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Harnessing digital twin technology benefits for new water plant designs

While the concept of the digital twin has been around for several decades, most of the talk about it in water and wastewater treatment has focused on using it to monitor and manage active operations. Yet the same capabilities that make digital twin technology useful to active operations can also help plant operators and their consulting engineers evaluate key technology decisions on designing, building, operating, and maintaining new or upgraded plant processes. Here is an advance look at the value digital twin technology offers.

The digital twin concept

As the digital replica of a physical entity, a digital twin is a virtual representation sophisticated enough to drive complex analytics and simulations without expensive custom integration. It enables users to contextualize data, personalize the system, encourage collaboration, and integrate processes seamlessly with deep learning and artificial intelligence (AI).

While digital twin technology has been well documented in the management of key aspects of water utility plants and pipeline infrastructure, the concept can just as easily be applied to new system design through unified engineering.

With unified engineering, users can model various design options, and they can also commission new installations with built-in capabilities to respond to a variety of subsequent operating challenges more effectively (Figure 1).

Benefit from past and present experience

Performance intelligence systems that support digital twin technology make it easier to analyze the outcomes of exceptional situations and test alternative responses. With data collection via real-time sensors and industrial internet of things (IIoT) infrastructure located throughout treatment plants, water utilities can have a better understanding of historical operating performance. This, in turn, makes it easier to develop and test new plant and infrastructure designs to deal with growing populations, increasingly scarce resources, and direct or indirect effects of climate change. The results make it easier to drive digital transformation, support scalable solutions, reduce costs, and drive business resiliency.

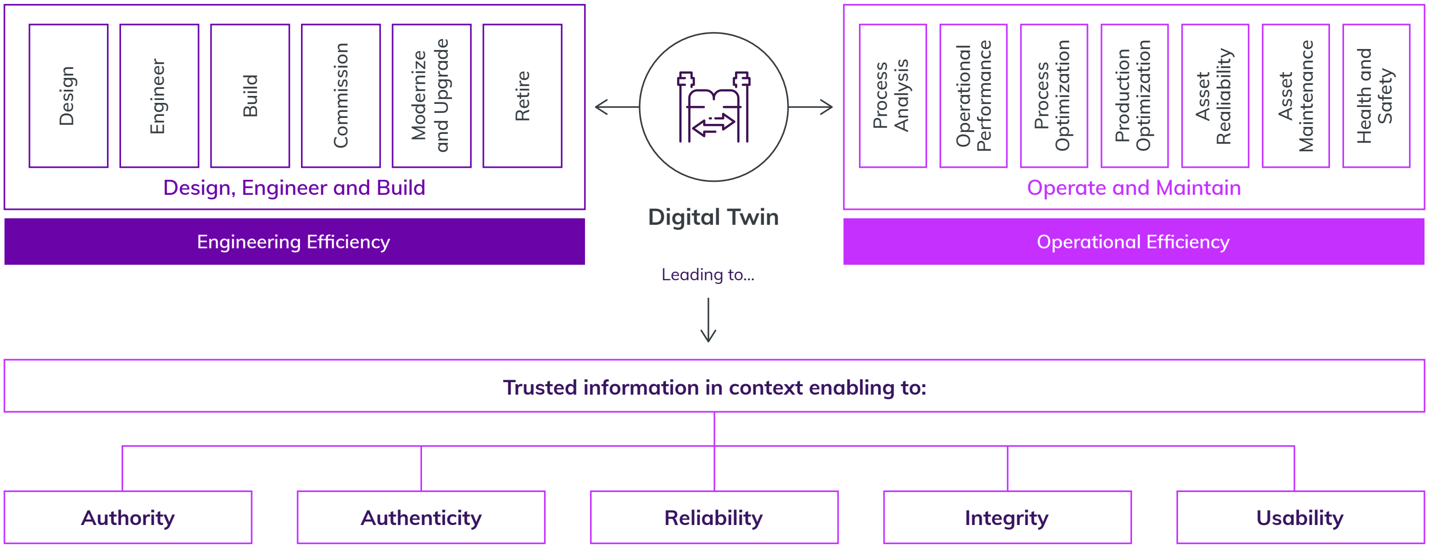

Figure 1. Digital twin technology provides valuable support for design engineering decisions (left) as well as operational and maintenance decisions (right). It also serves as a link between the two to help water and wastewater system operators optimize capital expense and operating expense efficiencies from initial design through the total plant lifecycle.

The possibilities are virtually endless and extend well beyond the initial treatment plant design. The same performance intelligence system and digital twin framework used to evaluate initial design options can subsequently be used to organize data from plant control systems, field sensors, and external databases and to resolve challenging operating issues (Figure 2).

Plan, test, and operate better designs—in theory and in practice

A performance intelligence system that can combine engineering data with real-time transactional data across all assets of a water and wastewater operation goes a long way toward the optimization of system design and performance. The power and visibility of a digital twin environment enable water and wastewater treatment plant operators to model all the interrelationships in that dynamic system and make complex operating decisions with confidence.

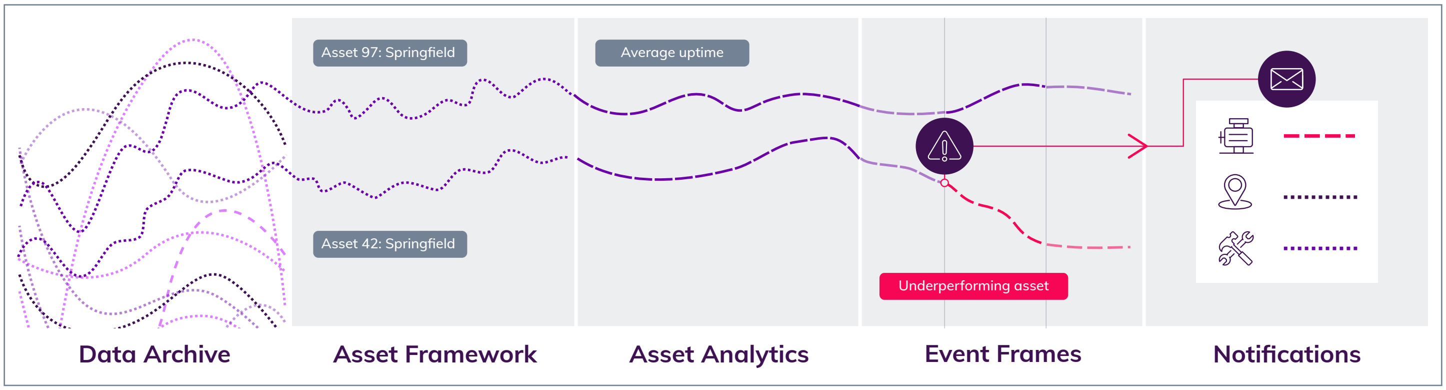

Figure 2. When evaluating performance intelligence systems, look for one that minimizes operator effort by organizing data intuitively into logical asset hierarchies. That includes accepting current and historical data from virtually any internal or external source format (SCADA system, datalogger, IIoT-enabled sensors, etc.), classifying it in a meaningful asset framework, analyzing it, displaying it in user-formatted dashboards, and generating automatic notifications for out-of-parameter conditions.

But design engineers and consultants can also harness the power of digital twin technology to optimize their front-end engineering design (FEED) efforts even before the first pipe is connected. And they can easily share the benefits of those digital twin insights with additional stakeholders such as engineering, procurement, and construction (EPC) personnel, as well as with operators after plant commissioning.

Cloud-based design software that takes advantage of object-centric data management as part of a digital twin approach can associate every valve, pump, pipe, etc. with an extensive variety of real-time, transactional, and attribute data. That makes it easier to model new designs based on known or hypothetical performance characteristics without the risk of an expensive, overdesigned project. Also, having the ability to integrate piping and instrumentation diagrams within 3-D models can speed the design cycle and provide easy visual references for all project participants (Figure 3).

And once a new treatment system is built and operational, the same digital twin models used to refine its design can also be leveraged for operational and maintenance insights and decisions, such as forecasting and managing energy consumption, leak detection, asset performance, and optimizing lifecycle costs. The same object-related data can also be used as input for AI and machine learning applications to model and evaluate 'what if' scenarios for added efficiencies. Choosing a performance intelligence system that makes it easier to share relevant data with enterprise risk management (ERM), enterprise resource planning (ERP), and management information (MIS) systems also gives business decision-makers greater insight into the management of their new system designs for optimum financial performance.

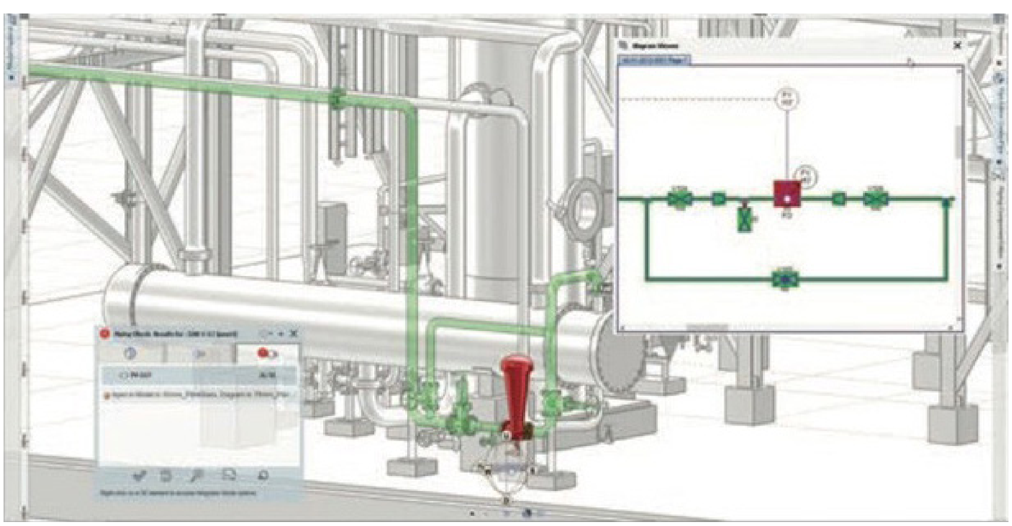

Figure 3. Design engineering software that takes advantage of digital twin modeling can make it easier for designers of new or upgraded plants to visualize, evaluate, and execute optimal designs in the context of historic parameters or hypothetical expectations. For example, this 3-D design package can generate lifelike representations of operating components automatically from pipe and instrument schematics.

Prepare for a digital future

Aside from the task-specific benefits it offers for design, construction, and operation activities, cloud-based digital twin technology also prepares its users to embrace the inevitable digital transformation needed to meet the demands of a changing world. It makes it easier to support scalable, virtual teams initially born of necessity during the pandemic but now valued for their positive influences on business resiliency and cost reduction. And when run as part of a performance intelligence system that accommodates historical and real-time data from a variety of sources, it overcomes the problems of siloed data. Digital twin technology provides the benefits of a more holistic, shared view of operations, analytics, and projections among decision-makers in every facet of water and wastewater operations..

About the author

Gary Wong is the global industry principal of infrastructure and water at AVEVA, a leader in real-time industrial performance intelligence. He leads their global data centers, facilities, smart cities, and water businesses. He has 25 years of extensive international experience providing sustainable, strategic, and cost-effective digital solutions. Prior to joining AVEVA, he has held positions with OSIsoft, Metro Vancouver and as a consultant directing both public and private sectors on operations, digital transformation, planning, sustainability, and engineering. Mr. Wong is also the chairman of the Smart Water Networks Forum (SWAN) Americas Alliance and holds a bachelor's degree in chemical engineering, is registered as a professional engineer in computer engineering, holds an M.B.A. from the Queen's School of Business, and is also a chartered professional accountant.

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