Spatial Solutions for Pipeline Data Management

White Paper

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1. Introduction

Magnasoft’s experience in the pipeline industry is reflected in our understanding of the challenges faced by pipeline operators and the importance of information technology for data management and effective decision-making.

Our pipeline GIS services are aimed at helping our customers in ensuring safe operations and maintenance of their extensive oil & gas pipeline networks. This is based on an integrated framework/ approach that assists in most, if not all, stages of pipeline management, from project feasibility & risk assessment to pipeline operation. The framework is modular and aids pipeline management by providing decision makers with extensive data analysis capabilities, map display and reporting features.

We provide project management, operations and maintenance services to the oil and gas pipeline industry throughout the world. Our specialization in these services extends to entire pipelines (onshore and offshore), production facilities, pump and compressor stations and storage terminals.

The services we offer for pipeline data development and management include:

- Data acquisition
- Data conversion
- Data integration
- Mapping & GIS
- Enterprise-GIS development
2. Pipeline Data Development & Management

The following are the key stages of activity for pipeline data development and management:

2.1. Data Acquisition

The development of an accurate pipeline centerline is very important to any pipeline mapping & GIS project. This centerline becomes the basis by which pipeline data is correlated to various spatial data such as high population areas, commercially navigable waterways, sensitive drinking water zones, sensitive ecological areas, earthquake zones, flood and landslide zones, etc. The correlation of this data is then used to prepare informed risk assessments.

Magnasoft works closely with leading pipeline survey consultants for data acquisition activities. Magnasoft, through its partners can provide the necessary services to acquire key GPS (Global Positioning System) coordinates along the pipeline system to establish a pipeline centerline.

The process involves obtaining GPS coordinates in latitude and longitude at known points along the pipeline system such as road crossings. The existing pipeline survey is then utilised to establish a centerline between the known points. This method is typically the most cost effective means of establishing an initial pipeline centerline for risk assessments.

We provide the following data acquisition services:

- Develop consistent data structure for acquisition
- Provide GPS data acquisition crews and equipment (in-house/and through our network of strategic partners)
- Provide post processing of data as needed
- Export pipeline centerline data to a mapping or GIS system
2.2. Data Conversion

Much of the data needed to execute a successful pipeline-mapping project frequently exists in a variety of incompatible storage formats. These may include paper files, paper alignment sheets, scanned documents, microfiche, older mainframe applications, PC spreadsheets and text files, CAD files, GIS, and modern enterprise database solutions.

Magnasoft has a wide variety of conversion tools and the experience necessary to help a customer convert, verify, validate, and assemble the data into an enterprise data system where it can be maintained, protected, and used in a variety of decision support systems. Magnasoft uses its pipeline expertise to develop data conversion models that translate raw data into useful engineering information upon which sound decisions are made.

Magnasoft works with clients to provide a data conversion plan, which brings a wide variety of different information sources together into an addressable, cost effective, enterprise-wide information system.

We provide the following Data Conversion services.

- Develop a data conversion plan, schedule, and cost estimates
- Identify all data sources and associated protocols
- Determination of new data architecture
- Review and provide recommendations for hardware architecture and equipment
- Selection of data conversion tools/ vendors
- Perform data conversion service from diverse formats
- Perform verification and validation of converted data
- Perform storage, backup, and recovery of information
- Provide training and documentation for client personnel

Log Data Conversion:

Leading exploration/ petroleum companies require fast and reliable access to critical data assets to increase their confidence and ability to make key exploration decisions.

Our log data conversion services include:

- Digitisation of well-log data, whereby, scanned paper images are transformed to usable computer data
- Data quality control
2.3. **Data Integration**

Magnasoft helps its clients collect, process, and distribute information for making decisions. In many cases, the client may have completed the conversion of data into an enterprise source but needs support in determining how the various data elements relate to each other and can be used for engineering decisions. Additional support may be needed to implement modern data distribution technologies such as wireless, Internet and PDA's to the needs of the pipeline industry.

Through strategic partnerships with IT service providers and industry consultants, Magnasoft has access to integration technologies and has the benefit of seeing other industry GIS applications used by our clients. This approach allows our Engineers to recommend data integration technologies tailored to each client's needs.

Our data integration services include:

- Development of an integration architecture including functionality, schedule and costs
- Determination of data relationships
- Setting the data requirements and access methodologies of the various users
- Proposing a collection/processing/dissemination process for information
- Program management of the implementation
- Perform testing
- Change management, growth and system responsiveness
- Perform training and documentation for client personnel
2.4. Mapping & GIS

Among the first steps of any pipeline GIS project is the identification and mapping of potential impacts to ‘high sensitivity areas’ along the pipeline system. Magnasoft can utilize existing GPS and survey data to map the pipeline centerline and overlay various ‘high sensitivity area’ spatial data such as high population areas, other populated areas, commercially navigable waterways, and unusually sensitive areas. This information can be used in conjunction with elevation and operating data to determine the potential impacts along the pipeline system.

Magnasoft provides the necessary skills for the development of a GIS system to support pipeline management. Our technical staff can provide the services necessary for data conversion, data acquisition, enterprise data models, GIS implementation, and application development.

Magnasoft provides the following Mapping and GIS Services:

- Establish a pipeline centerline from existing GPS and survey data
- Import pipeline centerline ‘high sensitivity area’ data into selected mapping packages
- Produce detailed centerline maps with ‘high sensitivity area’ overlays
- Provide mapping and GIS services to assist in risk assessments, through analysis and display of validated risk ranking results and prioritised pipeline segments based on risk assessment
- Develop an enterprise data model
- Establish a GIS implementation plan
- Provide GIS implementation services
- Provide customized application development (the type of pipeline applications are discussed in the subsequent section)

Our GIS solution framework for pipeline management is shown in Figure 1.

Key Features:

- Ability to manage and control a wide range of data required during the development, construction and operation of a pipeline system
- Tracking all stages of data flow from initial survey through land management and into pipeline operation
- Development of a data dictionary that can be used in conjunction with a GPS to capture pipeline location data, in a format suitable for uploading to the GIS
Figure 1. Magnasoft's proposed Pipeline GIS solution framework

- Complete and accurate traceability of pipeline construction components within a pipeline system
- Ability to include environmental data to assist with practical project management issues during construction of a pipeline near sensitive environmental zones
- Pipeline operations and maintenance to provide rapid access to pipeline integrity information for ongoing asset maintenance and for pipeline emergency
- Land management to help the pipeline operator to gather, store and report on all information relating to land owners, authorities and other contacts associated with the pipeline corridor
3. Enterprise-GIS

Magnasoft has the know-how and expertise for setting up enterprise systems and developing custom applications for pipeline management.

The enterprise-wide model has the following advantages over a stand-alone system approach:

- Number of users can work cooperatively in a shared environment (coordination of disparate databases by a single central system)
- Regardless of their location, users can interact efficiently with the system
- Provides a multi-user spatial data repository
- Spatial information is integrated with core business functions
- The solution can be quickly deployed and easily updated as technology advances and the business priorities change
- Provides true and near real-time facility lifecycle management

Figure 2. Enterprise-GIS set-up for Pipeline Operations & Management
3.1. Application Development/ Customisation

Magnasoft has expertise in developing/customising the following applications that function within an enterprise-wide GIS environment.

Right-Of-Way / Permitting

Two primary responsibilities of a Right-Of-Way Agent are to maintain records on existing properties and to acquire access rights for new lines. Although their tasks result in massive amounts of data, most of it can be associated with a tract of land or land owner.

Magnasoft offers development expertise, whereby a database form is generated and used to retrieve, update, and analyze data associated with each land tract. Tabular data (such as grantor's name, acreage, access restrictions) would be stored in the relational database. Icon buttons could retrieve and display previously scanned documents--including legal descriptions, payment contracts, condemnation plats, photographs, etc. Since the data are all linked to known locations, the proposed system helps in geographic indexing.

Maintenance / Inspection Reporting

In the past, field inspection engineers utilised blank inspection forms to describe the work carried out, the facility being inspected (valve ID, serial number, size, manufacturer, etc.) and its location (site, state, county, region, etc.) Since much of the data requested on the form had little to do with the actual inspection, parts of the form were often only partially or incorrectly completed, or ignored altogether.

Magnasoft can develop the following field user applications to assist in maintenance and inspection:

System-generated inspection forms: Before leaving the field office, the engineers can query the system for inspections to be made that day, week, or month. The system then generates the requested inspection forms as a report. Each form contains all the descriptive data already known about the facility to be inspected. The engineers need only to complete the form with any new data. They can also review this information to verify its accuracy. Once back in the office, the system can easily be updated with the new or corrected data. This provides an excellent process for cleaning up data sets of questionable quality.

Field data collectors: Using portable devices (PDAs, etc.) field engineers can complete the electronic inspection forms right at the inspection site, thus eliminating the need to re-enter the data back at the office.
When needed, the application could signal that the task is complete or that follow-up work is required.

**Emergency Response**

During emergency situations an enterprise-GIS provides real and tangible cost/time savings. These include developing a set of contingency plans for gas leak response for the entire pipeline system, listing of all quarter-sections or grid cells the facilities pass through as part of an one-call response, and susceptibility to failure analysis of specific pipes under certain conditions.

Magnasoft customises applications, whereby a graphic is provided for the user to select a feature, from which a list of database attributes describing that feature is presented. The user can also select an attribute value or combination of values whereby the graphic representations meeting the attribute criteria are displayed.

**Asset Accounting and Tax Valuation**

Every year pipeline companies inventory their infrastructure for tax valuation purposes. Very often, recent changes/additions in the pipeline network elements are not reflected in the database and are manually included. This leads to inaccurate accounting reports and tax valuation.

Magnasoft offers customisation expertise, whereby area-wise reports may be generated for tax valuation. This is brought about by using the up-to-date pipeline facility model and the known polygons defining the limits of each geographic area. Since the spatial relationship between these features can be determined, a report by area can be generated. Therefore, tax analysts can extract all pipe records that fall within each tax district, without referring to any maps. This data can be matched with the tax database to assign a tax levy to each district and a depreciation value by age. The final report can provide a description of all facilities by district, pipe size, length and age, and the balance tax due.

**One-Call Response**

Participation in One-Call organizations are becoming very common, even mandatory in some states. The usefulness of the proposed system for this application is twofold. Firstly, many One-Call organizations require the pipeline company to provide them with a location description of their facilities. This description may be nothing more than a list of all quarter sections or assigned grid cells the facility passes through. Manually creating this list may be very time consuming.

Magnasoft can develop applications to automate the list generation process. Applications may also be developed to help in screening dig notices. Operators can review a notice and
quickly display the area based on address, grid cell id, coordinate data, etc. If the pipeline facilities are at risk, a notice (with dig site details) can be issued (even electronically) to the field crew to indicate the same.

**Compliance Inspection Management**

In compliance with various governmental regulations, pipeline companies must prepare numerous sets of reports and have this data readily available at any time. Since many of these reports have industry or company-wide standard formats, they could easily be generated directly out of the enterprise system.

Examples of typical pre-defined reports include:
- meter, valve and pipe inspection reports
- encroachment permits and foreign line crossing reports
- leak, damage and repair reports

By having these data sets readily available at all times, periodic internal checks can be made to monitor the field activities and to meet maintenance schedules. Compliance inspections may also proceed much more smoothly as the data can be reviewed from any location.

**Risk Assessment**

Determining the level of risk associated with each segment of a pipeline is an important aspect. To fully analyze a pipeline, engineers must have access to a great deal of data. Internal inspections provide vital information on the current condition (weld defects, corrosion sites, dents, etc.) of the pipeline. However, these results do not reveal any information about the environmental conditions, history, or physical attributes of the pipeline. Data on the pipe's age, manufacturer, pressure and cathodic protection history, soil water content and pH, class location, etc., must be acquired from other sources.

Magnasoft can assist in integrating data obtained from internal inspections into the enterprise system, whereby engineers can fully evaluate the risks associated with operating the pipeline and the consequences should a failure occur. Maintenance and replacement programs can then be established to monitor/correct problem conditions based on severity and risk to life, property, and environment.