Risk Tools

Case study: how a nuclear power plant uses digital twin technology to improve operational safety

Introducing digital twin technology to a nuclear power plant is no simple task. But GleeYM's Yasir Masood, a risk consultant on one such project, explains how it ultimately provided twice the foresight to predict problems, reduce disruption and, crucially, optimise safety.

Digital twin technology involves creating a virtual replica of a physical asset, system or process, allowing real-time monitoring, simulation and analysis.

GleeYM programme and risk consultant Yasir Masood talked us through the challenges and opportunities behind introducing a digital twin to the operation of a nuclear power plant – creating simulations and analysing data infrastructure to prevent disruption and optimise efficiency.

WHY DID YOU DECIDE TO IMPLEMENT DIGITAL TWIN TECHNOLOGY?

The primary motivation for implementing digital twin technology at the power plant was the pressing need to enhance a number of things: operational efficiency, safety, profitability and predictive maintenance.

For years, the plant relied on traditional maintenance schedules, often reacting to equipment failures or unplanned outages. This approach led to costly downtime and prevented the plant from reaching its full operational potential.

"From a risk management perspective, the digital twin technology also opened doors to new opportunities."

The leadership team recognised that, in an industry where minor disruptions can have significant financial consequences, a new strategy was essential.

From a risk management perspective, the digital twin technology also opened doors to new opportunities. It was not just about avoiding equipment failures — it was about optimising every aspect of the plant's performance, from energy consumption to staff allocation.

The technology provides real-time insights, enabling the plant to make informed decisions and minimised disruptions using innovative AI embedded throughout the system.

HOW DID THE IMPLEMENTATION HELP THE POWER PLANT?

One of the most powerful lessons for the energy sector is the importance of foresight and preparedness, especially in high-stakes environments like power plants.

Serious nuclear accidents – such as the Fukushima disaster in 2011, the Chernobyl disaster of 1986, 1979's Three Mile Island accident and the SL-1 accident in 1961 – highlight the devastating consequences of inadequate monitoring and insufficient predictive capabilities.

"The motivation to prevent even a fraction of those disasters drove the decision to implement digital twin technology."

While the power plant I consulted for did not face the same nuclear risks, the motivation to prevent even a fraction of those disasters drove the decision to implement digital twin technology.

The digital twin became more than just a tool for efficiency – it evolved into a critical asset for maintaining operational safety and protecting both the plant's infrastructure and its personnel.

This experience demonstrated how leveraging advanced technology not only mitigates risks but also creates new opportunities for safety and efficiency, ultimately helping achieve strategic goals through digital transformation.

WHAT WERE THE MAJOR CHALLENGES?

Planning for the complexities of implementation posed significant challenges. Given the scale of the power plant and the sophistication of the digital twin, aligning current operations with the new system required careful co-ordination and foresight.

The stakes were high, especially considering the lessons learned from past power plant accidents.

During the planning phase, we faced immediate resistance to change. Many key stakeholders, accustomed to traditional methods, were initially sceptical about adopting the digital twin. They feared that modern technology might disrupt established workflows and require a steep learning curve.

Additionally, concerns arose regarding the perceived complexity of integrating real-time data with existing systems.

HOW DOES THE DIGITAL TWIN HELP YOU FORESEE OR MITIGATE RISKS?

While planning for the digital twin integration, we encountered an unexpected risk that could have derailed the project.

Although our focus had been on technical implementation and change management, a challenge emerged around data integrity and availability due to legacy systems.

As we planned how the digital twin would pull real-time information from various systems, we discovered gaps in data streams from older equipment, risking the accuracy required for optimal digital twin performance.

"By running simulations and reviewing the plant's data infrastructure, we identified potential weak points early."

In this situation, the digital twin, even in its planning stage, helped us foresee this risk before it escalated. By running simulations and reviewing the plant's data infrastructure, we identified potential weak points early.

This foresight allowed us to plan for necessary upgrades, such as installing new sensors and modernising data collection points in critical areas.

Adaptability was key to mitigating this risk. We revised our timeline to incorporate these upgrades, ensuring the digital twin would operate on a foundation of accurate and reliable data.

WHAT WERE THE MOST VALUABLE RISK MANAGEMENT INSIGHTS?

Traditionally, projects like this focus on upgrading equipment or implementing new processes. However, the digital twin provided a more granular view, highlighting the need for robust and reliable data to support the technology.

The most valuable insight was the importance of preparing the infrastructure to sustain innovative technology.

The digital twin allowed us to look beyond immediate project needs and plan for long-term success. It transformed our approach to risk management, enabling us to mitigate potential issues before they became problems. Without it, such foresight would not have been possible.

This insight redefined our approach to digital twin technology and any large-scale innovation. It's not just about implementing new tools; it's about ensuring the foundational support is strong enough to sustain them.

The digital twin taught us that the key to future success lies in addressing hidden risks during the planning phase, well before they manifest.

Case study: how a nuclear power plant uses digital twin technology to improve operational safety | Case Studies | Strategic Risk Global