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ARTICLE

Digital Twins for Water Utilities Validate Their Economic Feasibility by up Levelling System Operations and Improving Decision-making

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From aging infrastructure and changing environmental regulations to funding gaps and climate-fueled natural disasters, water utilities around the globe face a range of problems in their effort to deliver reliable and affordable water to their communities. Their potential solutions are similarly wide-ranging, from stimulus grants and conservation programs to smart water technologies.

Utilities are employing a variety of digital strategies to address urgent risks as well as meet the requirements for digital transformation aligned to strategic investments in water systems. One very compelling digital strategy that water utilities are adopting is a digital twin. Digital twins of water infrastructure can help utilities get the most out of their data to improve their decision-making. Most utilities have the key building blocks in place to make digital twins economically feasible as a short-term strategy with long-term benefits.

WHAT IS A DIGITAL TWIN?

A digital twin is a realistic and dynamic virtual representation of a physical asset, process, or system. Creating a digital twin for a water system involves integrating existing models and data. This could include engineering models (hydraulic models of the water network and 3D models of the water treatment plant and pumping stations), new virtual reality models (if 3D models are inadequate, outdated, or non-existent), and GIS, asset management and customer data. Additionally, digital twins are continuously updated with operational data from SCADA systems, sensors, meters, and other measured sources—creating a real-time model that can be used in operations and maintenance.

The integration of isolated, disparate data into a unified view provides a unique collaborative and connected digital twin environment that water utility personnel can use to gain insights from their data for better decision-making. The dynamic integration of operational data enables utilities to see what's happening in real-time or review any moment in time, while also providing a definitive ledger of change of the water systems and assets as they evolve. This dynamic aspect is also what differentiates digital twins from the static 3D models typically used for design and construction.

The end result is an information-rich digital infrastructure model that supports engineering, operations and maintenance, and capital planning for smart water networks. With digital twins, utilities can perform "what-if" analyses and simulations to

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make informed decisions throughout the lifecycle of a water system—from long-term system vulnerability and capacity planning to immediate performance monitoring and emergency response. The process enables utilities to better understand the past and current performance of their water systems while helping them predict future performance and simulate the impact of potential changes in the virtual world before funds are committed.

Digital twins help develop smart sustainable water management platforms and powerful decision support frameworks for the modern workforce. In particular, digital twins that are cloud-based enable the remote sharing of data, dashboards, and situational intelligence. Thus, a cloud-based digital twin overcomes the limitations of legacy water control rooms since it interoperates with systems and real-time data, SCADA, and data historians. A digital twin handles large volumes of disparate data sources to gain insights in near real-time, and reduce or eliminate false alarms.

BRICKS AND MORTAR

Moving toward a digital twin may seem daunting, but in reality most water utilities have already started. They have in place a variety of systems that they use in their day-to-day operations: sensors, SCADA, automated metering, asset registry, hydraulic modeling, and so on. And since the fundamental purpose of a digital twin is to unite the data from those different sources and provide a unified view of that data, utilities have already done the difficult work of implementing systems that generate digital data: aka the building blocks of their digital twin.

The next step involves the mortar that connects that data. And for a smooth journey, the mortar-slash-technology underpinning a digital twin must be open. Digital twin technology is not off-the-shelf software. Instead, every digital twin is assembled, built, customized, and advanced using pieces from many sources that will change over time. To ensure that a utility controls their digital twin and can include the systems and data important to them, they need to rely on technology that is open-sourced. This "openness" signifies that the digital twin can connect smoothly with other technologies.

The technology within that mortar must also include these other key features— decision-making tools and scalability. The importance of digital twins rests on the ability to use data to make informed decisions. This implies the use of built-in decision-making software that can link current status or conditions data with a robust, mature portfolio of tools for analyses and simulations. And scalability means that a digital twin can see and analyze at the scale of (for example) a city or a treatment plant, all the way down to an individual pump or valve.

DIGITAL TWINS FOR NETWORK OPERATIONS AND MANAGEMENT

Many utilities already have hydraulic models of their water networks that they use for planning and design. Incorporating those models within a digital twin helps utilities simulate events such as pipe failures, power outages, and so on, to analyze the resilience of their water network systems and assess their risk. Furthermore, integrating those models with SCADA data provides an accurate assessment of how a water system is currently behaving. This enables utilities to simulate and test different ways that their water systems could be operated to improve emergency response, increase efficiency, or save energy.

Continuously updating digital twins with measured operational data also helps a utility determine the location of potential leaks and reduce water loss. And a digital twin can leverage data from existing work management and asset management systems, as well as other enterprise systems, to support risk-based asset management—informing their decisions such as repair vs. replace and helping them prioritize capital improvement projects.

DIGITAL TWINS FOR PLANT OPERATIONS AND MANAGEMENT

Digital twins of water and wastewater treatment plants are particularly useful for improving plant efficiency, reliability, and resilience as well as for training and safety compliance. Virtual walkthroughs, communications, and simulations give personnel enhanced visibility to plant data and insights for better decision-making. For example, reliability engineers can simulate hypothetical events such as a multiple screening system or pump failure to evaluate the severity and consequences of the failures and take preventative actions.

Digital twins can also be used to flag real problems, such as equipment that is not operating properly—enabling virtual exploration and quick access to pertinent data. For example, operators can zoom into the equipment area and pull up data related to that particular item (such as manufacturers' specifications or repair manuals). This gives personnel immediate access to information without wasting time digging through file cabinets or hunting through document libraries.

CONCLUSION

Digital twin technologies (such as Bentley's OpenFlows™ powered by the Bentley iTwin® platform) are smart integration solutions that connect information technology, operational technology, and engineering technology. These connections are helping water utilities exploit the potential of their data in a way that was economically unfeasible just a few years ago—uniting legacy data with operational and engineering data to provide a wider view of a utility's water system and enable data-driven decision-making.

In the coming years, digital twins will become an ingrained part of every aspect of the water utility control room. Utilities can start building digital twins overnight with the data and systems they already use. As they become the new normal for water utilities, digital twins will improve the reliability of water systems, reduce utilities' capital and operating expenditures, lessen their environmental footprints, and provide their customers with safe and efficient services.

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