Realizing the Benefits of Process Advisory Digital Twins for Water, Wastewater, and Reuse

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Rapid advancements in technology have changed many aspects of the water industry in the last two decades and the pace of change shows no sign of slowing. One of the most exciting (and most discussed) advancements in our industry has been the proliferation of "digital twins."

Digital twins is a broad term used to describe the virtual representation of physical assets and systems that enables users to simulate decisions and analyze results. Digital twins can vary widely in complexity and scale and are typically developed to deliver specific benefits to the user, such as adding greater certainty to capital planning decisions, planning for potential disruptions to operations, and providing training to operators of a new or upgraded facility.

Digital twins can be as simple as basic models to predict the formation of disinfection byproducts or estimating chemical dosing, to more-complex models that provide 3D models of a facility (e.g., 3D building information modeling [BIM]) and even fully interactive process, collection, or distribution system simulators. Most importantly, they provide a way for operators, supervisors, managers, and others at the utility to test decisions in a safe, secure environment.

With such a wide variety of configurations, the term digital twins can seem overwhelming to utility personnel; however, by looking at the digital assets already in use at a utility, it might be surprising to see how far along the digital twins spectrum it already is.

Finding Your Digital Twins

With mobile devices and computers able to store more information and handle more-complex calculations than ever before, there has been a quantum leap in the ability to leverage digital twins for all aspects of utility asset planning, design, operation, and maintenance. These leaps in technology have made digital twins a solution that can encompass a wide spectrum of tools, depending on their intended use. One popular example of digital twins is a physical

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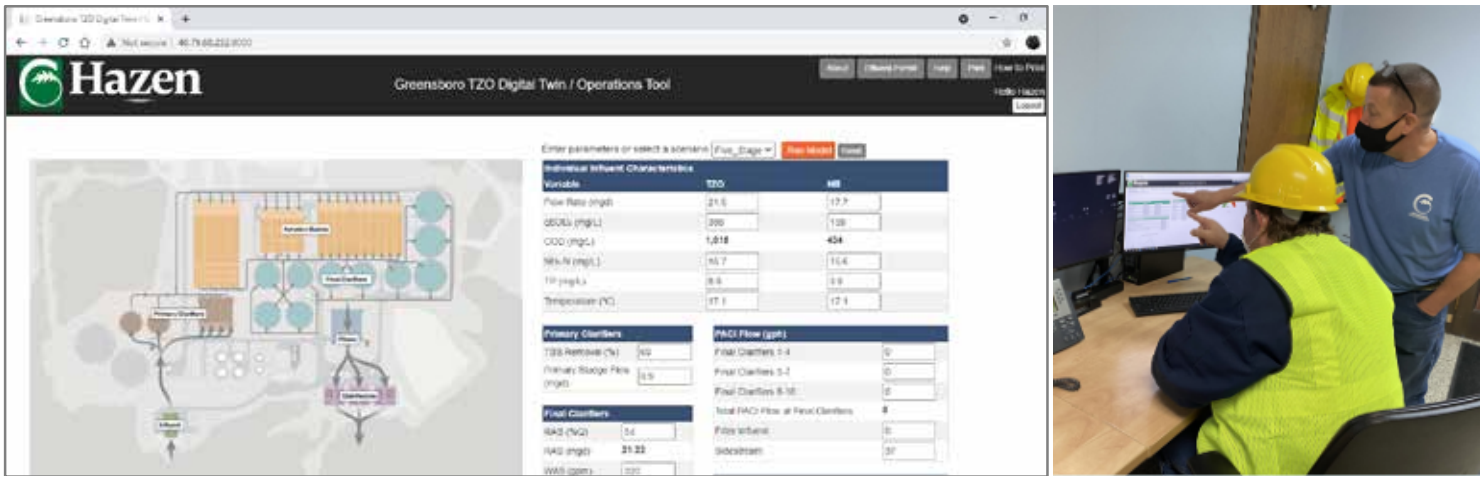
A single pane of glass was developed using existing licenses at the utility to link information together for viewing of asset information, interactive 3D models, 360-degree photos, geographic information systems, and data analytics and visualization across the organization.



An example dashboard and a photo of staff using the process advisory digital twins for evaluating treatment decisions and testing various operational scenarios.

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representation used to inform asset planning, design, construction, or maintenance, such as a geographic information systems (GIS) utility network representing a water distribution system or a BIM to represent facility assets.

Another popular version is a process representation to support system operational planning, training, and even real-time control. These process digital twins can be hydraulic, biological, and/or physiochemical process models. They may be empirical or mechanistic—or both—and may use machine learning tools for model development and implementation. Physical and process representations can even be combined for highly sophisticated digital twins to support powerful real-world models and visualizations.

The digital twins continuum demonstrates their range of complexity and how they can be leveraged to support the entire spectrum of utility needs, from long-term planning to fully automated real-time operation. Digital twins can also grow over time to encompass more assets, systems, and capabilities.

Digital Twins for Creating Visibility and Insights Across the Organization

Hazen and the Passaic Valley Sewerage Commission (PVSC) in New Jersey recently embarked on a data management strategy to integrate BIM, GIS, and business intelligence systems into a single pane of glass. This digital strategy was deployed to enable secure and scalable data sharing between business groups and different enterprise information technology (IT) systems, minimizing repetitive information and maximizing the usefulness of the data that PVSC receives and creates.

The team worked with the IT department and GIS personnel at PVSC, and also Microsoft and Esri, to outline and implement a new Esri Enterprise ArcGIS Portal in its Microsoft Azure Cloud, creating a single pane of glass for viewing building information data, geodata, operation data, and more. This initial phase also created the necessary cloud infrastructure to develop, test, and host digital twins technology that represents near real-time information in 3D-model view, 2D plans and maps, and buiding information (BI) visuals. This seamless integration has allowed PVSC staff to analyze and visualize GIS data alongside other data sources.

Process Advisory Digital Twins

Wastewater process models developed using commercial software (such as Biowin or GPS-X) are often employed for wastewater treatment facility design or process optimization planning. These models are complex and require detailed user training, frequently limiting the number of staff who can run or analyze simulations. Process advisory digital twins help overcome this operational barrier, expanding the number of staff who can

leverage model information for hands-on operator training or within an advisory mode. They act as a "flight simulator" to test the outcomes of potential process decisions. User-friendly interfaces and output visualizations empower facility operators to develop and test preset options and their own ideas for optimization without affecting actual facility operations.

Enhanced versions of these same process advisory digital twins can leverage machine learning to identify difficult situations before they happen, allowing staff to proactively address (or even prevent) the situation, rather than just react to it. Data analytics and visualizations of machine learning information can identify surface connections and patterns in data automatically, making it easier and faster than conventional data review.

The City of Greensboro, N.C., recently converted the T. Z. Osborne Water Reclamation Facility (TZO WRF) from a two-stage biological process to a five-stage biological process to address new effluent total nitrogen (TN) limits. During construction Hazen worked with Greensboro to create custom process advisory digital twins to assist with start-up. The goal of the twins was to train staff on the new TN removal process, familiarize them with all the flexibility that the new design provided, and empower them to continue to optimize the process after start-up.

This twin is based on a process model of the TZO WRF, calibrated on site-specific data to provide accurate solids production and effluent quality predictions. A custom dashboard was developed to sit "on top" of the process model, providing a user-friendly interface for training and process optimization. The twin provides a clickable aerial image of the plant, with a simplified set of inputs and outputs customized and based on feedback from plant staff. In addition to whole-plant inputs, this twin is focused on the new aeration basin configuration, providing the user with all the information needed on the flexibility of the operation.

Overall, process advisory digital twins can be a great steppingstone for utilities considering an investment in digital twins technology, providing significant operational benefits and a framework for expansion into a more-comprehensive tool.

Summary

The work at Greensboro and Passaic Valley is just an example of how digital twins can be used to assist with various aspects of utility management and operation, from advisory twins to facilitating the asset management and risk management process. No matter the application, the goal is to create a time-saving view into the function of a utility in a cost-effective manner by utilizing assets and structures that are already paid for.

By creating innovative, integrated dashboards through a single pane of glass and building process models that function as training and simulation tools, utilities can drive efficiency, improve the development of actionable insights, and save time, while also freeing up staff to work on important projects and creating connections between data and people.