Digitizing As-Built Gas Utility Asset Data For GIS

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This article looks at the challenges faced during digitizing existing gas utility asset data (which is present in the form of hardcopy drawings) into GIS and approaches to deal with those challenges. When a gas utility company goes for GIS implementation, one of the stages involved is "Digitization" of the existing hard copy drawings.

Digitization involves migrating (also called porting) the existing asset data available in hard format to GIS. This migrated asset data is important to GIS as all the functionalities of GIS are woven around that. However, though this migration seems like a simple process of transferring data from one place to another, it involves many challenges.

Types Of Asset Data

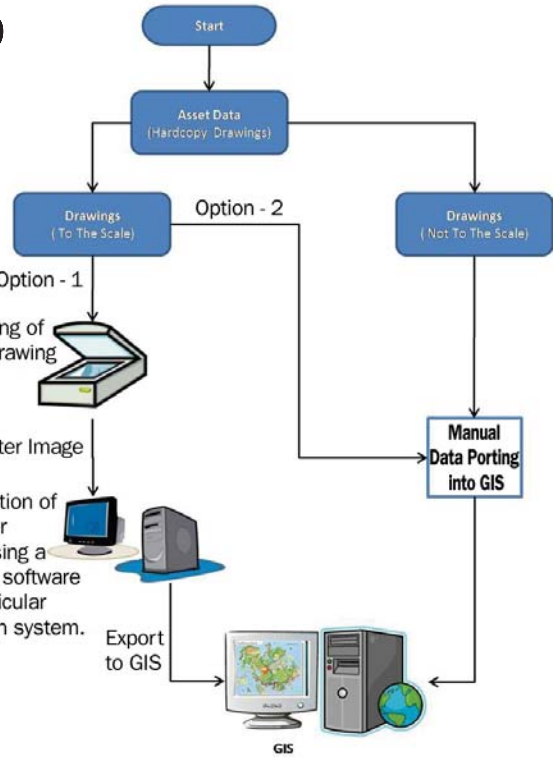
The hardcopy data can be in the form of "To scale" drawings, and "Not to scale" drawings (Figure 1).

In the case of the drawings which are "To scale," there can be two options for migrating them to GIS. Option 1 is exporting vector data to GIS. This option involves the following steps:

1. Scanning of the drawing sheet to generate the raster image. The generated raster image can be in .tif, .tiff, .jpg, and .bmp formats. A "raster image" is based on cells or picture elements (pixels). The resolution is based on size of cell i.e. smaller the cell, higher the resolution.

2. This raster image is imported into a mapping software for vec-

Figure 1:



torization and assigning a projections system. Examples of mapping software systems which have features for geo-referencing are, ArcInfo from ESRI, MapInfo Professional from MapInfo Corporation and AutoCAD Raster Design from Autodesk. The output files will have formats like, .shp and .dwg. A "vector image" is based on objects (points, lines, areas). The resolution of a vector image is independent of detail. The user vectorizes the pipeline network elements (like pipeline, fittings, valves, Pressure Regulating Stations, Service Regulators) and saves the file.

3. This file is converted to a format compatible with the GIS platform using a converter software — e.g. Feature Manipulation Engine(FME). Some of the popular GIS platforms for the gas utility industry are GE Smallworld, ArcGIS and AutoCAD Map 3D.

4. The converted file is then exported to the GIS platform where the pipeline network data sit on the land-base data in GIS.

Option 1 might not be valid except in limited scenarios. It might not be feasible in case of a large number of drawings, drawings with different scales, legacy drawings of not so good quality and drawings which cover only few meters of pipeline length. Also, this option involves manual efforts at multiple stages and additionally final data cleaning and editing into GIS. It has been observed that generally companies do not go for this option. However, this option has the following advantages:

- The work of vectorization of pipeline network data can be outsourced without any need of taking land-base data (which is proprietary and valuable) outside the company premises.
- Total time taken to carry out porting could be less compared to Option 2 because — while carrying out vectorization of pipeline network elements — the user has the raster image at the background as a reference.

In the majority of cases, Option 2 is preferred compared to Option 1. Option 2 is manual (direct) porting of the gas utility asset data into GIS. In the case of drawings which are "not to scale," there is no option other than porting them manually directly into the GIS (i.e. Option 2). The following discussion is related to Option 2.

As the name manual porting suggests, in this case, the user creates each network element in GIS manually. This option involves following steps:

1. The user refers the as-laid drawing and draws the trails on the GIS screen using various drafting tools available in GIS. These trails could be a point, a polyline or a polygon. The user creates the pipeline network in a form of a layer (normally called as "network layer") on and with reference to the "land-base data layer" as the background.

2. These trails are converted into pipeline network elements; point, polyline or polygon. For example, point would be service regulator or valve; polyline would be Polyethylene (PE) pipeline; and polygon would be district regulating station (DRS) boundary.

3. The user then assigns the associated attributes and information (as mentioned in the as-laid drawing) like length, diameter, thickness, capacity, size, material, annotation, offset distance, etc. to these elements and saves the data. The network elements appear on the screen as per assigned legends.

This is a critical activity for a gas utility company as the data entered at this stage will be referred as an input to multiple business process like Network Planning and Design, Operations and Maintenance, Emergency Management, Customer Information System, etc.

Challenges Involved

There are several challenges in the manual porting of data.

Variation in pipeline length is one challenge. It is common to see the distance between two similar points on the drawing and the land-base not matching.

For example, the distance between Point A and Point B on the drawing is 100m as per chainage mentioned. On the other hand the distance between the same points on the land-base data (as it has come from different source) could be shown by the system as 107m. This would lead to confusion in the user's mind about accepting the correct length as an attribute to the pipe. To deal with such cases, the attribute table for the pipe should have an extra field for entering the "actual length."

In the example cited above, 100m will be the actual length which is the "on-site" length and the same length will be used for analysis in case the GIS is having an interface with Network Analysis Software (e.g. SynerGEE ® Gas from Advantica).

Missing reference objects in the land-base data is another challenge. It is very common to observe missing objects in the land-base data. At many locations in the as-laid drawings the distance of the gas pipeline is shown a reference to some particular objects such as, electricity pole, manhole, gate of the building property, etc. Such references are important for emergency crews for locating the gas pipeline.

In case of the absence of such reference objects in the land-base data, it is always better to create the object using drafting tools in the "network layer" instead of modifying the land-base data by creating the object in it. This will save time and also serve the purpose.

Absence of offset distances is another challenge in manual porting. In an as-laid drawing, it is quite possible to have a stretch of pipeline where offset distances (with reference to the boundary wall edge or road edge or drain edge) are not mentioned. In such cases, drawing the profile or contour of the pipeline in GIS becomes difficult for the user.

Under such circumstances, the GIS implementation team shall fix a "default offset distance" along which the trail for the pipeline would be drawn. The entire user base of GIS shall be made aware of this assumption.

Pipeline details in vertical plane are a challenge. The hardcopy drawings contain pipeline network details in the horizontal plane as well as vertical plane. For example, cross-sections of river crossings, railway line crossings, drain crossings, major diversions, etc.

The GIS screen presents the data in the horizontal plane. To incorporate the asset data which is in the vertical plane, there shall be a provision to store vertical section details attached to a pipeline as an attribute. The vertical section can be stored as a raster image or a .dwg AutoCAD file.

Tracking hardcopy drawings after porting is a challenge. It is important to keep track of the hardcopy drawings after porting asset data into GIS. The total number of drawings could run into hundreds. It is beneficial to have a field named "reference drawing number" as an attribute field for the elements (pipe, valve, pressure regulating station, etc.) ported into GIS.

Non-standard asset information presents a challenge to data porting workers. The hardcopy drawings are submitted to the utility by different contractors operating in different areas. It is possible that these contractors follow their own differing conventions for naming and numbering assets.

To reduce the porting difficulty, prior to commencing porting activity, a set of legends, numbering and naming methodology should be adopted and then finalized, documented and communicated to all the users involved in porting activity. Further, it should be ensured that the understanding of all the users is at the same degree. This will particularize the data ported and will reduce any confusion/corrections in future.

Verifying accuracy of ported asset data is another challenge. As the porting activity progresses, a process for checking the correctness (as per drawing) of the ported data should be in place. This checking could be done by proof checking among peers or by a senior person choosing drawings and ported sections in GIS randomly for checking.

The company can even have a policy based on the past experience in which it can specify the percentage of pipeline length for each type of pipeline network to be proof checked. A typical example of this could be 5% length for low pressure (below 100mbarg) PE pipeline, 10% length for medium pressure (above 100mbarg and below 4barg) PE pipeline, 25 % for high pressure (above 4barg and up to 19 barg). Extra attention shall be given to high pressure steel pipeline network data and all the strategic isolation valves.

The Way Ahead

After implementation of GIS, the ideal way to deal with as-laid information is to have the as-laid drawings submitted in soft form from the contractors. The following steps are suggested:

1. After project execution, the contractor submits the as-laid drawings (in soft form) prepared using a mapping software to a particular projection system as determined by the parent utility company. These could be in .dwg or .shp files.

2. The parent utility company converts the as-laid drawings to a format compatible with GIS platform.

3. The as-laid drawings are exported to GIS at one go.

In cases where as-laid hardcopy drawings are all that will be coming from the contractors due to contractual or other reasons, the gas utility company should prepare a standard set of GIS centric "guidelines for as-laid drawings." These guidelines will help in capturing all the aspects of asset data required for porting into GIS and will smooth the manual porting process. ***P&GJ***