Migrate Mapping of Transmission Pipeline Data From ArcView to ArcGIS

Abstract

California Gas Transmission (CGT) at PG&E has used GIS to manage its more than 6,000 miles of pipeline facilities since 1993. We began by transferring all of our paper maps to CAD. From there, we transferred all of our data to ArcInfo. Updates to our system were made in ArcView. The data was stored in ArcInfo covers and was becoming very unmanageable. We needed a good way to have many people editing the database at the same time. We decided to implement a versioned Geodatabase in ArcGIS with ArcSDE for SQL. This process took more than 2 years. We migrated on Nov 11, 2003. The focus of this paper is to highlight our process, failures, and successes. Our GIS is used to support Engineering, Planning, risk management assessments, compliance with the new Integrity Management Rules for Pipelines, analyzing class location changes, and Underground Service Alert notifications.

Assumptions

This document assumes the reader is familiar with ESRI's GIS software. Terminology is used throughout this document that refers to features of ESRI's software.

Who is CGT?

California Gas Transmission (CGT) is a business unit of Pacific Gas and Electric Company (PG&E). PG&E is a privately held utility serving more than 4.0 million gas customers and 4.8 million electric customers in northern and central California. CGT manages PG&E's gas transmission business. It has over 6,000 miles of pipelines ranging from 2" to 42" and operating between 61 psig and 2160 psig. CGT transports natural gas from Canada and Texas. It also transports California gas production to the local distribution pipelines that serve its California customers.

GIS History at CGT

Digitizing paper maps into CAD was the first step in populating CGT's GIS. The CAD pipeline vectors (segments) were "tagged" with a unique number. The pipeline segments were joined to a spreadsheet that contained data from the existing pipeline alignment sheets with the same unique number. The point facilities along the pipeline were added and populated with data.

The core data was stored in ArcInfo covers. ArcView was used as a "front end" to maintain pipeline facilities. A large investment was made to develop Aml and Avenue scripts that would enable ArcView to have a robust CAD-like capability.

The data was checked out from ArcInfo via ArcEditor using Remote Procedure Calls (RPC). The mapping group performed edits and the data was turned back over to the administrator for updating the master ArcInfo covers.

Two major problems arose from this method:

1. Validation of individual field values was not performed. This led to incorrect or inconsistent values being populated in the fields.
2. This “check in” process had only rudimentary validation. There was a cursory check of the outgoing number of segments and the incoming number of segments. Pipe and facilities could potentially be inadvertently deleted and not discovered until much later. This did occur and cleaning up small-scale corruptions of the data is ongoing although most have been identified.

This process worked well as a beginning, but as the size and utilization of the GIS increased, we were concerned that its drawbacks could be fatal. During the year of 2000 and 2001, PG&E considered separating CGT as a separate company. A separation from the parent company would eliminate CGT’s access to the paper maps maintained by the gas distribution business. It also required additional information to be added to the GIS. This provided the driver to improve the GIS and ensure the integrity of the data and investment made to develop our GIS.

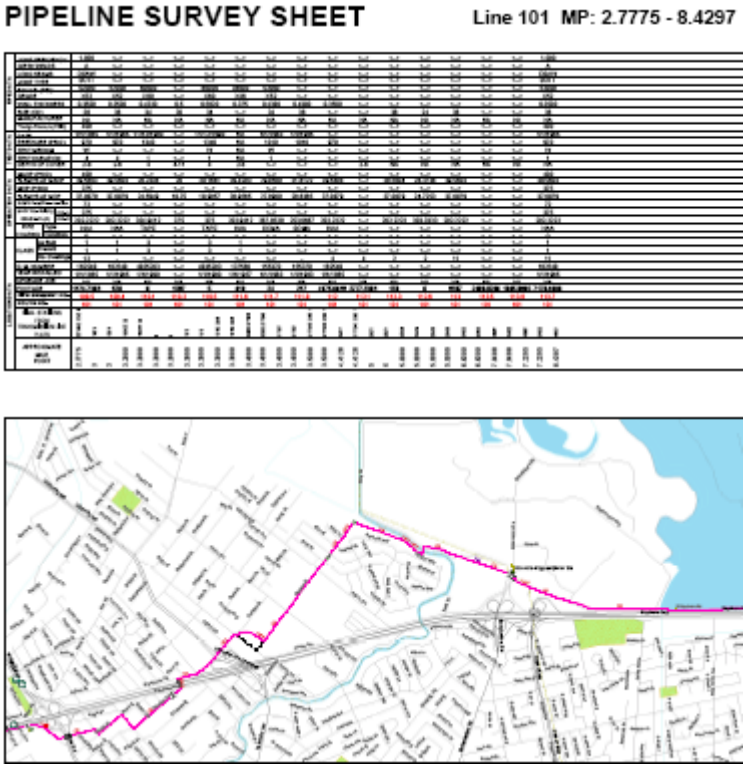
GIS Design at CGT

CGT’s system software is ESRI’s ArcGISArcGIS suite of GIS solutions. ArcSDE 8 for SQL is serving the data. There are 6 editors using ArcEditor and 4 administrator’s using ArcInfo. VISIO was used to design the geometric network. A versioned Geodatabase is used in a geometric network.
The first network was created as a separate instance on the SQL server. At the same time development feature datasets were created. Test data was migrated over to this development database. The data then remained as a snapshot for testing.

The pipeline is modeled with segments at each change of specification. The stationing (measurement) value is Milepoints. Milepoints exist at the beginning and end of each segment with a 4 decimal precision. The Milepoints either came from historical values, or were calculated. The Milepoints are prorated along the segment to produce stationing. Also participating in the network are points (events). These points include Stations, Cathodic Protection, Taps, Valves and miscellaneous other point features.

Linear referencing was attempted along with the base geometric network. This model did not work because of the need for recalculating the route every time an edit was made to a point. Although tools were created to handle that requirement, it added an extra layer of complexity that did not produce enough benefit.

Failure: Linear referencing events. This method was trained and implemented, but was abandoned a month later. Those points were transferred to the geometric network.



Alignment Sheet with Pipe Data

Goals of Migration

- Protect CGT's investment in GIS as the source of all the pipeline facility data
  - Migrate data from unprotected files to a secure database.
- Improve the effectiveness of data entry and update by the mapping group
  - Provide mapping with additional functionality that would enable editing data and moving graphics more effectively.

Process of Migration

Approval to purchase:

To implement this migration it was required to present a “Business Case Development Plan” to meet corporate standards and to ensure the best business decision for the company was being made. The plan had to be approved by the Information Technology Advisory Committee (ITAC) before beginning the project. This plan included a business analysis, the roles, responsibilities, lifecycle costs and risks. The proposal was presented to a panel of 20 ITAC members in August 2001. Approval was gained in November 2001.
The plan included purchase of

- 3 licenses ArcInfo 8
- 6 licenses ArcEditor 8
- 1 license ArcSDE 8
- Windows 2000 Server
  - SQL
  - 400 Gigabytes of storage

Company resources:

Technical Experts
The team consisted of 10 CGT employees.

- GIS Project Manager/Administrator
- ArcSDE and ArcInfo 8 programmer (VB)
- ArcInfo 8 programmer
- GIS Specialist
- 2 GIS reviewers
- SQL Database Administrator
- Mapper
- Computer Analyst
- Technical Writer

Other Resources
Learning Center
Computers

External resources:

ESRI consultants were utilized at 2 different stages.
Initial Install:

> The first consultant came out to assist with installation. The consultant aided by installing SDE; provided familiarization with configuring the system and assisted with the migration of some of the data including raster data. There was a direct benefit from his help and valuable knowledge was gained from the install.

Overview of design system and tuning of SDE

> 2 consultants from ESRI were hired to review the design, tune the database, and provide insight and training. The consultants were in Walnut Creek for 5 days. The cost was high, but the oversight, input and validation of the design was profitable. The decision to develop and migrate in-house was reinforced. The underlying premise for the entire GIS has been to produce in-house expertise. By utilizing the resources available, development goes further for a much lower cost. In addition, the team's expertise is developed by not using outside consultants.

Installs:

SDE and SQL

After the approval from ITAC, the server was purchased. SQL and ArcSDE were installed.

PG&E's in-house technical resources are highly skilled. In-house expertise was leveraged when needed to assist with all of the hardware and most of the software installation issues. A technical miscommunication failure occurred on the Windows 2000 SQL server and it was completely wiped clean of all software. This required a re-install of SQL, SDE and rebuilding the data sets, 1 month after the consultant left.

Success: In-house technical resources.
Failure: Miscommunication about the developmental stage of the migration.
Failure: System initial crash required reloading all software.

ArcGIS

The install of ArcInfo/ArcEditor required registering DLL's. A recommendation was received that Wise Solutions could create a bundled install. The product was purchased, time was spent learning it, but the functionality that was required was not achieved. As a solution, a step-by-step document was created to install the product and register the DLL's. This method proved valuable when adding regular upgrades and service packs. The <.mxd> and the <normal.mxt> use a copy routine (Robocoby) which is run daily by the users to keep up to date and their toolbars all in the correct position.

Success: Developed an easy method to perform installs.
Challenge: Toolbars not stable.
Failure: Wise Solution product to bundle the install did not work.

Programming

Tools were built by the programmers and tested by the GIS reviewers. Following are a few of tools that were developed:

- Batch plotting
- Alignment sheet generator
- Export data from domains to values in a shape file

Documentation

Training documentation was completed in-house. A local analyst assisted us with writing the document. Not enough time was allocated for this resource, because the learning curve was more significant than planned. The technical team had to complete the document. There is a delicate balance to be struck between training a technical writer and having a technical user write the document.

Success: In-house technical resources.
Failure: Not enough time allocated for technical writer to learn the software.

Training

Users attended 5-day training class. The training was set up at a Learning Center owned and operated by PG&E. ArcGISArcGIS was installed on all of the computers at the facility. Unfortunately, excessive lag time was experienced while working over the network, away from the building containing the server.

Success: 5 days was the correct amount of time to train users.
Failure: - ArcGISArcGIS too slow over network for remote training program.

Current State

The program switch from ArcView to ArcGIS is 8 months old. It has proved to be profitable and recommended. It was a good decision to transition and work through problems, even though the software is not perfect. The mantra "Software is a process, not an event" is key to avoiding frustration. A myriad of benefits, both foreseen and not foreseen have been experienced. Trials continue to occur with the software. The complexity of the software is a clear boon and a curse at times.

Success: Versioning is robust and the process is a windfall.
Success: Rotating views for plotting
Success: Raster image viewing
Success: CAD like tools
Challenge: Reconciling and resolving conflicts complicated.
Failure: Software with Graphic cards, printer driver and mouse conflicts
Failure: Ergonomic problems with mouse clicks
Failure: Program crashes
Failure: Slow performance

GIS Utilization at CGT

The system is used to great advantage at CGT. The migration happened at an opportune time. GIS is integrated with and supports many critical processes in CGT.

- System Integrity
    - Ability to add rasters (aerial photos) and large parcel data sets for the following purposes
        - Identify potential class location changes
        - Identify High Consequence Areas (HCA's)
- Risk Management Assessments
- Compliance with Integrity Management Rules for Pipelines
- Pipeline Engineering
    - CGT's entire pipeline is in GIS along with all pipe specifications.
- Planning
- Work Management
- CPUC Audits
- Under Ground Service Alert (USA)
    - All excavation requests are mapped.