Nuclear engineering goes digital

Large nuclear projects are often complex, whether in terms of technology, human factors or regulations. This can lead to difficulties in their execution, but also higher costs during the design, construction and operation phases. Adopting digital technology will raise both economic and industrial performance for all industry stakeholders.

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Chief Technology Officer (CTO)
PhD in Information and Communication technologies, Robert has extensive expertise in Industrial Internet of Things and Advanced Technologies.

On 27 June 2018, a major step forward for the energy sector was made by EDF, Dassault Systèmes and Capgemini. These three groups, one of which is the world leader in 3D software, announced that for the next twenty years, they would operate a partnership agreement for the digital transformation of the publicly-owned group's digital engineering process.

Their joint objective: sustainably support industrial projects through the deployment of Dassault Systèmes' 3DExperience platform, to facilitate access for industrial players to real-time project data. The tool will also help design digital twins in nuclear plants, whether at the design, construction or operation phase.

So whether for the Hinkley Point C project in the UK, future EPR projects around the world (especially in France, Finland or India), or engineering on France's active nuclear fleet (58 pressurised water reactors across 19 plants), all will contribute to this approach and benefit from it.

Data,
new form of fuel for the industry

"The nuclear sector handles huge volumes of data. Both due to the time taken to incubate a project over its life cycle (40 to 60 years) whatever it be, and due to regulations, which impose extensive reporting on all stakeholders." For the past thirty years, this mass of heterogeneous, unstructured data has been managed

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in a veritable constellation of digital solutions. Today, the emergence of new digitalisation technologies — such as the scanner or optical character recognition — allow us to imagine the transition from an approach of physical document-based information, to a data-based information approach.

"The current issue is to implement a new, interoperable, pooled data repository in order to ensure better project management and imagine new approaches to operation and maintenance."

At the outset of such a project, Assystem engineers and their peers have thousands of pages to read concerning operational requirements... which have to be satisfied in hierarchical order or coupled together, even when they may be conflicting. *"This is where digital technology and artificial intelligence can go further than what Humans are capable*

of doing, through a data-driven approach rather than a document-driven process." This new approach to system engineering results in greater efficiency during engineering phases, with the development of more innovative architectures that satisfy the requirements of customers and regulators more effectively.

Data-driven
system engineering

This issue of digitalising both documents and expertise aims to capitalise on previous work projects to ensure that current and future performance is more efficient. *"In the end, substantial gains in productivity, quality and costs are on the table. In the UK for example, the Project Delivery Model for the Hinkley Point C project in progress, involving data-driven organisational modelling and delivery, will offer customers improved visibility of the performance schedule."*

NUCLEAR FIGURES

72 reactors under construction and **160** in the design phase

" Digital technology and artificial intelligence can go further than what Humans are capable of doing"

Although the construction part of building such a reactor is easier to schedule, the installation of equipment is more complex, as they come with complex electrical, mechanical and ventilation issues (between twelve and fifteen coupled processes).

"If we assume that everything is digitalised, by introducing models and simulation, we can work on scenarios and risk analysis (depending on the incidents). This should enable us to transit from a deterministic approach to scheduling to a stochastic vision, which takes into account the complexity and sensitivity of processes. Above all, this new process based on the principle of digital continuity, assists decision-making on all tiers of project governance right up to senior management."

Digital twin:
keystone to the operation of nuclear infrastructure

In the operating phase, the mixture of cold and hot data will enable the traceability of all modifications in real time, the detection of anomalies and forward planning for replacement parts management. *"Already, artificial intelligence is used to produce reports from observations, photos, etc. Similarly, as the plant is capable of self-operation in terms of calculations and instrumentation & control, automated fault management is possible for all or just on certain machines..."* Private blockchain technologies are also used to prevent fraud and ensure security during machine maintenance (using registers for each machine or specific zone).

During the preparation of decommissioning, it is possible to create a search engine using the mass of existing reports (videos, films, diagrams). *"Experts ask questions and use the responses to plan decommissioning as effectively as possible, while reducing provisions for random incidents, which are currently immense"* (between 20 and 30 % of decommissioning budgets). This analysis approach could even go as far as monitoring the radiologic exposure of personnel and their equipment requirements.

Digital ecosystem:
the key to success

To address these questions, Assystem develops innovative approaches to system engineering in partnership with Dassault Systèmes, via its 3DExperience platform. *"Our advantage? Knowledge of the EPR sector and integration of business processes into the platform (defining architectures, functions that must be put in place, etc.), not forgetting the development of data processing by semantic analysis (search engine to identify trends, highlight buried information that is undetectable by conventional reading)."*

This entails the conversion of report documents into data and the development of AI technologies to analyse them and detect conflicts, for example, then propose engineering solutions with the best possible performance for the design, commissioning, operation or decommissioning phases. At Assystem, we are convinced that digital technology needs to be linked with an approach to create the most diversified innovation ecosystem possible. So, in terms of data processing, we signed a strategic partnership with the start-up Saagie, providing our data scientists with access to the latest big data technologies in a secure collaborative environment. Lastly, on matters relating to complexity management, we have established a partnership with start-up CosmoTech, which is creating a highly original platform used to take into account the inherent complexity of nuclear projects. In addition to these partnerships, we

enjoy close contacts with the French academic world, in particular the National Institute of Applied Science (INSA) in Lyon and Rouen, technology and engineering universities Mines Alès, Arts et Métiers, EISIA and the DataScience Institute.

At a time when nuclear projects are proliferating around the world (), working with this data-driven "probabilistic" approach in the reactor design process cuts the delivery lead time and increases its quality. *"Yet we will always need industry experts to check the quality of document analysis (using ontologies based on feedback), debug solutions and configure tools and algorithms to deliver decision-aid tools."* ∎

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