PROJECT INFORMATION

Project Title
COGNITWIN – Cognitive plants through proactive self-learning hybrid digital twins

Project Objective
The COGNITWIN project will investigate how today's process industries can learn from historical data and adapt. Our strategic, high-level objective is to establish the fully digitalised concept of self-learning and proactive next generation of digital twins, which operate in the hybrid world and can i) recognise, forecast, and communicate less optimal process behaviour well before these occur and ii) adjust itself in order to keep the process continuously close to or at optimum.

Project Duration and Timing
42 months
September 2019 – February 2023

Project Funding
Costs: €8.65 million
EC Funding: €6.98 million

Project Partners
SINTEF
Hydro Aluminium Deutschland
Sumitomo SHI FW Energia
Sidenor
Elkem
Saarstahl
DFKI
Cybernetica
Nissatech Innovation Centre
Fraunhofer-Gesellschaft
University of Oulu
TEKNOPAR Industrial Automation
Noksel Steel Pipe Company
Scortex

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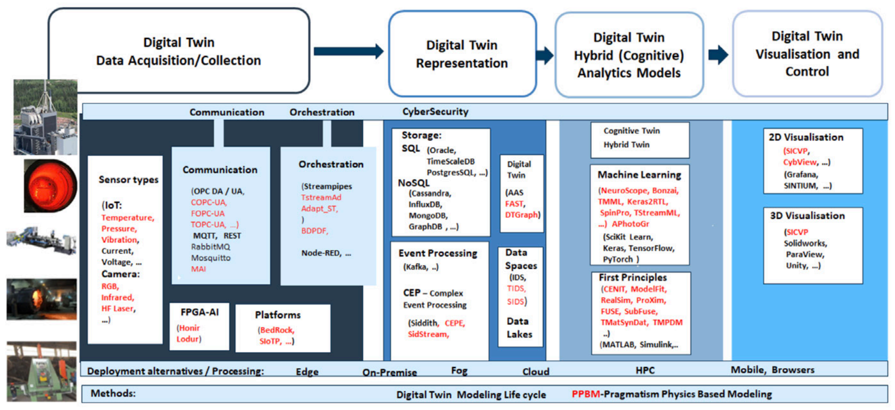
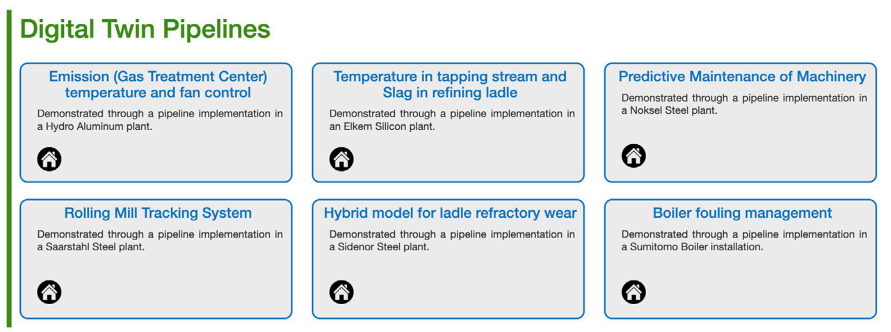
is experimentation with the Industry 4.0 AAS standard, the so-called Assets Administration Shell, which is now emerging as an international standard. We are one of the first projects to highlight the use of this standard and show this in practice in some of the pilots that we have."

One example of the pipelines is the steel rolling mill tracking system developed for the steel manufacturing company Saarstahl. Rather than using classical measurements such as temperature or pressure for its digital twin data, it uses video streams of the rolling mill which are then processed via advanced image analytics and video analysis. Machine learning is used to train the system to understand and analyse situations, allowing it to recognise the steel beams and understand if they are placed correctly, notifying operators if something is not right.

Though the project has identified that the same architecture can be applied across the board, the researchers involved have also learned that the best approach is not to try and entirely replace existing systems, especially in processing environments that have been operational for many years. Again, the toolbox approach excels in providing the flexibility needed to deal with any given environment, allowing companies to pick and choose different components that can be retrofitted into their specific industrial situation at any point along the production process.

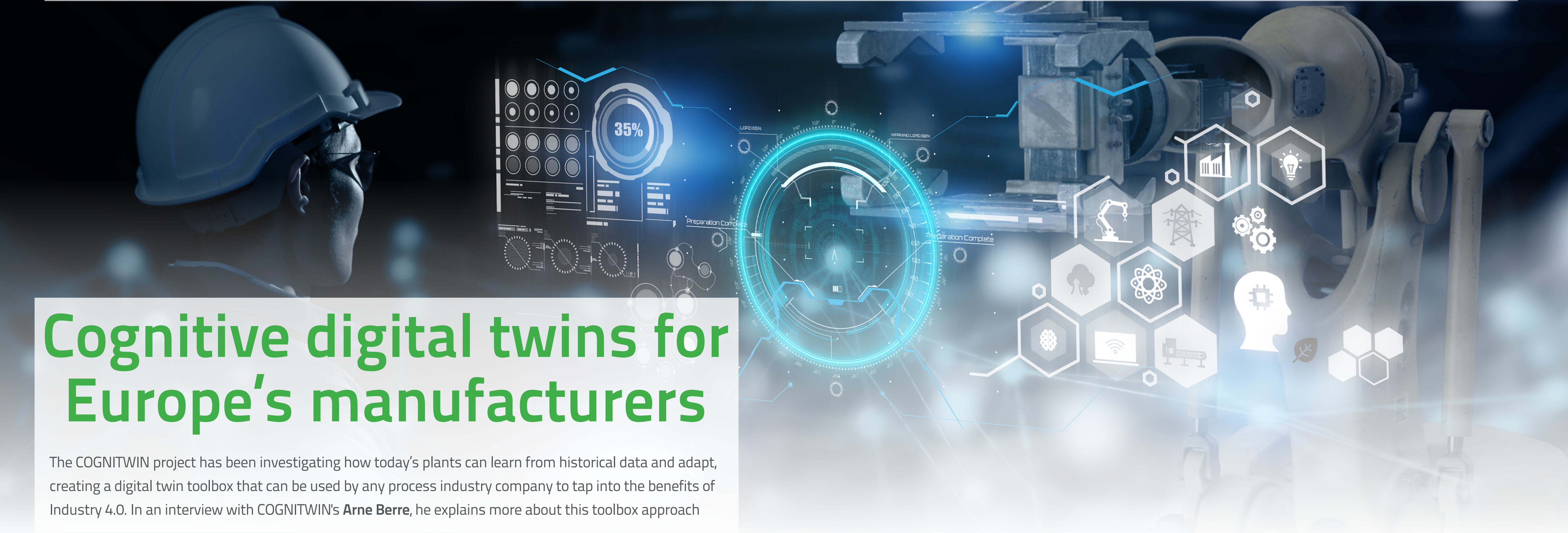
With the project coming towards the end of its lifespan, one of the final activities is to explore possibilities for cross-pollination in functionality between the six pipelines, in particular for standards and cognitive aspects of human operator representations. The project is also accelerating its exploitation-related activities, led by project partner Cybernetica, which will identify key exploitable results and explore future business models for the use and extension of the COGNITWIN Toolbox for future applications.





Figures from the COGNITWIN Toolbox portal: https://cognitwin.github.io/toolbox/

Project insight



Cognitive digital twins for Europe's manufacturers

The COGNITWIN project has been investigating how today's plants can learn from historical data and adapt, creating a digital twin toolbox that can be used by any process industry company to tap into the benefits of Industry 4.0. In an interview with COGNITWIN's **Arne Berre**, he explains more about this toolbox approach

While the concepts of digitalisation and Industry 4.0 are making rapid inroads into the European manufacturing sector, there are several aspects that can be still incorporated into the system to strengthen the goal of optimal process operations. One such aspect to the digitalisation vision is the "cognitive element", where process plants can learn from pattern recognition in historical data and adapt to changes in the process, simultaneously being able to predict unwanted events in the operation before they happen.

The COGNITWIN project aims to add cognitive elements to existing process control systems, thus enabling their capability to self-organise and offer solutions to unpredicted behaviours. The concept of a cognitive digital twin builds upon two previous iterations. The first, the digital twin, is a virtual representation of a system, aligned in time with reality, which is based on sensor data from the actual system. The second iteration, the hybrid twin, combines data from a digital twin with models of the chemical or physical processes taking place to gain more insight into what is happening. Finally, the cognitive digital twin adds cognitive aspects, using intelligent reasoning and understanding of the situation, and sourcing knowledge from experienced human operators.

COGNITWIN will set a new standard for the design, development and operation of the European process industry by introducing a platform for virtual component-based architecture that integrates IoT, big data, AI, smart sensors, machine learning and communication technologies, all connected to a novel paradigm of self-learning hybrid models with proactive cognitive capabilities.

One of the main outcomes of the project is the COGNITWIN toolbox, which provides a variety of components and services that can be mixed and matched to create a solution for any company working in the process industry, and is structured according to four digital twin pipeline steps: digital twin data acquisition; digital twin data representation; digital twin cognitive and hybrid models; and digital twin visualisation and control. These steps are the basis of a common architecture that has been developed over several previous projects.

COGNITWIN's technical coordinator Arne Berre explains the thinking behind the toolbox approach: "We don't think that there is one platform that everyone is going to use, but there is a common architecture, a common pipeline structure that will fit most cases," he says. "As part of the project, we have taken this common pipeline structure and developed six digital twin pipelines based on pilots with companies that highlight the possibilities of our approach. Each pilot company was partnered with R&D and technology providers to help them develop their toolbox and components."

The toolbox, provides a variety of components and services that can be mixed and matched to create a solution for any company

Of the 10 different domains of the process industries outlined by SPIRE, COGNITWIN has investigated three: the non-ferrous processing industry (using the examples of aluminium and silicon), the steel processing industry, and the engineering process industry (using the example of boilers for producing energy). The six pipelines developed follow the same four-step structure and cover many of the typical aspects of process industries from data acquisition, through data managament to data analysis with AI/machine learning and visualisation and control – for example: emission temperature and fan control; temperature in tapping streams and slag in refining ladles; ladle refractory wear in steel processing; predictive maintenance of machinery; a steel rolling mill tracking system; and boiler fouling management.

"What we see is that each pipeline follows the same pattern, but each one substitutes in various components and services from the toolbox to fit the particular needs of the pilot," says Berre. "Another aspect that is seen in the pipelines