Biographical Information

Edward J. Wiegele
General Manager, Americas
Integrity Services, GE Energy

Specific Responsibilities

Mr. Wiegele joined M.J. Harden Associates, Inc. (now GE Energy) in 1996–bringing with him over 13 years of pipeline and engineering experience. As General Manager, Americas, he manages offices in Calgary, Alberta, Kansas City, MO, Houston, Texas and Mexico City, Mexico where GE Energy provides integrity engineering services as well as in-house production, consulting, project management, and software / application development for GIS projects.

Past Experience

Previously, Mr. Wiegele was employed by PanEnergy Corporation (now Duke Energy). As Director of Marketing, he was responsible for all pipeline marketing activities in northern Illinois, Indiana, and Ohio. As the Director of Engineering Project Management, he directed a staff of project managers responsible for the implementation of all major capital additions for Panhandle Eastern Pipe Line, Trunkline Gas Company, Trunkline LNG, and Centana Energy. During this time, he served on the Transmission Project Advisory Group (TPAG) for GRI (Chairman for 1994 and 1995).

As Director of Drafting and Materials, Mr. Wiegele established the Drafting and Materials Division subsequent to the merger of Panhandle Eastern and Texas Eastern Transmission. He initiated the development of their on-line, Automated Mapping / Facilities Management (GIS) system.

Mr. Wiegele also served as Project Manager, Supervisor, and Project Engineer where he managed the design and construction of various pipeline transmission and gathering facilities.

Educational Information

Bachelor of Science - Civil Engineering, Iowa State University

Professional Memberships

Geospatial Information & Technology Association (GITA)
American Petroleum Institute (API)
Interstate Natural Gas Association of America (INGAA)
Southern Gas Association (SGA)

Realize the Value of Pipeline Data Management Across the Enterprise

Wednesday, September 22nd
2004 – Houston, TX

Realize the value of pipeline data management across the enterprise by exploiting legacy databases

Authors: Ed Wiegele Integrity Services, GE Energy
Stuart Clouston Integrity Services, GE Energy
Dana Book Integrity Services, GE Energy

1019 Admiral Blvd.
Kansas City, MO 64106
816-889-1177

Abstract

Within most pipeline organizations, maintenance and other facility departments use a range of separate data sources and applications to manage the integrity, maintenance and safety of their pipelines. These databases represent a significant investment over many years and are an integral part of day-to-day operations.

It is evident that integration of data into a single, coherent data management system can provide significant benefits. However, the cost of implementing entirely new systems – with intensive data capture programs – is difficult to justify given the earlier investments. As a result dedicated risk management software using static and separately maintained data is often used as a quick, low cost alternative to meet regulatory compliance commitments.

Experience has shown that, with the right technology and an understanding of the specific needs of an organization, a phased approach to integrated data management can be achieved at minimum initial cost by exploiting legacy data. This provides a low cost yet scalable solution that can grow with the changing needs of the business.

In addition to the benefits of legacy data integration, this paper presents an insight into the additional benefits of technologies for distributed data access to provide simple, process-focussed reporting tools.

Introduction

The utilization of GIS in the management of pipeline assets requires the understanding and management of integrity threats, such as corrosion and 3rd part damage, to ensure safe operation throughout the life of the pipeline. A pipeline, although simple in nature, has a complex range of continually changing, interacting events and operating conditions that must be carefully understood and managed.

The Challenge Of Managing Pipeline Data

Ask almost any pipeline operator and they will tell you a similar story, integrity and facility critical data exists various forms throughout their organizations and at best in “islands of automation” where small databases, records or software are being used to carry out specific tasks. In addition, other departments often duplicate work and little or no data is shared.

Typically the following key barriers exist to efficient data flow and management:

- Multi-format data (paper records, digital, databases)
- Data distributed and managed in remote and often independent locations
- No means to align and compare related data
- No clear procedures for maintaining and controlling data
- No methods for communicating when data is updated
- Poor tools for sending data to and from the field
- Information held as knowledge with individuals
- No means for sharing data across the organization

Given these common issues, why has the pipeline industry been slow to react to the ever-increasing need for better management of data? Of course a wide range of reasons exist but there are some common trends that have influenced progress. The major pipeline operators were some of the early adopters of Geographic Information Systems (GIS) and AM/FM CAD packages. These systems were used primarily to capture the pipeline facilities and geographically reference them using aerial photography to allow representation of centerline position as it relates to the real world. Typical applications were for landowner management for onshore systems and more generally for generation of alignment sheets, as-built drawings and response planning. These systems were not easily leveraged into pipeline engineering and integrity management processes.

Why Integrate Data?

The Need For Managed Data

To a pipeline integrity engineer, gathering data is just the first step in an entire process of maintaining the condition and integrity of the asset. The next step is to take various sources of data, review and combine them, interpret the data and taking action as appropriate. As an example, gathering corrosion data is critical and it is easy to identify from an in-line inspection report what immediate repairs are necessary to ensure integrity. But, where the immediate integrity is not at threat, but corrosion is identified and must be understood in terms of causes, future inspection/assessment and integrity, other related data is necessary to draw conclusions such as performance of corrosion protection, soil data, product content etc. at the given location. Data availability, accuracy and quality are just the first piece of a much larger puzzle. The challenge is how to build a system takes data and turns it into information in the context of managing a pipeline asset. To do that, an inherent understanding of how data needs to be used, compared and its relationships to other data needs to flow through into every aspect of a data management system’s design.

For those operators with older pipeline networks, many are faced with the issue that they hold much of their data in many different formats, have missing data, and prior to the age of digital based storage, have limited understanding of the quality and consistency of their facility, maintenance and inspection data.

Recognizing the value of managing and controlling pipeline data in the overall safe operation of pipelines, regulators in the US are placing significant focus on initiatives and regulations that will guide pipeline operators to demonstrate effective and auditable management of their pipeline assets. It is inevitable that integrated data management of pipeline systems is the future for integrity management and will allow risk-based maintenance approaches to move to the next level. As an example, the US Liquid and Gas Rules for Integrity Management and associated requirements for inspection, assessment and remediation within specified time frames makes it hard to imagine that integrated data management systems are not necessary for success.

What Should You Consider When Defining Systems For Pipeline Data Management

Data Models – a foundation for success

At the heart of any successful database is the data model. The data model defines the types of data that can be stored e.g. pipe segment, dent, valve etc and along with the specific attributes that must also be managed e.g. material, wall thickness, length, width, depth, serial no., manufacturer etc. Additionally, a location reference for all data is required for comparison and identification. Design of the data model requires understanding of the processes and applications the data will be used for. Again using a simple example to accurately locate a corrosion feature, whilst a GPS (Global Positioning System) co-ordinate is great to identify where to excavate, a linear distance to a girth weld and o'clock position are necessary to be confident that the correct feature is identified. The same applies for all other processes generating temporal data whether it be capturing pipeline burial depth surveying, land owner management or storing operational data.

Over the last few years, acknowledging that pipelines in general have similar requirements to each other no matter where they are, and that they are somewhat unique (linear over large distances with large volumes of continuously changing data), the industry has steered towards the establishment of standard data models. Established and sponsored by operator, vendor and research bodies a number of models have gained recognition, with the first model being the ISAT model, and subsequent models such as PODS and APDM being established to leverage the work done by M.J. Harden, GTI (formerly GRI) and the pipeline industry. While these models are variations of the ISAT model, they are substantially similar and do not significantly deviate from the original ISAT model. These models are accepted as a good basis of any pipeline transmission system.

Establishing a common linear reference

The standard method of referencing the location of any item on the ground is by use of an X-Y based location using either the geographic coordinates (latitude-longitude) or some locally established Cartesian coordinate system (easting-northing or X-Y). Corridor applications (transmission pipelines, fibre optic lines, railroads, highways, etc.) are unique in that a linear-based, one-dimensional positioning system is commonly used to reference the location of an event (both on and off the centerline). This linear (one dimensional) system locates an event by specifying the distance from a known beginning point to the event in feet, meters or miles. This linear location system is referred to as *station location* or *engineering stationing*.

In this system, every location along the centerline is displayed in the following format: *aa*+*bb* where *aa* = distance from the starting reference point in hundreds of feet and *bb* = feet from the previous 100ft location. As an example, a point with a station value of 143+28 is 14,328 feet from the starting reference point of the line.

In an ideal system where no modifications to the original centerline have been made, the starting reference point is usually the beginning of the line or line segment–usually a metering station or pump / compressor site. Modifications to the centerline route will generally cause new reference points to be introduced to the measuring system. The use of a "station equation" at the point of correction, relates the "behind" stationing to the "ahead" stationing. Although station equations complicate the linear location system, the basic concept still remains with each point being located by referencing its distance from some known starting point along the centerline.

Tools that dynamically segment Data

Segmentation is a method used with linearly referenced data to collect areas with common characteristics together for analysis. This is accomplished dynamically when the data is needed so that the individual linear features can be stored most efficiently. Pipelines can considered to be made up of many event ranges along the pipe (e.g. a section of pipe of common coating would be an event) and then a segment would be where a group of defined multiple event ranges do not change. We use these segments to apply specific analysis that would be influenced should one of the parameters (events) change in value or location along the pipe. In this case (Figure 1) we have defined six segments for analysis. However data is continuously changing on pipelines and even facility data changes with time. This demonstrates the impact of a pipe replacement where a section of pipe with three wall thickness changes occur is replaced by a single section of common wall. In this case when segmented we have now only four segments for analysis. Dynamic segmentation software automatically segments the pipe for analysis so that any changes to integrity critical data is considered prior to analysis. This way any analysis always verifies that the most recent data is used.

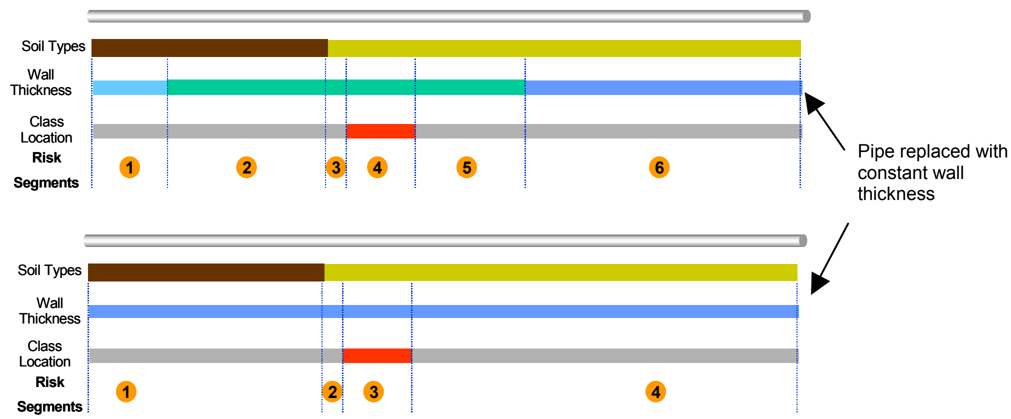

Figure 1 Dynamic Segmentation allows grouping of common data for analysis

Scalability

Significant investments may have already been made to manage the integrity, maintenance and safety of pipelines. To protect these investments, the solution must incorporate a phased approach that leverages legacy data. The solution must allow individual applications to be implemented against the existing data sources to accomplish immediate assessment needs. The system, however, must be also able to achieve long-term objectives to go beyond departmental solutions to share data and applications across the entire enterprise.

Data Alignment

Effective decision making to a pipeline integrity engineer is directly related to how well multi-year inspection data, environmental/geographical, facility and operational data can be aligned to identify potential threats, validate historical trends and establish mitigation measures.

Accurate alignment of data along the common linear reference is the only true way to use data for assessment. Inherent inaccuracies from various measurement methods render matching absolute position e.g. GPS co-ordinates impractical and of little value when it comes to aligning multiple data sets. The challenge therefore for any data management system is to take multiple data types e.g. point data, linear data, raster data and spatial data and relate it to one another to a high degree of accuracy. Furthermore, techniques to calibrate data are essential e.g. correct/refine ILI feature locations by matching them with other facility location data e.g. valve positions from other more accurate data sources such as field surveys. This ability to continuously improve data location accuracy will have an ongoing benefit throughout the life of the asset.

An accurately aligned data set is the first and most critical step to improving processes and analysis throughout the integrity management cycle.

Managing and Maintaining Data

Mapping and Storing is not Managing

Advances and availability of GIS software and technology has made it very simple to take almost any data, overlay it in a geospatial reference frame and relate them to one other e.g. corrosion features displayed on a pipe displayed on a map. However, at this point a very clear distinction must be made. Visualizing datasets relative to one another is only a part of a successful data management system. Many people have implemented a simple GIS to visualize data on maps however without purpose built tools to maintain that data. Given the large volume of data that continuously changes along a pipeline, it soon becomes unmanageable and most likely redundant. Alternatively their use is so restricted that the real value of integrating data will never be realized.

Therefore prior to moving down the path of investing in a pipeline GIS or data management system the following key questions should be asked:

1. Is there a good method for loading and aligning large volumes of data e.g. inspection data?
2. Is there linear reference system common to all data?
3. If I make a pipeline modification or re-route how will I update all related data?
4. Do I have methods to calibrate out inaccuracies in measurement methods for locating data along the pipeline?
5. If I run analysis or 3rd party applications from the system, how will they be affected by changes in pipeline facility, geographic, operational, inspection or maintenance data?

Let us demonstrate the significance of these questions with a couple of examples. Assume we are performing a risk assessment on a section of pipe using a 3rd party risk software application to prioritise maintenance activities and that data is being provided via a common company database. In the event that risk critical data e.g. coating survey or class location data changes, then we need a means to ensure that there is a foolproof method (or the software is intelligent enough) to ensure that the risk calculations are always correct. So given the discussion on dynamic segmentation earlier, to prevent significant errors all data required in any risk equations must always be dynamically segmented prior to calculation to capture changes unknown by the engineer performing the risk analysis. As a second example, consider we have made a re-route of a pipeline. Given that all data is linearly referenced along the pipeline as described earlier, if we make a change to that reference system e.g. an insert of an additional 2000 feet of pipeline, then all other data downstream of the re-route will be affected. The data management system needs to be able to automatically update all data affected by such a change seamlessly. In order to do this the software needs to understand and manage specific data relationships. While this example may appear rare, a more likely event having similar impact would be if you were to make a modification to a pipeline that introduced an additional weld, all data sets that reference weld numbers e.g. corrosion features for their location would need updated data attributes in the database.

Only by establishing data maintenance capabilities such as these can you establish a future proof system for managing integrity data.

Exploiting Existing Data

Most, if not all company's, have already invested large sums of money and resource into database and software systems that are used in various parts of the organization during normal pipeline operations. Day to day processes now rely on certain systems that have become essential tools for engineering, management and planning processes. Figure 2 shows diagrammatically how common data flows and interacts with many activities and processes within a pipeline operator's organization in just managing the asset integrity.

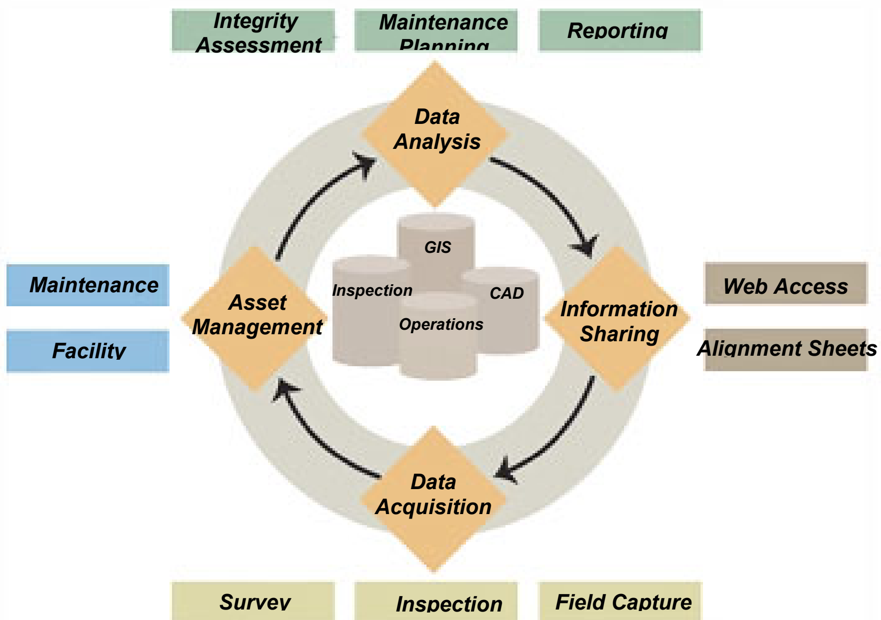

Figure 2 Data flow through pipeline integrity management processes

Traditionally one of the biggest challenges in getting on the path to an integrated approach to data management has been a combination of a reluctance to change and the inability to demonstrate a defendable value proposition for further investment. One of the main reasons for these barriers was the need to basically replace existing IT infrastructure and software databases and applications with new solutions. However with a combination of proven approaches to handling and maintaining pipeline data and improved software and database technology, solutions that exploit existing company data offer an opportunity for a strong business case. By communicating with and leveraging an enterprise's existing data sources such as GIS, local databases and business software, a low start-up cost ensures a more compelling value story.

Figure 3 illustrates conceptually how connecting to external (live and legacy) data sources it is possible to feed a purpose built environment for managing pipeline assets without the need to migrate data and change establish practices within the organization. Or in other words, get better data from existing data with minimum cost and disruption.

Besides the obvious cost implications there are a number of very real and tangible benefits of using this approach that arise from integration with a purpose built software environment for handling pipeline data:

- Establishment of a common linear referencing system (where one didn't exist before)
- Maintenance and management tools for that linear reference
- High accuracy data alignment
- Dynamic segmentation for analysis such as risk assessment
- Additional reporting tools (querying, alignment sheet generation) of aligned data sets

- Establishment of a rich platform of accurate and controlled data for analysis and integration with pipeline focused engineering software and applications
- Single source of data for controlled distribution throughout the organization
- Means for distributing data throughout the organization (e.g. the internet)

This approach brings disparate data sets together to allow pipeline operators a low cost, scalable solution, creating a single data environment for the entire organization and establishing improved tools for managing data going forward.

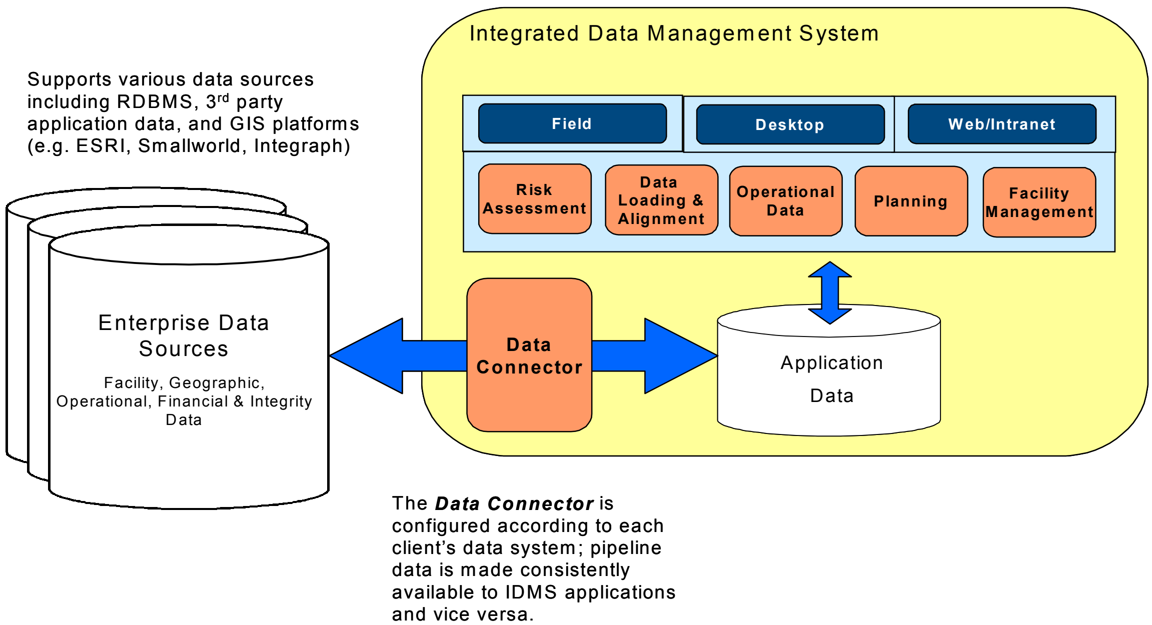

Figure 3 Integrating Enterprise Data Sources into Pipeline Data Management Systems

Getting Data To Those Who Need It – Distributed Data and Remote Access

If all we do is to pull data into a single location then really the job is only half done. To realize the benefit of an integrated data management system we need to go a step further to ensure that:

- Data is easily accessible to those who need it across the enterprise
- Data is accessible in the field and at remote locations or other field offices
- Data can be easily collected in-field and updated in the main database

Only by delivering these as part of the solution can there be confidence that the system will be used and data kept current.

Without doubt, one of the obvious advantages of a centralized IT based integrity management system is the freedom of access to correct and controlled data throughout the organization. Most GIS and data systems can be readily web and structured to ensure rapid access over the Internet.

As discussed previously, an active system is likely to be linked to a multitude of live/legacy database, applications and other business management and financial tools. With the inclusion of comprehensive security protocols, data has never been so easily shared and available to those who need it throughout organizations. A central database and environment effectively managing multiple data sources and acting as a single point of access to the enterprise's data. Multiple sites, such as field offices, have not only read access to data but full control and responsibility for maintaining data if required. With a single data source in a common data model, pipeline-engineering applications to drive efficiency into day-to-day process can quickly be established in the knowledge that data feeding the analysis is both current and accurate.

The last piece of the puzzle is a mechanism with which to take data to and from the field. Using detached client technology, replicas or “snapshots” of the database can be downloaded to laptop or handheld device for field access. This is invaluable for field verification work, giving instant access to data such as location/co-ordinates, inspection data records, facility data and alignment sheets. With comprehensive data maintenance tools, field records can be instantly entered and corrections to co-ordinate references e.g. a GPS position of a corrosion feature or valve station, can be logged for audit and permanent entry into the main database system.

Conclusions

Establishing an integrated data environment for pipeline asset and integrity management does not need to be a costly replacement of existing IT and software infrastructure. Given good system design focused on meeting the individual needs of the organization, existing enterprise data sources, in addition to best practices for managing and maintaining data, pipeline organizations can start to experience the benefits of integrated data management with minimal initial investment.

Using a comprehensive data model of pipeline assets held in a central repository, the integrated solution will become an essential part of the pipeline operator's business processes helping to reduce both capital and operating expenditures. Using Internet based distribution systems, workforce, inventory and enterprise application integration capabilities are combined with robust, scalable architecture to provide a seamless flow of information throughout the enterprise.

In an industry using risk-based methods, which for success, rely on accurate, up-to-date information, a coherent and controlled data environment is central to the overall process and future of risk-based maintenance and monitoring.