



Baird



Leveraging Your GIS, Part 2: Optimize Capital Planning and Savings

Municipalities and utilities are facing serious declines in revenue. The initial reaction to this situation is to cut operational and capital budgets. Although this may meet a short-term or single-year goal, it will only increase the burden on future rate increases and weaken the overall financial capacity of the enterprise. Good financial planning will always offer solutions to reduce future rate increases. In this new economy, utilities are being forced to use what they already have, which in turn requires a more creative approach of existing system use. Properly investing in and using a geographic information system (GIS) with full functionality will result in an overall reduction in capital project costs and operations and maintenance costs and will become the foundation of a lower-cost enterprise asset management (EAM) system. Leveraging your GIS to reduce operations and maintenance costs was addressed in part 1 of this column in the October issue. This month's column focus-

es on how to use your GIS to achieve capital savings through optimized decision processes.

A technology survey conducted by AWWA in 1993 showed that 64% of utilities had some level of interest or involvement in GIS implementation. Fifty-five percent indicated the GIS needed to interface with a hydraulic model. The survey also showed "that the degree of computerization and the interest in new technology within utilities in the water industry are higher than anticipated and that the integration of GIS with FM [facilities management] or implementation of comprehensive AM [automated mapping] and FM [known today as CMMS—computerized maintenance management system] will provide maximum benefit to water utilities" (Purves & Cesario, 1993).

UTILITIES ARE BECOMING MORE GIS-CENTRIC

Today, many utilities have experienced positive returns from GIS technology. The US water industry benefits overall through standardization, common open standards

for consistency, and lower costs through economies of scale. GIS's powerful functionality goes well beyond mapmaking. Utilities must have physical assets to accomplish their business purpose and function; as a result, utilities are naturally "asset-centric." Many organizations focus on their assets as costs and as a result only organize their assets for budgetary purposes based on accounting practices and applying straight-line depreciation. When it comes to managing assets, however, the most cost-effective method for understanding how assets work—both individually and collectively—requires an asset-centric approach. When the power of GIS is fully used, it becomes a dynamic GIS-centric methodology (Baird, 2010).

Brian Haslam, president and CEO of Azteca Systems and a GIS-centric industry expert, explains, "Every municipality and utility is on a timeline of how much GIS functionality they employ and how GIS-centric their EAM becomes. As they move from short-term objectives to be more asset data-driven to optimize their

operations, they will progress along and convert to a GIS-centric approach in order to capture the maximum of both short-term and long-term savings” (Haslam, 2010a). Haslam has also stated that GIS is the best place for both dispersed assets and condensed assets (such as treatment plants and facilities) and is now viewed as a mission-critical enterprise system and the system of choice to support management needs (Haslam, 2010b). Azteca Systems was recently distinguished as a “global industry leader” for GIS-centric asset management, work order, permitting, and licensing solutions (Cityworks, 2010).

GIS AS A CONDITION OF FINANCIAL ASSISTANCE

The US Environmental Protection Agency (USEPA) recently released the Clean Water and Drinking Water Infrastructure Sustainability Policy. The policy states “Drinking water and wastewater systems should use robust and comprehensive planning processes to pursue water infrastructure investments that are cost-effective over their life cycle, are resource-efficient, and are consistent with community sustainability goals. Systems should also employ effective utility management practices, including consideration of alternatives such as natural or ‘green’ systems and potential climate change [effects], to build and maintain the technical, financial, and managerial capacity necessary to ensure long-term sustainability” (USEPA, 2010).

The development of a full-fledged GIS supports the data needed to build and maintain the technical, financial, and managerial capacity required by the USEPA. In fact, the new policy states, “Communities [that] lack the technical, managerial, and financial capacity to become and remain sustainable should be encouraged to acquire it as a condition of financial assistance” (USEPA, 2010).

LEVERAGING GIS IN SUSTAINABILITY PLANNING

Current planning practices require the use of GIS technology, not just specifically for utilities but for communities as a whole. USEPA and the Department of Transportation (Federal Highway Administration) have worked together to develop case studies to support communities that are considering multisector or “whole of government” AM strategies. To meet renewal challenges and simultaneously address the essential expansion and upgrade of our infrastructure calls for exploring new processes, practices, and skills crucial for the long-term sustainable management of assets (USEPA, 2009).

The United States is not alone in having to address infrastructure issues. Other countries, such as Australia, continue to introduce many new internationally tested AM principles and practices. These methods offer communities established approaches in systems-monitoring capabilities, information handling, and advanced decision-support systems that can function across service sectors (e.g., water, wastewater, highways, airports, mass transit). Canada continues to embrace these new tools and techniques to make better decisions about optimal investment and reinvestment strategies.

OPTIMIZING CAPITAL SAVINGS WITH GENETIC ALGORITHMS

GIS is mission-critical for a robust and comprehensive capital planning process. The geodatabase of the GIS can be used as the asset registry and as the core data repository for all assets. This database can be used to create a comprehensive “all pipes” hydraulic model. An all-pipes model can offer both operational and capital efficiency analysis. Paired with an optimizing genetic algorithm (GA) application, tens of thousands of scenarios can be quickly run to deter-

mine the low-cost/best solution combination based on individual community goals. “This new fundamental GA process identifies alternatives all along the cost curve, demonstrating a significant capital cost savings as opposed to outdated trial-and-error scenario runs,” said Jeff Frey, cofounder-technical director of Optimatics (an international water and wastewater system optimization company). Frey also noted that “GA optimization has proven to be extremely effective where decisions need to be made regarding a complex system. This developing trend of optimized decision support [ODS] demonstrates efficient management of water resources, which optimizes even 50-year water master plans, irrigation systems, operations, risk-based renewal and replacement strategies, new source water planning, and wastewater systems. The cost-effective analysis curve demonstrates the optimized solution” (Frey, 2010). Many utilities are applying GA optimization analysis to determine low-cost and hydraulically viable scenarios as part of reliability and redundancy planning efforts (Optimatics, 2010). This level of analysis is critical when communities have grown quickly and their system now comprises several small- and large-pressure zones that may need a comprehensive review for operational efficiency.

With the lower cost and availability of computer processing time, hydraulic models can be used for many purposes and not sit on the shelf for three to five years between master planning activities. “Hydraulic models will also be used for distribution system management to determine effective options for age reduction. With the GIS and hydraulic model combined, more effective operation and control of distribution systems can be achieved to ensure the highest quality of water” (Wilkes, 2010).

ACHIEVING AND DEFENDING ROBUST CAPITAL PLANNING EFFORTS

Pressure on utility water resources and capital planning efforts will continue, especially in this new economy. Integrated resource plans will require ODS efforts before approval and funding are obtained. City councils and water boards will require more scrutiny of project alternative analysis. Developers will demand ODS for new development in order to verify and possibly reduce future capital costs for capacity and expansion. This optimized process also will be used to justify and test the capital costs used in calculating local developer connection and tap fees, especially in litigation-sensitive environments. The key to sustainability planning includes leveraging the investment in GIS for both the CMMS and the optimized hydrologic model.

A critical list of additional action items includes the following:

- Change procurement practices to select bids based on total life cycle costs, not just the initial low bid price. Life-cycle operations and maintenance costs are often 5–10 times (and sometimes as much as 20 times) the initial construction costs.
- Use a robust CMMS to balance planned maintenance costs with expensive unplanned maintenance.
- Apply CMMS work history feedback for redesign and hydraulic model optimization to select capital projects, considering that the capital process locks in 65–85% of all of the life-cycle costs in the project identification and preliminary feasibility design phases. Life-cycle cost-reduction opportunities diminish progressively through detailed design planning, construction, and project startup phases.
- Avoid the default decision to replace the entire asset by reviewing CMMS work history and conducting condition assessments to determine where and when a rehabilitation technique (e.g., trenchless

technology for pipes) can be applied to extend the life of the asset.

- Reform the role of the finance officer to think less like an accountant and more like a financier. This includes separating operations costs from maintenance costs to better track performance and cost-saving metrics. Traditional government financial accounting is restricted to using historic costs rather than replacement costs, which drastically limits the benefit of the financial reports for infrastructure investment decision-makers.

LEVERAGING A GIS-CENTRIC APPROACH TO ACHIEVE A LOW-COST ASSET MANAGEMENT PROGRAM

A common definition of sustainability is to endure. Effective “endurance” requires the continual application of the best methods and new technologies to the operational and capital planning activities of communities.

Sustainable capital planning gives us confidence that the project recommended is the right solution at the right time for the right price. A strategic capital financial model and analysis considers the life-cycle costs—the original price less salvage value, plus operating costs, maintenance costs, renewal costs, and decommissioning costs (USEPA, 2007).

Technology has truly transformed the water industry. As public health concerns and regulatory requirements increased, filtration, disinfection, and softening were added to the treatment train. Advances were made in laboratory analysis and chemical treatment to detect and remove harmful chemicals. Improvements in metering and supervisory control and data acquisition systems helped resolve many water pressure issues. Improved data for work crews are available through GIS/CMMS. Today, we also have the capability to construct accurate and detailed hydraulic models of our distribu-

tions systems and to complete analyses using GAs that provide the optimal, lowest-cost solution that meets many different constraints (Roost, 2004).

The fundamentals of AM, listed here, continue to be the most critical actions to ensure infrastructure sustainability.

- Develop an asset inventory (a list of assets and their principal components).
 - Assess asset condition and failure modes (quantifying the deterioration rate and remaining useful life of the asset, not just the age-based analysis).
 - Determine residual lives (i.e., the remaining useful life of the asset).
 - Evaluate life-cycle and replacement costs/economic evaluation (the sum of all costs throughout the life of an asset, including planning, design, acquisition, construction, operation, maintenance, rehabilitation/renewal, and disposal costs).
 - Set a target level of service (a defined standard against which the quality and quantity of service can be measured). A level of service can include reliability, responsiveness, environmental acceptability, customer values, and cost.
 - Determine business risk exposure/criticality (the chance of something happening that will affect the objectives). Risk is measured in terms of likelihood and consequences.
 - Optimize operations and maintenance investment (keeping an asset operating as designed or preventing it from deteriorating prematurely).
 - Optimize capital investment strategies.
 - Determine funding strategies.
 - Build an AM plan—an enterprisewide plan that includes AM for multiple sectors (USEPA, 2009).
- The most basic operational components of GIS, CMMS, and hydraulic modeling are the keys to achieving low-cost success in imple-

menting EAM strategies. The challenge is to transform the thinking and behaviors of operators, engineers, finance professionals, municipal management, elected officials, and the public so that they will understand and adopt the cost-saving principles of effective life-cycle management. This effort should begin with water systems (because they are critical and life-sustaining) and then be extended to all public infrastructure so that we can build enduring processes to help us achieve long-term cost savings for sustainable communities into the twenty-first century.

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