GREGORY M. BAIRD

Baird

Leveraging Your GIS, Part 1: Achieving a Low-cost Enterprise Asset Management System

In a television advertisement for Dr. Scholl's foot massaging gel inserts, smiling customers with happy feet ask "Are you gellin'?" The question for utility managers is "Are you G-I-S-in'?" Properly investing in a complete geographic information system (GIS) with full functionality produces an overall reduction in operating and maintenance costs and will become the foundation of a lower-cost enterprise asset management system.

Technology and computers (hardware and software) have tremendously increased the operating efficiencies of utilities. The statement does not really need any clarification. Convert any manual office process from paper to an intelligent automation system, and even though there is the initial up-front cost, the return on investment and operational savings will continue almost indefinitely.

A GIS falls into this category. A unique system of hardware, software, and data used to create, store, edit, organize, manipulate, and analyze information within a geographic area, a GIS offers the ability to visualize models of physical infrastructure in a map view. These features have driven almost every municipality and utility to adopt GIS as a functional baseline of their information technology strategy. However, if mapping is the only functionality a utility is using, the full potential of the GIS system isn't being realized.

USING AN ASSET-CENTRIC APPROACH

Water and wastewater utilities are the most capital-intensive industries. The term capital intensity is used to describe the level of assets required to support a business in the generation of revenues. The ratio of assets to revenues represents the net dollar amount of assets needed to generate one dollar of revenues. According to Olstein and coworkers (2009), capital intensity determined that for municipally owned water systems, $7.03 of investment is needed to recover revenue of $1.00. The investment to achieve the same outcome for an electric utility is $1.61 and for telecommunications is $1.11, with the average of all industries at $1.69.

Utilities require physical assets to accomplish their business purpose and function; as a result, utilities are naturally asset-centric. Many organizations may focus on their assets as costs and as a result only organize their assets for budgetary purposes based on accounting practices. For financial reporting purposes this is inevitable, but when it comes to managing assets, then the most cost-effective way of understanding how our assets work individually and collectively requires an asset-centric approach. The asset-centric approach with the power of GIS becomes a dynamic GIS-centric methodology.

RECOGNIZING THE VALUE OF GIS-CENTRIC OPERATIONS

Municipalities and utilities in the United States rely on their GIS software. The US water industry benefits overall with common open standards for consistency that help achieve lower costs with the economies of scale. GIS's powerful functionality goes beyond mapmaking.

"As . . . GIS became widely adopted and as GIS incorporated open-system standards, particularly database interoperability, organizations started to see . . . GIS as much more than maps and spatial analysis tools," wrote industry expert Brian Haslam, president and chief executive officer of Azteca Systems (producers of a GIS-based work management system for utility and government organizations). He continued, explaining that for local governments and utilities, . . . GIS is the most widely utilized and common platform for cataloging, viewing (map-rendering being just one way to view), and analyzing asset data. Many organizations have also discovered that the geodatabase is a superior tool for cataloging condensed assets such as treatment plants and facilities. GIS is now viewed as a mission-critical enterprise system and the system of choice to support management needs for utilities such as public works, transportation, land management, permit management, license management, and more (Haslam, 2010a).

In this growing green culture, the "more" will include comprehensive enterprise asset management, energy management, smart growth, smart metering and monitoring, municipal customer response management, and environmental asset management. Utility data-centric applications include financial/accounting applications, document management, biological and chemical lab analysis, supervisory control and data acquisition (SCADA)/plant control systems, customer service and billing, computerized maintenance management systems (CMMS), and GIS. CMMS and SCADA systems can directly support time-based preventive maintenance when the SCADA gathers equipment run-time information that can be passed to the CMMS to trigger the preventive maintenance actions. Alternatively, predictive maintenance techniques track equipment-operating parameters—not run times—to determine when maintenance is necessary (Draper, 2008).

Although most of these systems were originally developed to stand alone, operational effectiveness and cost savings can occur as these systems work together. The evidence that GIS is a core component is that every business application wants to connect to it.

GIS as the central asset depository. A GIS-centric organization understands that GIS is not just for making maps because the advanced data structure becomes functionally critical as the asset data management master repository. Therefore, the simple approach is to make GIS the asset registry.

Under this approach, the GIS geodatabase is used to store the asset attributes. Additionally, there is no redundancy for data storage (no reliance on views, data mapping, database triggers, or "transparent" links). All asset data are fully user-definable and customizable without vendor support. This would include common standardization such as data names, fields, tables, relationships, and other design elements. The overriding principle of interoperability is the key to providing the maximum compatibility with any other GIS-centric application, including concurrent use of the geodatabase (NAGCS, 2010).

A GIS-centric approach avoids expensive and complicated redundancy. Data exchange or interchange refers to the lowest level of sophistication for transferring data when there is no direct linkage between the two systems; rather, they run separately, and information is extracted from one business system and stored in an intermediate file that is subsequently accessed by the other business system. An interface refers to a direct connection, but similar to the interchange, the two systems still operate independently. As a result, protocols and structures must be established and be compatible within the two systems. Integration is the most sophisticated of the three methods of linking sysems together. Pure integration occurs when the two systems work seamlessly in a single entity with a single database, but this is rarely achieved (Edwards et al, 2009).

GIS-centric means that the single database is the geodatabase. There are other complicated network designs for limited purposes. According to Wikipedia (2010), an operational data store is a database designed to integrate data to make analysis and reporting easier, but it requires cleaning, resolving redundancy, and checking against business rules for integrity with a limited history because it is updated more frequently than a data warehouse.

GIS as the asset registry. The asset registry is central to any asset management program or strategy. In the US Environmental Protection Agency's (USEPA's) Fundamentals of Asset Management workshops, the first step is the development of the asset registry. USEPA defines an asset registry as a "systematic recording of all assets an organization owns or for which it has responsibility. A registry uses asset identification numbers to which attribute information can be linked." Using the GIS as the asset registry centralizes the asset's attributes and creates the home for the data to answer the first three basic questions of asset management: (1) What assets do I own? (2) What is the location of the asset? (3) What condition is the asset in? (USEPA, 2010a).

The sources of the data for an asset registry will include as-built drawings, design drawings, manufacturers' manuals, bid documents, schedule of quantities, staff input, photos, and videos.

Most asset registries are organized hierarchically, and the lowest level is the maintenance-managed item where an asset is maintained, parts are identified, or decisions are made to repair, refurbish, or replace. This lower level of the hierarchy can be associated with a work order. Understanding the asset at each level and creating lower levels within the asset hierarchy increase the confidence level of the decision-maker that the planned action is the best solution at the right time. Cost evaluations are part of this process to make the best low-cost decision. It is also important to understand that the need for obtaining data is greater at the lower levels of the hierarchy. Therefore, a data collection strategy is used to mitigate costs.

The two main approaches of generating registry data include using what is already available with the most critical assets first, using the existing crews as they respond to work orders, and hiring engineering students as interns. All future assets and projects should be required to hand off all asset data in an electronic format, with contract details spelling out the terms. Remember, everything in asset management starts with the asset registry. The next-most-critical component of asset management is the CMMS.

CMMS and asset registry as the enterprise asset management system (EAMS). A CMMS alone is not an asset management system. The USEPA defines an EAMS as a CMMS that focuses on the maintenance work order and maintenance performance for a defined period combined with an asset registry focused on an asset's performance over its life cycle and on aggregate performance of asset groups (USEPA, 2007).

A powerful CMMS, with work orders providing the ability to separate planned or unplanned maintenance costs, builds life-cycle cost history, records actual direct costs of the activity, documents the procedures followed, notes the failure mode and primary cause of failure, and allows comments on indirect costs and impacts to customers and possible unproductive time. All of these data enable the additional opportunity for failure, causal, consequence, and efficiency analysis. Having a robust CMMS is fundamental; the bells and whistles of additional asset management applications cannot make up the difference.

A GIS-centric EAMS not only contains work order functionality (such as scheduling jobs, assigning personnel, reserving materials, recording costs, inventory control, and tracking other relevant data) but advances to include inspection data with details and ranking of the asset's condition, work history, performance, and physical data (specifications, purchase date, expected life, warranty and service contracts, valuation) in order to conduct risk analysis. Condition-based maintenance is predictive maintenance initiated on the basis of the asset's condition as an alternative to "failure-based maintenance" or "use-based maintenance" triggered by time or meter readings. By establishing and tracking safe minimum levels of performance and changes to operating procedures, the shared GIS geodatabase environment accessed transparently through the CMMS and data-enriched with work history produces a reliability-centered maintenance process to ensure assets continue to do what their users require in their current operating status (Haslam, 2010b).

THE POWERFUL COMBINATION OF GIS AND CMMS CREATES A LOW-COST EAMS SOLUTION

The Water Environment Research Foundation states that condition assessment establishes the current condition of assets as a means of prioritizing and forecasting maintenance and rehabilitation efforts. Condition assessment can help operators understand the level of asset deterioration and the effect on the probability and consequence of failure (WERF, 2010).

The data contained within the CMMS provide for prioritizing assets based on poor current performance:

- high unplanned maintenance cost (those that exceed 15% of replacement costs),
- high consequence of failure (the cost of the consequence exceeds the replacement cost),
- high ratio of unplanned to planned maintenance (unplanned maintenance exceeds 50% of planned maintenance),
- high total maintenance cost (exceeds 20% of replacement value).

ACHIEVING OPERATIONAL AND MAINTENANCE SAVINGS

Other critical operational metrics include maintaining an 85–95% level of planned work. This is the portion of corrective maintenance work hours that are scheduled in advance by the CMMS (allocating human capital effectively for greater cost savings). Keep in mind that the total cost is the planned and unplanned maintenance for each asset. Overtime is another cost factor that needs to be managed. As a target, only 5–8% of the maintenance work hours should be performed at an overtime rate. Maintenance workers should spend 70–85% of their working hours on productive activities versus rework or waiting for parts. Annual maintenance spending as a percentage of asset replacement value of the plant being maintained should be 1.5–2.5%. The percentage of rework (poor installation and workmanship or incorrectly prescribing a fix) should only range between 2 and 5% (USEPA, 2010a).

CMMS WORK HISTORY IS THE LOW-COST CONDITION ASSESSMENT TECHNIQUE

The capital invested in the total cost of the asset increases on an asset cost curve in which low-cost preventive and predictive maintenance is deployed for assets rated to be in good or fair condition. Rehabilitation, renewal, and replacement become the remedies for poor and failing assets. Understanding and tracking the condition of the asset are vital to the entire asset management process. Making capital investment decisions on age alone will only waste limited funding. Applying condition assessment techniques, including work-history review and analysis, is vital for achieving greater cost savings.

Condition assessment techniques increase on a cost curve. The work history of a robust CMMS is the low-cost method of performing condition assessment and asset management decision-making. More expensive condition assessment techniques include visual inspections, nondestructive and destructive testing, smoke testing, dye testing, lamping, video inspection, sonar, ground-penetrating radar, and digital imaging and analysis.

The more cost-intensive condition assessment techniques are only applied to expensive and critical assets. Large-diameter pipes with high water loss or a low remaining useful life are a prime example of such assets. Other at-risk assets could be identified because of high cost risks, poor condition, and performance scores approaching minimum levels of service and no redundancy. The CMMS work history may already identify "hot spots" of concern in the system. Using the "stepped approach," CMMS work history is used for most of the assets, whereas more sophisticated and expensive assessment techniques are only applied to higher-cost, higher-business-risk assets. Waiting for a critical asset—such as a water main—to fail may cost two to three times more by creating a large destructive sink hole and boil-water orders for a community.

The more a utility understands its assets—the demand for the assets, their condition and remaining useful life, their risk and consequence of failure, their feasible renewal options (repair, refurbish, replace), and the cost of those options—the higher the confidence everyone can have that the utility's investment decisions are indeed the lowest life-cycle cost strategies for sustained performance at a level of risk the community is willing to accept. This process is called asset management (USEPA, 2010b).

The goal is affordability and sustainability. Leveraging all the power of GIS helps improve the cost-effectiveness and reliability of an asset management program. Combined with a robust CMMS, better allocation of resources and a lower cost risk analysis can be achieved.

—Gregory M. Baird, greg.m.baird@agingwaterinfrastructure.org, is managing director and chief financial officer (CFO) of AWI Consulting LLC. He has served as the CFO of Colorado's third largest utility and the finance officer of California's fourteenth largest city. He has participated in the issuance of more than $1 billion of municipal bonds and has consulted at the city, county, and state levels of government. Baird is an active member of AWWA and serves on the Rates and Charges Committee working on the update of Manual M1, Principles of Water Rates, Fees, and Charges *and is on the Affordability and Conservation subcommittees. He is also on the Economic Development and Capital Planning Committee with the Government Finance Officers Association (GFOA) for the United States and Canada, a member of CGFOA for Colorado, and the California Society of Municipal Finance Officers. He is also the rates and affordability chair for WIN-Colorado, the statewide coalition formed to address the aging infrastructure issue. Baird has an MPA from Brigham Young University's Marriott School of Management and received formal rate training from the National Association of Regulatory Utility Commissioners at Michigan State University's Institute of Public Utilities.*

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