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Creating Smart Water Networks

Sensors and Models Add Intelligence to American Water’s Distribution Systems

American Water manages an impressive network of more than 49,000 miles of watermains and collection pipes that serve 15 million people in 47 states. The company is the largest and most geographically diverse publicly traded U.S. water and wastewater utility company. Given the regulated nature of its business, American Water must justify expenditures to improve its distribution systems.

“Every dollar we save on operating costs is equal to six dollars we can invest in our infrastructure without impacting our customers’ bills,” says Jian Yang, Ph.D., P.E., senior engineer, American Water. “From the executive leadership team all the way down to our operators, making the system more efficient and cutting down on the operating cost is one of our major motivations.”

With a close eye on operations, the company is quick to try and implement new technologies and approaches that add efficiency, improve planning and cut back on operating costs. American Water makes heavy use of WaterGEMS from Bentley Systems for their hydraulic modeling needs.

Eye on Integration

Water utilities have a long history of using sensors via Supervisory Control and Data Acquisition (SCADA) systems returning data about the conditions and current operational picture of their networks. Hydraulic modeling also has been extensively implemented to provide a mathematical representation of the whole water system from tanks, pumps and water-distribution pipes as well as how the whole works together in terms of its mass and energy balance relationship.
Hydraulic modeling generally has been used for long-term planning and to ensure the system can handle new development and population growth while adhering to compliance requirements. Meanwhile, data from the SCADA systems are used heavily in daily operational decisions.

“In recent years, there’s realization that these two technologies—that have existed in parallel—have much in common, and a lot can be gained by sharing information between hydraulic analysis models and SCADA systems,” says Thomas Walski, Ph.D., P.E., F ASCE, Bentley Fellow, and senior product manager at Bentley Systems. “The connection is mutually beneficial.”

Linking these two technologies allows the SCADA system to provide information on what’s happening right now, while the model provides information on what’s going to happen. Engineers can use the two technologies to see the energy and performance as well as model and simulate new designs to see how those parameters might change if new pumps, pipes or tanks are added or operations are modified.

**Isolating Pumps**

Pump performance is a critical factor for overall operational efficiency. Pumps typically account for 90 percent of the energy use, at significant cost, yet performance can’t be gauged just by looking at or listening to them.

“With the right type of data and analysis in your model, you can identify which pumps are wasting energy,” says Walski. “You can also see where pumps should not be run in combination, because they compete with one another. This insight pays you back very quickly.”

New pumps are more efficient than old ones, but cost is only one factor. A model can simulate the replacement to understand the steps and implications as well as analyze whether it’s worth buying and installing a replacement or refurbishing the existing pump.

“We look at the SCADA data to understand how the pumps operate and then compare with the pump curves and hydraulic modeling to evaluate how the pumps should be performing and how they are actually performing,” notes Yang. “You can base replacement/repair decisions on quantitative return on investment calculations rather than just a ‘seat-of-the-pants’ decision,” adds Walski.

**Responding to Breaks**

Operations people have a good handle on how things work on a daily basis, but when something goes wrong, more insight is required. In the case of a major pipe break, engineers can simulate conditions and try out potential mitigation measures virtually.

“You don’t want to play around and test changes in real time,” says Walski. “You want to simulate it first with the model, and then, if it works, you can apply it.”

The immediate response to a pipe break is event-driven and reactive. When you have a major main break, engineers and operators must assess the problem, with operations on the frontline to remedy the situation. They assess the magnitude of the break and impact area as well as come up with alternatives to mitigate the event. After the short-term fix, engineering is responsible for the long-term solution, whether operational adjustments or capital improvements such as another pipeline, tank or pump station.

After the immediate repair is made, the break triggers a long-term proactive planning effort. Historical data about pipe breaks in the area are collected, because the break can be a performance indicator for the entire water-distribution system. Engineers evaluate the system to understand whether the pipe-replacement rate needs to be accelerated or if there’s a need to improve pressure management.

“Ten years ago, if there was a major main break, operations would work to understand and mitigate,” says Yang. “They then would feed information back to engineers, who would work to try and simulate it for greater understanding. Now the operator can pick up the phone...
and call the engineer, and the engineer has a tool to model the break right away. They can do almost a real-time simulation of the break to understand the magnitude and its impact, and then also model the best mitigation with short- and long-term solutions.”

As a result of this new insight, the consequences of a break have been reduced. “While the operator or other contractor comes in to fix the problem, we can know exactly how the system behaves,” adds Yang. “We can also know where to make the best division to interconnect with the system to improve its strength or resiliency.”

Opening Up

Data used to be kept in silos, where people with water-quality data didn’t necessarily talk to people with pumping energy data or people in planning or those in the field who were drawing the map. Now there’s a lot more data sharing across all utility enterprises. The trend is to open up the data and make them available to more people for decision support.

“Within American Water, we have a number of enterprise data-analysis teams,” says Yang. “There is an SAP team for enterprise integration, SCADA for operations, a Geographic Information System with maps of above- and below-ground assets, and our hydraulic modeling. Those also tie with the customer billing system. This integration gives us ‘x-ray vision’ to improve operations and mitigate any issues.”

The people using these data no longer are in one group. They’re in different disciplines such as engineers, operators, customer service, IT professionals and other departments that handle all aspects of the data.

Ongoing Advancements

There continues to be an evolution of pressure and flow meters, but the real revolution on the SCADA side has been improved communication at lower costs. In the past, a leased phone line may have been needed to collect data from remote pumping stations. Today, there are advancements in satellite and cellular communication networks that greatly aid connectivity while keeping costs down.

“Some of our operators have moved past collecting data to synthesizing data to tell a story,” says Yang. “For example, in a treatment plant, besides collecting data for turbidity, pH, temperature, etc., they synthesize the data and do some artificial intelligence operations to understand the most-efficient chemical dosage for achieving the best water treatment.”

Enabled Insight

The “bread and butter” of hydraulic modeling has been to answer questions about new developments to understand if there’s enough fire flow for the added demand or whether improvements have to be made. Thanks to SCADA integration, modeling now is used for things happening in real time.

The trajectory for the future is about marrying SCADA data collection and automation with hydraulic analysis and predictive analytics.

“Our future distribution network will get smarter and smarter,” says Yang. “Currently, most of our time is spent collecting data. In the future, we will have more integration and insight.”
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