Case Study: Implementing Topobase at LVVWD

Challenge	**To seamlessly integrate CAD and GIS data with minimal impact on user productivity**
Solution	**Utilize Autodesk Topobase to manage spatial information for assets**
Benefits	• **Enhanced data quality** • **Completed projects 20 percent faster** • **Reduced annual overhead costs for legacy system and data maintenance by $460,000**

The Las Vegas Valley Water District (LVVWD) is the largest water purveyor in southern Nevada serving more than 1 million people. The LVVWD manages its asset and facility information within a single organizational structure, the Asset Management/Facility Management/ Geographic Information Systems (AM/FM/GIS) Division. This Division consists of staff with geographic information system (GIS), computer-automated design (CAD), and land survey expertise, as well as information system application development.

Las Vegas, including its metropolitan area, is one of the fastest-growing cities in the U.S., exploding with both commercial and residential development at a rate of 6 percent annually over the past 10 years. At any point in time, the LVVWD is supporting more than 1,500 active projects, and the AM/FM/GIS Division is processing more than 200 new projects and work orders each month. An average of 200 miles of distribution and transmission main are installed annually, driving an increasing demand on the LVVWD for spatial information services. To address the current and future needs for this information, the LVVWD looked to Autodesk for a solution that would leverage its legacy data management systems and existing design tools while providing enhanced data quality and faster turnaround of its services for customers. Autodesk provided training and consulting services to facilitate implementing Topobase at LVVWD.

The Business Challenges

Organizational Background

The LVVWD is a not-for-profit, quasi-governmental agency, responsible for ensuring water is available to more than 1 million people in southern Nevada. The AM/FM/GIS Division within the LVVWD supports information management systems that deliver information to several internal and external customers.

- Engineering Design – Process new engineering service requests from developers and their engineering and architectural contractors for new residential and commercial building projects.
- Planning Division – Process and deliver information regarding water usage to support planning for new distribution systems.
- Inspection and Major Construction – Support work order requests for inspections at new construction and rehabilitation of existing systems.
- Customer Service – Manage information from enterprise customer information and financial data applications to support customer service inquiries.
- Water Supply Operators – Provide as-built drawings of the distribution networks for maintenance and repairs of facilities.

In addition to responding to an increasing demand for products and services resulting from the exceptional growth in the area, the AM/FM/GIS Division was challenged with

keeping the costs for delivering its services relatively low while satisfying expectations of staff, management, and customers.

Business Drivers for Enhanced Spatial Capabilities

One of the main tasks of the AM/FM/GIS Division is the generation and maintenance of as-built information for its facility and pipeline distribution network. The Division internally had developed significant automation to integrate CAD and GIS technology. This approach was the foundation for developing highly productive as-built and map generation systems as well as advanced office and field data distribution systems. However, with recent advancements of spatial technologies, new requirements surfaced that could not be addressed; this included cross-system support for geometric networks and key database data quality functions.

The Division identified significant costs associated with lack of support for real-time spatial and attribute validation. Validation is needed to ensure that that the physical properties of the GIS database accurately reflect the engineering characteristics of the water distribution network, including connectivity and logical relationships between appurtenances. Many of these checks could be performed only after the project was “as-built” and residing in the GIS database. As a result, the Division expended as much as 25 percent of its GIS staff time to correct postprocessing connectivity and logical errors.

Maintenance of the legacy system was also a costly overhead burden. Procedures were written in a number of programming languages to achieve integration of CAD and GIS data. Although these programs did achieve integration of the data, significant effort was required for development and testing when changes were implemented. For example, some code changes required as much as a month of testing to validate system functionality.

The business drivers focused on reducing the overhead burden of maintaining the quality of data within the legacy system environment and the increasing demands from customers for better delivery times. The goals for selecting and implementing Autodesk Topobase included:

- modernizing the content management of the CAD/GIS system that the Division uses
- creating efficiencies and collaboration between the CAD and GIS work groups, including capabilities for multi-user editing, version management, and real-time attribute and spatial data validation
- providing the flexibility and power to perform a wide variety of validation in real time while the as-builts were being verified.

Information Management Systems at the LVVWD

Legacy System Architecture and Functionality

The LVVWD legacy system supported AutoCAD Map, ArcMap, and custom applications with an Environmental Systems Research Institute (ESRI) ArcSDE geospatial database.

The legacy process incorporated several applications to support the integration of AutoCAD and GIS processes. The system included interfaces that permitted AutoCAD users to request information directly from the spatial database engine (SDE) and perform edits to GIS data that would be automatically incorporated again into the SDE environment. CAD users accessed GIS data using a system that brokered requests from SDE. Layers and features automatically were converted from SDE into standard AutoCAD map layers and blocks based on standard geographic extents. A feature-level locking system was used to coordinate edits between CAD and GIS users.

CAD2ORA was used to “edit” and apply “attributes” to map features. Attributes were

stored in Oracle and were later incorporated within SDE when the CAD user submitted the completed project work. The submittal process automatically extracted the AutoCAD project layers into ARC/INFO coverage and a series of automated quality assurance checks and processes were performed, all of which were logged to ensure quality control.

Any existing versions were reconciled using Project Loader, an application developed by the LVVWD that flagged any inconsistencies between versions. After reconciliation, the data were loaded into the SDE geodatabase. Staff could then generate maps using ArcMap or could extract the data for further editing using AutoCad. The workflow for typical data processing using this system is shown in Figure 1.

While this system supported the LVVWD workflow and business processes, it required high-level maintenance. The system contained over 41,000 lines of code, and used multiple programming languages and a hard-coded interface. The system was constrained by the large amount of code, complex architecture, and lack of open architecture of the multiple components.

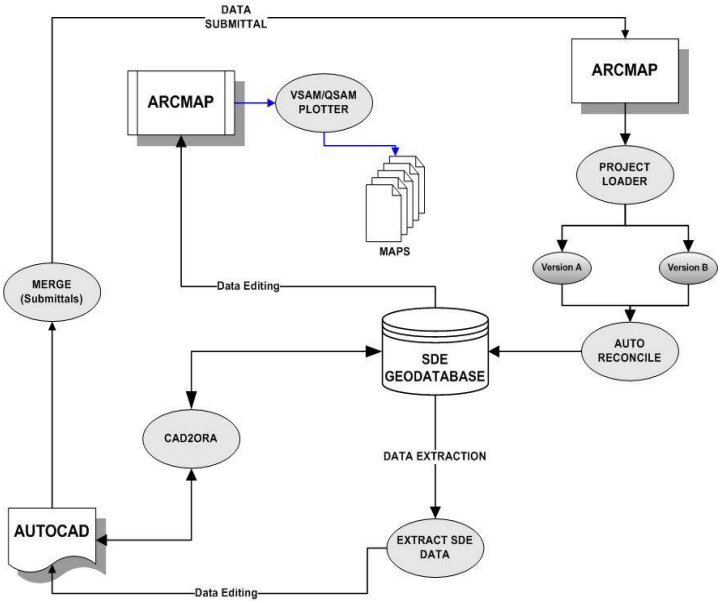

Figure 1 Legacy Spatial Data Processing

Enhanced Spatial Data Processing Using Topobase

Autodesk Topobase enhances the LVVWD legacy system with the following features and benefits:

- Open, flexible architecture that easily integrates Topobase with the existing legacy system and supports other enterprise data management systems, such as Hansen and PeopleSoft. Topobase adheres to the Open Geospatial Consortium specifications and uses a powerful application programming interface (API) to store data in native database formats. This flexibility allowed the Division to create custom applications to support business processes.
- Infrastructure design and management within a single environment. The enhanced environment provides tools to manage all the events that take place in the life cycle of infrastructure assets. A key component is the capability for on-the-fly spatial validation using Topobase display models to visually confirm connectivity in the water distribution network. This capability reduces an existing layer of legacy code that checks for data integrity and quality issues.
- Centralized spatial information database with the ability to synchronize data between the CAD and GIS applications using a common Oracle Spatial database. By leveraging the Oracle Spatial database, Topobase creates a layer of data management to simplify the process of working with geospatial information. Efficiency of the business processes are achieved by eliminating the overhead burden for checking errors and maintaining additional code.

Implementation of Topobase at the LVVWD

Approach for Implementation

The LVVWD leveraged its Oracle Spatial database to create an enhanced data management system integrating CAD, map, asset, GIS, and customer information to support Division business processes. Oracle Spatial is a key enabler of the Topobase functionality by providing a way to store and retrieve multidimensional data such as points, lines, or polygons. With its open operating environment, Topobase can easily integrate existing GIS and enterprise systems to provide data to other parts of the organization.

Because 90 percent of the GIS content that is managed by the Division is developed in AutoCAD Map, the enhanced system needed to support existing business practices and processes. As shown in Figure 2, a typical project involves a number of different customers and handoffs between functions within the LVVWD. Information is provided in nondigital format to the Planning Division and is digitized to create the development plan. A global-positioning system (GPS) is used to capture field data and produce digital field markups that are verified during construction by field inspectors and automatically modified to produce “as-builts” and content for the GIS.

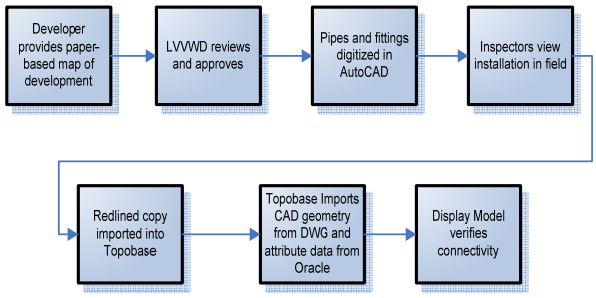

Figure 2 Typical Project Workflow

Compared to other systems, Topobase provides a more flexible data model, allowing the LVVWD to implement design models that accommodate the type of data managed. Topobase also supports the development of custom forms using .Net, an industry-standard technology, allowing the LVVWD to streamline and simplify its data management effort. By selecting an application designed and supported by an industry-leading company, the LVVWD was able to rapidly integrate Topobase with the legacy system to support its business processes using in-house staff without the need to acquire specialized training. The LVVWD achieved high productivity and needed precision using CAD software for GIS data/content management. Topobase complemented these existing work processes and automated drawing systems. These were key factors in the LVVWD decision to integrate Topobase with the existing legacy system.

System Design

Two of the LVVWD primary requirements were that the enhanced system present a familiar look and feel and support its existing production tools. Topobase provides the integration between the map rendering in AutoCAD Map and the geometric validation tools to ensure that the engineering-based water distribution network data is accurate and precise. Figure 3 shows the design of the enhanced system and the system interoperability of the databases of SDE and Topobase.

Key system design elements for the successful Topobase implementation with the existing system included the following:

- Synchronization of parallel databases, reduction of error checking, and manual conversion of data from SDE to Topobase
- Use of display models that are standard for Topobase and the ability to generate customized tools and forms to support project workflow.

Synchronized Parallel Databases

Although the AM/FM/GIS Division had considered several data models for utilizing the legacy SDE and Topobase databases,

the Division implemented a synchronization model that is transparent to the users. The approach allows users to use the database and tools that best support job functions. For example, the existing map production systems produce more than 6,000 maps annually with ArcMap tools. The synchronization model incorporated these functions:

- Conflict resolution is avoided altogether by employing feature-level locking during data editing. Preventing conflicts is more cost-effective than resolving conflicting data edits during project reconciliation.
- Versioned edits are performed in both systems (Topobase and SDE). Data are automatically synchronized between systems when published to the “live” or “default” state.

Synchronization is easy to perform using the add/delete/modify actions to edit Topobase jobs and SDE tables. The integrated system provides a push-button solution that is performed at the Topobase and ArcObjects API levels. Synchronizing the two databases updates the information management system for any changes made within either Topobase or SDE applications.

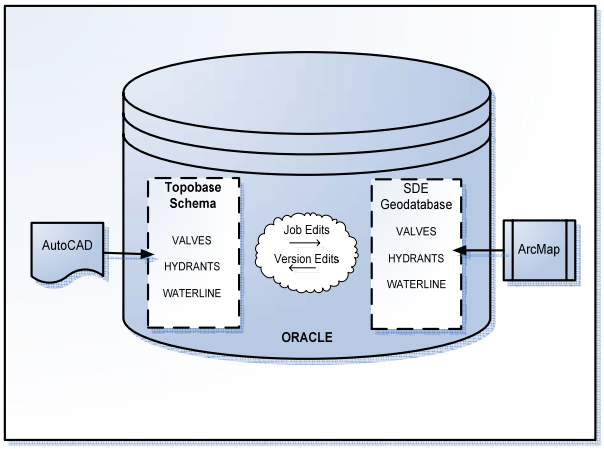

Figure 3 System Interoperability (SDE and Topobase)

Display Models

The enhanced system takes full advantage of Topobase Display Models, which assign symbology to feature classes based upon display rules. For example, air-vacuum, air-release valves, and butterfly valves are displayed using different symbols depending upon the attributes of the type of valve. Topobase Display Models also support real-time spatial and attribute validation on-the-fly and are an example of the Topobase inherent flexibility.

The Display Models are used to notify the user when geometric network connectivity rules are broken by reacting to changes to a feature quality attribute. For example, if a waterline is moved on a map, the associated valves that have not moved are flagged automatically as disconnected from the network. The Display Model immediately recognizes the flag and uses a different symbol when drawing the valve. This in turn causes the engineering staff to make a deliberate decision regarding the need to move the disconnected valve to the new waterline location. Flexibility in the design of the system allows use of the same rules base and display models, even when edits are made via Structured Query Language (SQL).

Customized Tools

The LVVWD customized the editing environment in Topobase to follow its business rules and current work processes instead of imposing software constraints and changing its business processes. Customized tools that automate some basic Topobase functions were developed easily in VB.net code by internal staff. These functions include “Split Feature” to edit a feature for connectivity, and “Create Perimeter” to increase the “Jobs” perimeter work area on a map.

Versioning the data is simple when using Topobase. The editing tools can prohibit other users while data are edited. Once a perimeter is established for editing, the features are locked, and access to other users is denied. This ensures that the correct version is available for other users.

LVVWD Realized Benefits by Implementing Topobase

Cost Savings

Cost savings resulting from the implementation of Topobase include the following:

- Faster turnaround of projects and services to customers. Project completion rates are anticipated to improve by at least 20 percent, resulting in the collection of additional fees for the same administrative cost.
- Reduction of time for data review and error correction. The effort for data correction is expected to be reduced by at least 15 percent. Based on its current workload, the Division estimates that it realized annual cost savings of approximately $250,000 resulting from improvements in efficiency and lessened database administration.
- Overhead cost reduction. An additional savings resulted from reducing the overhead associated with managing legacy CAD/GIS interoperability and content management systems. The Division estimates that it achieved annual cost savings of $210,000 in this area. Topobase replaced these systems and significantly reduced complexity—requiring only 7,600 lines and providing more functionality. The Division estimates that the enhanced system will reduce costs associated with the system operation and maintenance by at least 60 percent—an annual cost savings of approximately $460,000.

Fast Integration and Implementation

New tables in the Topobase schema were created based on the existing GIS database design of the Division and were populated by batch file insert statements, allowing rapid data design and deployment of the Topobase system. Both the legacy system for as-builts and Topobase systems were operated in parallel for several weeks prior to full implementation, allowing the Division to phase the implementation. The Topobase system was implemented within 5 months and provided a simpler, yet more powerful system, for CAD/GIS data integration.

The LVVWD and Autodesk Consulting collaborated in planning for the deployment of the enhanced system. Training sessions and hands-on workshops developed internal Topobase system development capability and obtained user feedback and suggestions. The initial rollout of the system was performed with a group of power users who became in-house experts and technical resources to the general user population. Using this approach, the Division was able to anticipate user issues and accomplished the change-over to the new system with a high level of user acceptance.

Improved Response Times and Data Quality

The Division also achieved faster turnaround of the redlined markups of “as-builts.” GPS data collected by the inspectors are integrated into the maps and downloaded into the database. The software connectivity tools ensure that any changes to the original construction plans are reviewed and that spatial data are validated, allowing the Division to turn around reviewed “as-builts” in less than a day.

Implementation Results

The Division is now able to easily handle as-built drawings for approximately 200 projects and work orders per month and incorporates higher quality data into the GIS automatically. No backlog of requests for maps and “as-builts” exists, and staff can focus their efforts on systems development rather than maintenance. Support for geometric networks and logical connectivity are maintained and generated in real time as “as-builts.” Database and application tools maintain the accuracy of the data and provide a visual indicator of potential problems in the spatial maps. New feature classes can be created or modified much more quickly within one week using Topobase than with the legacy system.