ZDMP Blog

Digital Twins in Industry 4.0

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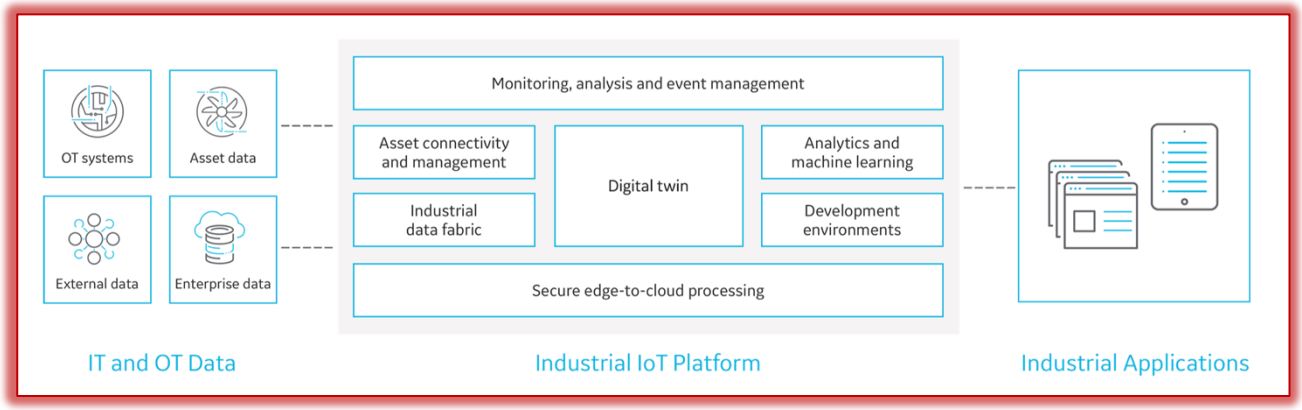
Some questions for you

- Do you have all your industrial processes digitized and controlled?
- Do you know how much it costs you to produce your products and the resources you consume?
- Do you have control over production in real-time and can you anticipate possible problems?
- Can you observe and predict the outcome of your production processes or the creation of your products and take the appropriate corrective actions?

Digital Twin concept

The initial idea of the concept of Digital Twin (DT) [1] comes from NASA's Apollo program which built two identical space vehicles. One of them was launched into the space to perform the mission whilst the other stayed on Earth to compare, control, and take decisions on mission control. Digital twins are one of the major trends in the field of Industry 4.0, since they present great opportunities to optimize processes, improve predictive maintenance, and promote new lines of business. Hence, the concept refers to the development of software that works as a virtual copy of a service, product, or business process built (or based on) from data that is extracted from the real environment.

In most definitions, the DT is considered as a virtual representation of any asset of the enterprise that interacts with the physical object throughout its lifecycle and provides intelligence for evaluation, optimization, prediction, etc [1]. But the DT itself also refers to a comprehensive physical and functional description of a component, product, or system that includes more or less all information which could be useful in the current and subsequent lifecycle phases to make simulations [2]. Basically, a DT monitors the life cycle of a product/process by replicating its operation in a virtual model that serves as a basis for experimentation, supervision, and control. The figure below shows where the digital twin is conceptually placed.



Process and product characterization and modelling

Today, the advanced digital transformation of any company infers that any asset must be digitized. A digital asset is a virtual representation in binary formats for the corresponding physical asset (eg, product, machine, and infrastructure) [2]. The digitalization of all these assets provides the company to have an exact virtual representation of all its processes, which would also allow to monitor in real-time everything that is happening in a manufacturing process to detect deviations from the established plan. This also makes it possible to have an exact map of the behaviour of the processes to simulate any condition to advance the criteria to be taken.

The benefits of this technology are multiple, as it permits to experiment and predict situations in a safe environment. A company can implement its roadmap in the DT and understand what the results will be before actually applying it. Simulations can be performed by introducing different variables to optimize their processes. The characterization and

modelling of any process or product makes it feasible to conduct error-free decisions and thus implementing zero-defect decision-making.

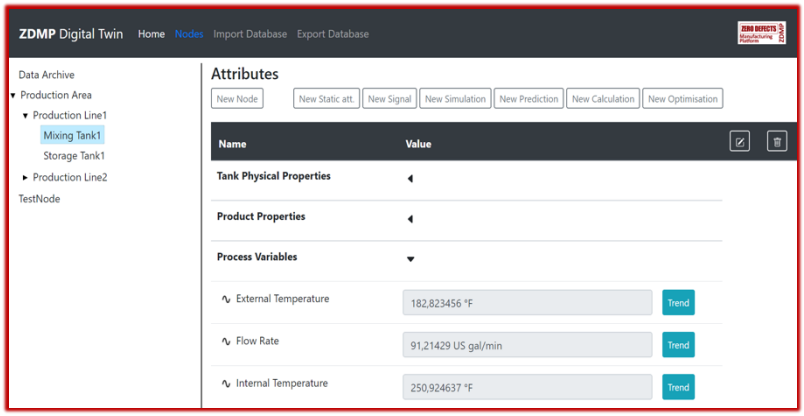


Figure 1: ZDMP Digital Twin modeller interface

Material and Energy Efficiency

With the current trend of digitalization and demand for customized and high-quality products with short delivery times, industry is forced to adapt its production and manufacturing style [3]. A digital representation of the current state of manufacturing assets, processes, and products allows knowing how many materials are being used for the production of a certain product, how many materials are being used in the production processes, and how much energy is being employed in each of them.

Having the possibility of managing all this information in real-time permits the stimulation of enterprise processes with other working conditions when trying to rationalize the consumption of materials and energy to apply efficient approaches. This allows the company to determine under which production parameters a reduction in costs can be obtained and therefore a more rationalised processes can be determined. Additionally, from the perspective of zero-defect production, a DT allows developing models to detect anomalies in the consumption and infer probable future defects related to them, therefore improving the predictive capabilities of the system, which contributes to better process understanding.

Essentially the value of a DT can be summarized as a software for real-time remote monitoring and control, to obtain greater efficiency and safety, to implement predictive maintenance and scheduling, to develop scenario and risk assessments, to create a more efficient and informed decision support system, and to implement personalization of products and services.

What will ZDMP achieve

Digital Twin refers to a digital replica of potential and actual physical assets (physical twin), containing processes and products that can be used for various purposes. With the digital twin is possible to represent and model processes and products features (ie physical characteristics, bill of materials, tolerances, etc). Moreover, it provides data objects describing various aspects of the physical and logical parts of a manufacturing process. Additionally, it also includes the status of the different (potentially distributed) components of the manufacturing system and product features. A digital twin allow ssimulation of the future state of the manufacturing process or product production using AI algorithms to perform a dynamic virtual representation. The Digital Twin application implemented in ZDMP allows defining the structure and contextualization of the elements of any kind of industry, such as assets, products, and processes and their mathematical behaviour inside a Simulation subcomponent. Base functionalities (nodes, attributes, signals, static values, etc.) allow modelling both processes and products, where one of the main differences is the type of simulation that will be run.

ZDMP Links

• Architecture Component(s)	Digital Twin
• Work Package	WP7 – Process Quality and WP8 – Product Quality
• Tasks	T7.3 Material and Energy Efficiency T8.1 Characterization and Modelling

References/Acknowledgements

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