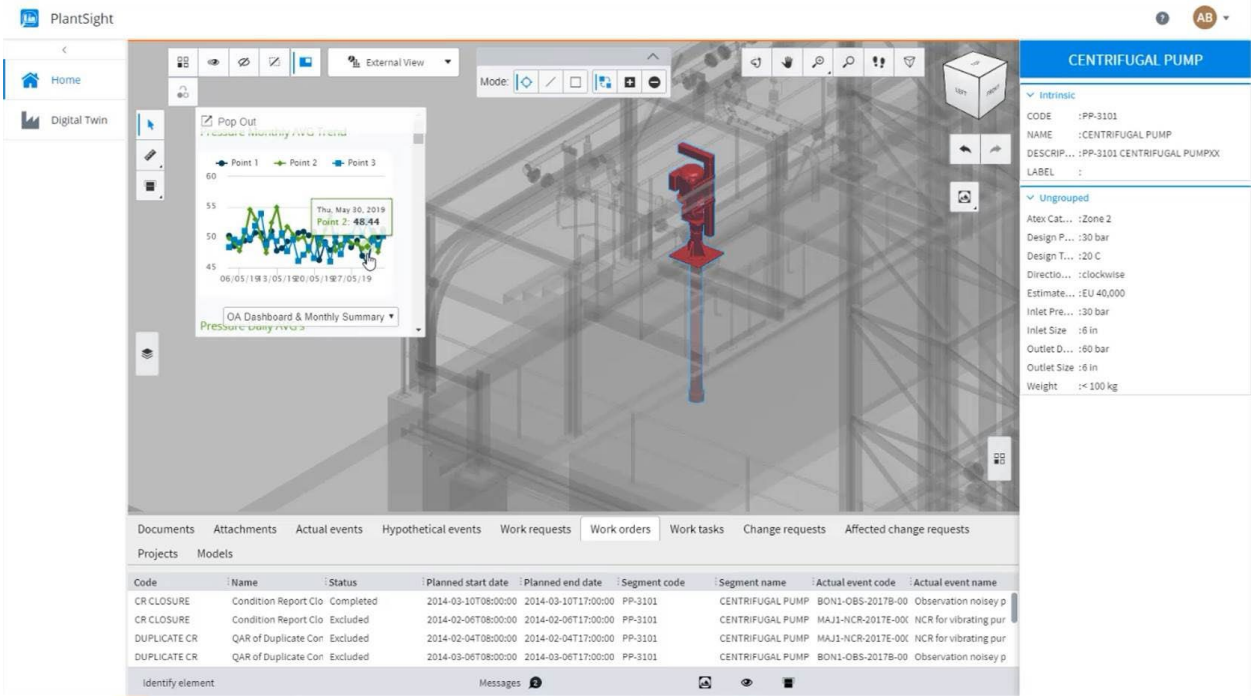

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Image Caption: PlantSight combines operational and asset data on top of engineering data for a more holistic view of performance. *Image courtesy of Bentley Systems.*

As oil and gas operations become more digitized to improve operational performance, as well as remain competitive and more sustainable, the role of digital twin technology becomes even more important. Gartner says that by 2024, at least 90% of greenfield investments will already have comprehensive digital twin models, on-site data integration, and dynamic software configuration capabilities. As the need for renewable transition escalates, the need for complex oil and gas digital twins may slip down the list of importance. Nevertheless, the benefits a digital twin brings to any digital operation are attractive, including:

- Enabling automated, remotely operated, minimally manned, highly efficient, and more sustainable assets.
- Providing an accurate and reliable source of information across the whole lifecycle of the asset.
- Accessibility across multiple teams, from engineering design and handover through to operations and maintenance.
- Providing facilities for training and familiarization of operations prior to on-site visits.
- Multidiscipline integration of third-party models, data, and information into one application.
- Improving overall decision-making with the addition of simulation and predictive capabilities.

To date, the focus has been on how to build digital twins, and the foundations are there in applications, such as PlantSight and AssetWise from Bentley. However, what is becoming increasingly important is how organizations keep those digital twins—the complete set of information about their assets, not just models and engineering—up to date and accurate. How do those organizations connect to their supply chains, maintain an open choice, and collaborate effectively on a global scale? Adopting these practices will define the next five years in the oil and gas and energy industries. New organizations entering the market will be the catalyst for this change. The other axis of change will be connectivity between the digital twin and operational and transactional systems. New approaches to federation and integration are essential, and the packaged integration tools that are available are leading the way in delivering these integrations in the industry.

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Image Caption: The typical benefits of a PlantSight digital twin. *Image courtesy of Bentley Systems.*

Overall, digital twins can improve asset operators' situational awareness and optimize asset performance by modeling dynamic behavior. As a focal point system for asset operations, digital twins have the significant potential to improve oil and gas companies' asset and business performance. The oil and gas industry is already a leading adopter of digital twins, as evidenced by the inclusion of the 2022 *Going Digital Awards* finalist Shell and their Deepwater Project Delivery Digital Platform. This project uses a digital twin created with PlantSight to aggregate data from various sources and provide a comprehensive picture of the project, leading to clarity and alignment among the diverse teams working on the project.

Conclusion

As the climate debate has escalated over the last few years, oil and gas companies are now working hard to update their strategies and shift capital as part of the energy transition. Technology, such as digital twins, will play a large strategic role as they provide the visualization, context, and the right information at the right time. By providing an accurate overview of energy assets, digital twins enable efficiency, emission reduction, and an acceleration of the energy transition. It may entail acquisitions of renewable companies or longer-term investments in their own technology.

Lastly, oil and gas companies need to partner with vendors that have the expertise, domain knowledge, and technology. Bentley applications, for example, have been used for a long time in renewable energy projects from design to operations in solar, offshore and onshore wind, hydroelectric, and other sources to make the energy transition smoother. While digital twins are only one of the options available to reach the goal of a net-zero emissions future, they remain a key focus of the digitization process and of the oil and gas industry.

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