Developing a Unified Definition of Digital Twins

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Digital transformation has changed how the water industry sees, interacts with, and controls water and wastewater systems. The digital transformation process started decades ago with data digitization. Once collected, data are organized into database systems that provide the data context (metadata), thus creating information out of data. Models (physics-based or data-driven) of a whole utility system or its components also have been used for decades as analytical tools that mimic the behavior of physical systems. The models process system information into knowledge about the system's current and future behavior using deterministic and/or stochastic methods. Knowledge of system behavior is then used to support utility decision-making.

Ongoing Development

Today, we're on the verge of the next major step along the digital transformation road. A June 2022 *Journal AWWA* article, "Demystifying Digital Twins: Definitions, Applications, and Benefits," examined how digital transformation uses data to support utility decision-making (Figure 1). Utilities are integrating the information they've collected over decades into decision-support systems that are characterized by combining various types of data with exponential increases in the power of processing tools, including artificial intelligence and machine learning, and traditional models such as water distribution system hydraulic models (WDSHMs).

An excellent example of this two-step transition is the change in WDSHMs, which have been widely used for decades following the development of EPANET modeling software and the availability of geographic information system data. Early WDSHMs were typically skeletonized to match available data and computer processing power, and they were used to estimate maximum- or average-day demand scenarios. Today, most WDSHMs are all-pipe models, with tens to hundreds of thousands of pipes. However, most WDSHMs still are used only to develop hypothetical maximum- or average-day demand scenarios. Future WDSHMs will use more advanced algorithms and accurate data sets to transform WDSHMs from hypothetical scenario tools into real-time modeling tools.

Once a computer model sufficiently represents reality, it can be considered a digital twin of a system component it represents. However, a comprehensive definition of a digital twin for the water industry hasn't been established. Recently, the Smart Water Networks (SWAN) Forum (https://swan-forum.com) and AWWA's Digital Twins Committee collaborated to develop a unified definition.

Developing Digital Twins

Many water professionals identified the potential benefit and use cases of digital twins in the water sector years ago, but no formal dialogue on the subject has taken place across utilities

and vendors. Although there were isolated cases of global utilities using digital twins for operational efficiency, there was minimal alignment on digital twin components or concepts. A common language and broad agreement on key concepts will help change the landscape of how utilities use digital twins to increase efficiency and conserve resources.

Based in the United Kingdom, SWAN provides a global voice for smart water, and it formed its Digital Twin Working Group in May 2019 to increase adoption of digital twins across the global water sector. The group has three primary objectives: (1) raise awareness of digital twin concepts, (2) identify the key challenges to developing digital twins, and (3) collectively develop best practices.

In 2020, a working group within AWWA conducted a digital twins survey so a wider group of water professionals could provide their perspectives on the topic and identify specific needs to guide the group. In 2021, AWWA granted full approval of the group as the Digital Twins Committee (DTC), which is within the Engineering and Construction Division as part of the Technical and Educational Council. The mission of AWWA's DTC is to develop, gather, and organize information and case studies for digital twins as well as coordinate and standardize terminology across the association and other organizations through educational content, platforms, and reference guidelines for digital twins across water utility organizations and throughout their asset life cycles.

Several AWWA committees have a rich history in advancing water sector practices through computer modeling, cybersecurity, technology, and automation. As technology has evolved, each committee has found a specific focus. For example, the Engineering Modeling Applications Committee (EMAC) consists of technical experts who focus primarily on water distribution system modeling. EMAC is responsible for authoring and updating AWWA's Manual of Water Supply Practices M32, *Computer Modeling of Water Distribution Systems*. The Water Utility Technology & Automation Committee focuses on operational technology, including updates to AWWA Manual M2, *Instrumentation and Control*.

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Members of both committees raised the topic of digital twins, considered through the lens of their specific committee focus. Other committees within AWWA also confirmed the importance of digital twins and their future. This wide-ranging interest led to the formal development of the DTC, which now includes more than 150 water professionals.

Defining Terms

One of the DTC's first charges was to develop consensus on standard terminology to clarify the definition of a digital twin in the water sector and the benefits it might bring. It's easy to debate a definition of a complex system such as a

Digital Water Transformation

Figure 1

digital twin as there are many different perspectives. However, reaching consensus is critical to helping the global water sector align its policies and practices.

Following review and discussion by the applicable groups in SWAN and AWWA, the following is our consensus definition of a digital twin in the water sector: *A digital, dynamic system of real-world entities and their behaviors using models with static and dynamic data that enable insights and interactions to drive actionable and optimized outcomes.*

Achieving a unified definition for this and other terms is a significant step forward, but it's only the starting point in educating the water industry on the topic. Multiple articles and columns within *Journal AWWA*, both published and upcoming, go into greater detail, including these titles:

- "Let's Discuss Digital Twins," (*Journal AWWA,* September 2021)
- "Houston Public Works' Journey to a Digital Twin" (*Journal AWWA,* October 2021)
- "Demystifying Digital Twins: Definitions, Applications, and Benefits" (*Journal AWWA,* June 2022)

Both SWAN and AWWA invite members to join their various committees. Please connect with us at the email addresses below to learn more about the various working groups and subcommittees within each organization. We want to hear from water professionals working at utilities of all sizes and in all roles that may interface with digital twins.

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https://doi.org/10.1002/awwa.1946