

Overcoming the Challenges of Digitalisation in the Energy Industry





Introduction

The energy industry is undergoing a major shift towards efficient, sustainable and data-driven operations. Digitalisation promises to transform the sector by streamlining processes, enhancing decision-making, removing costs of non-quality and significantly improving expediency of delivery. This white paper examines the benefits of digitalisation across the project lifecycle, the challenges involved, and the steps needed to unlock its full potential.

What Is Digitalisation in This Context?

Digitalisation encompasses all technologies that enable automation, optimisation and real-time management. In this paper, we focus on digitalisation as the process of establishing a data-driven approach during engineering execution through to the Operate phase, with the ultimate goal of developing a digital twin.

The Digital Twin: Benefits and End Goal

A digital twin serves as a virtual representation of a physical asset, process or system, and it can be categorised into two primary archetypes in the process industries:

1. **Asset (Physical) Digital Twin:** This is a detailed virtual replica of a physical asset, such as equipment or an entire plant. Tools like AVEVA Unified Engineering enable the creation of these twins by consolidating data, including 3D models, datasheets, drawings and maintenance records, into a centralised repository. This approach ensures that all information remains easily accessible, up-to-date and accurate, thereby streamlining workflows, reducing downtime and enhancing overall operational efficiency.

2. **Process (Performance) Digital Twin:** This twin models the dynamic operational behaviour of the entire asset. Using tools like Aspen HYSYS or similar process simulation software that model the process along with suitable subsurface / reservoir modelling tools and / or appropriate power management software replicating the power management system where appropriate, it mirrors real-time plant conditions and predicts performance under various scenarios. This enables operators to optimise operations, improve efficiency and proactively manage maintenance needs based on data-driven insights.

While both types of digital twins provide significant value, this article focuses on the **physical digital twin**. It explores the technologies, strategies, and challenges associated with developing and leveraging this data-centric representation to enhance operational efficiency and reduce costs across the project lifecycle.

A digital twin provides instant access to datasheets, purchase orders and maintenance records. Traditionally, when equipment fails, operators must search multiple systems for specifications or part numbers, causing delays. With a digital twin, all data is consolidated in one place, shortening lead times for parts, reducing repair times and improving interface management in brownfield projects. This minimises downtime and enhances operational efficiency.

For EPC contractors, digitalisation reduces the likelihood of Cost of Non-Quality events by ensuring all disciplines have access to the latest data in the fastest time it becomes available. For example, a change in process stream data can be instantly updated in mechanical and instrument datasheets, ensuring purchase orders are based on accurate specifications.

Contractors can share databases with vendors, enabling them to update data and develop drawings or 3D models within an integrated environment. These can then be automatically synchronised into the project's master database. This is particularly advantageous when there is a work split between different operating centres or indeed with a specialist sub-contractor working in parallel where an interface exists and requires meticulous management. By eliminating manual data transfers, a data-driven approach minimises inconsistencies, creating a solid foundation for construction.

To best control change during execution in a digital environment, a robust Management of Change (MOC) process is applied. It is crucial to ensure that changes made by the leading discipline are immediately available and ready for use by the lagging disciplines, given the real-time nature of the database. Additionally, implementing a streamlined process for technical assurance and certainty without making it overly cumbersome will help manage the impact on other disciplines and maintain the integrity of the data. Striking a balance between efficiency and quality of change is key to getting it right.

This balance will vary from project to project and client to client, and it needs to be clearly set out at the beginning. Ensuring there is some management of control on these changes is essential to maintain both efficiency and quality.

During the FEED phase, digitalisation improves project execution efficiency. At this stage, engineering data expands rapidly as multi-discipline definition is required to meet AACE Class 3 Cost Estimating standards. An integrated database environment enables updates to propagate across all deliverables, reducing the effort needed for document revisions. For instance, ensuring consistency between line lists and P&IDs and furthermore with the 3D Model is a notoriously challenging task. However, io's digital execution strategy allows for data extracts directly from P&IDs, which can then be compared against line lists to eliminate discrepancies. Ultimately, this enhances work quality, reduces the risk of schedule delays, reduces the frustrations of highly trained engineers by avoiding mundane tasks and drives client satisfaction.



Advanced Design Tools: AVEVA UE and Hexagon

The integration of advanced design tools like AVEVA Unified Engineering (UE) or Hexagon's SmartPlant solutions provides significant advantages in digitalisation, particularly in addressing challenges such as 'swivel chair' engineering and establishing a single source of truth.

Eliminating 'Swivel Chair' Engineering

'Swivel chair' engineering refers to the manual transfer of data between disparate systems, leading to inefficiencies and increased potential for errors. AVEVA UE mitigates this by providing a unified, data-centric platform where multi-discipline teams can collaborate in real-time. This integration ensures that process simulations, line lists, flowsheets, datasheets, 3D models and isometrics are all updated within the same data repository, effectively configuring the digital twin in real-time.

Establishing a Single Source of Truth

By centralising all engineering and design data, tools like AVEVA UE and Hexagon SmartPlant create a single source of truth accessible to all stakeholders. This centralisation enhances project transparency and facilitates continuous digital handover, ensuring that the digital twin remains an accurate representation of the physical asset throughout its lifecycle.

Enhancing Collaboration and Reducing Errors

The integrated environments provided by these tools allow seamless collaboration among global project teams across various disciplines. With all team members working from the same data set, the risk of inconsistencies and errors due to manual data transfers is significantly reduced. This approach not only improves efficiency but also enhances the quality of deliverables.

Accelerating Project Execution

Utilising a unified platform streamlines workflows and accelerates project execution. For instance, simulation data created during the FEED phase is readily available for use in detailed design, allowing for real-time validation and updates. This continuity reduces delays and ensures that the digital twin is always up to date, mirroring the real physical asset.

Challenges of Digitalisation

Despite its benefits, digitalisation presents three key challenges: complexity, cost and culture.

Complexity

Many digital tools are still emerging, leading to longer setup periods. While CFIHOS standards provide guidance, foundational elements—such as templates for engineering lists and drawings—must be developed and agreed upon upfront with stakeholders. Tools like AVEVA UE and Hexagon SmartPlant introduce additional setup complexities, requiring careful alignment of engineering data to ensure consistent data formatting and workflows. For instance, equipment capacity data may have differing units (e.g., pumps in m³/h versus tanks in m³), necessitating rigorous configuration at the outset to handle such variations. This configuration cannot be done by the engineer, rather the programmers / systems architect that understands the language in which its written. These tools demand precise pre-execution planning to integrate effectively into project workflows. Reconfiguring systems during execution risks delays, deliverable inconsistencies, and potential data loss, undermining the system's value. Without proper configuration up front and in our view during FEL, digitalisation can leave companies with disjointed systems that fail to achieve a unified approach.

Cost

Implementing digital systems can be expensive, with high licensing fees for engineering-specific database providers like AVEVA or Hexagon and the need for specialised resources in the form of programmers that understand the language(s) of the software and can aid with the customisation and set-up. Developing custom systems often exceeds the expertise of engineering houses, leading to inefficient resource allocation. Digital implementation requires significant upfront investment, which can discourage companies from fully embracing the technology.

Culture

Cultural resistance is another barrier. Personnel, particularly those with extensive experience in analogue environments, may hesitate to adopt digital tools due to fears over job security, unfamiliarity or concerns about a steep learning curve. For instance, intelligent P&IDs initially require twice the drafting time to ensure proper line connections and correct symbology, reducing productivity during early adoption stages.

Realising the Vision

To overcome these challenges and unlock digitalisation's benefits, companies must focus on three areas: people, processes and partnerships.

People

Leadership plays a crucial role in driving change. Senior management must champion the initiative, appointing super users who guide teams through adoption and address resistance. These highly skilled individuals can share knowledge, promote the benefits of digitalisation and foster confidence within teams.

Processes

Standardising processes begins with early configuration. During the preFEED phase, producing engineering lists and defining data flows ensures systems are correctly set up, reducing rework and improving data accessibility later. Front-loading hours during preFEED and FEED phases establishes a strong foundation for the digital twin.

Partnerships

Strategic partnerships with software providers, such as AVEVA or Hexagon, are critical to success. Close collaboration ensures swift resolution of software bugs, comprehensive staff training and the development of custom automation tools tailored to project needs. These partnerships ensure systems are fully integrated into workflows and deliver optimal results.

Conclusion

Developing a digital twin enhances operational efficiency and reduces costs across the value chain by improving data accessibility, consistency, and quality. To fully realise this vision, energy companies must address the challenges of complexity, cost and cultural resistance. With strong leadership, early planning and strategic partnerships, the energy sector can unlock digitalisation's full value, positioning itself for a more efficient, sustainable and resilient future.

Why io?

io stands out as a trusted partner in driving digital transformation in the energy sector. Embedded within a major pre-FEED that pulled through to FEED, executed by McDermott (MDR), io played a pivotal role in implementing and championing the largest-ever AVEVA Unified Engineering (UE) project at the time. This significant initiative is one highlight of io's expertise in deploying advanced digital tools to create scalable, efficient, and integrated systems. Our hands-on approach ensures that clients realise the full potential of digitalisation by bridging the gap between cutting-edge technology and practical execution.

With a deep understanding of the complexities of modern engineering projects, io delivers tailored solutions that address unique challenges while driving operational excellence. Our right-to-left thinking allows greater certainty through the elimination of "waste" in digital processes, making them efficient, scalable and repeatable.

Choosing io means gaining a partner with proven experience in enabling seamless digital transitions, optimising data workflows, and ensuring that your digital twin is not just a concept but a transformative asset that enhances performance, reduces costs and positions your organisation for long-term success.

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