BIOGRAPHCIAL INFORMATION

Kevin Peters
Project Manager
Advantica

Specific Responsibilities

Mr. Peters joined Advantica in 1998. As a project manager in Advantica's Capacity Management U.S. department, Mr. Peters is responsible for managing projects whose scope involve, data model design, database development, data conversion or data maintenance. In fulfilling his duties, he works with clients to develop logical data models and their integration into the physical GIS data model. In addition, he is involved in the database development and conversion activities including, the creation of technical specifications, acceptance criteria and QA/QC tools and procedures. Mr. Peters is currently responsible for managing data modeling, database and data development activities associated with a GIS implementation project for the City of Orangeburg South Carolina Department of Public Utilities.

Past Experience

Mr. Peters has over fourteen years of technical and management experience relating to the AM/FM/GIS database development process. Prior to joining Advantica, Mr. Peters spent three years with APEX, Data Service's Strategic GIS department. As Project Manager with APEX, Mr. Peters managed, design, software and production teams in creating strategic GIS solutions for utilities and municipalities. Mr. Peter's experience also includes seven years at Cartotech, Inc. where as a Conversion Manager he directed software and production teams in implementing a variety of AM/FM/GIS conversion projects.

Educational Information

B.S. – Geography, Penn State University

Professional Memberships

GITA

BUILDING A COLLABORATIVE APPROACH TO DATA MANAGEMENT

Kevin Peters
Advantica
P.O. Box 86
Carlisle, PA 17013-0086

ABSTRACT

Database design and the acquisition of data for an enterprise wide GIS system presents several challenges including the cost of development and resulting quality. As a small utility with a limited budget, the City of Orangeburg, SC Department of Public Utilities (ODPU) was faced with such challenges. The ODPU required a database that supported the water, wastewater, gas, electric and administrative divisions. As part of that support, the database not only had to meet the existing needs of users, it also had to meet their future needs, including the ability to interface and share data with supporting systems such as Outage Management and Network Analysis. This paper will discuss how the ODPU met those challenges via:

- A collaborative approach that involved participation and interaction among the ODPU, data collection\conversion vendor and GIS implementation vendor,
- A data model design that considered requirements related to data capture and system integration,
- A data capture process that supplemented and enhanced legacy AutoCAD source records by blending it with GPS/field collected information, and data from other government agencies
- The development of an independent QA/QC process that ensured converted data met stringent user acceptance criteria.

INTRODUCTION

Any effort involving database design and data acquisition for an enterprise GIS is presented with obstacles that impact cost and quality. For the City of Orangeburg, SC Department of Public Utilities' (ODPU) the challenge was amplified due to a limited budget and resource pool, and the fact that they required a database and data that supported five different divisions, water, wastewater, gas, electric and administrative. To achieve the daunting challenge, the ODPU infused a collaborative approach in their efforts to design a data model, capture the data, and ensure the converted data met high quality standards. This collaborative approach to data management transpired, amongst the five ODPU divisions, amongst the project team (consisting of, the ODPU, a GIS Implementation Vendor, and a Data Collection\Conversion Vendor), and between the ODPU and Orangeburg County.

ORANGEBURG DEPARTMENT OF PUBLIC UTILITIES (ODPU) BACKGROUND

Founded in 1898, the Orangeburg Department of Public Utilities' (ODPU) is located in central South Carolina and provides service to residents and businesses in the City of Orangeburg and surrounding areas. With approximately 180 employees, the ODPU operates an electric distribution, natural gas distribution, water distribution, and wastewater collection system. In addition the ODPU owns and operates two electric generation plants, a propane plant, a water treatment plant and wastewater treatment plant. While financially independent from the city, the ODPU requires council approval for large projects such as a GIS implementation. Functionally, the ODPU consists of five separate divisions each with its own director:

- Electric Division, which maintains a system fed by 21 substations and serves approximately 26,000 customers,
- Gas Division, which maintains 274 miles of main and serves approximately 10,000 customers,
- Water Division, which maintains 420 miles of main covering 260 square miles in Orangeburg and Calhoun counties and serves approximately 20,000 customers,
- Wastewater Division, which maintains a system covering 22 a square mile area centered on the City of Orangeburg and serves 9,000 customers
- Administrative Division, which is responsible for customer care, billing and financial reporting for the four utility divisions.

In early 2002 the ODPU realized that in order to more efficiently serve their diverse customer base, they required an open, integrated and department-wide GIS system that would enable them to increase their productivity through better information access and enhanced business processes. Specifically, the ODPU identified the following as their main business drivers for that system and its supporting data:

- Provide the ability to audit assets (i.e., know how much the entire system is worth)
- Improve customer relations
- Improve access to information (meters, work orders, premise, etc.)
- Improve the process of locating assets in the field
- Provide a consistent data maintenance process
- Provide reports to regulatory bodies such as the DOT and Public Service Commission
- Provide integration with Outage Management and Network Analysis

By mid-2002, the ODPU had received proposals for the acquisition of a system and data that would achieve these business drivers. By the fall of 2002, the ODPU chose a GIS Implementation Vendor, who was charged with the creation of a data model, the establishment of QA/QC procedures and tools, integration to existing systems, and the implementation of the GIS. The ODPU chose a separate Data Collection\Conversion Vendor who was charged with the field collection and conversion of the data required to support the GIS.

PRIMARY CHALLANGES

The initial phases of the ODPU's implementation involved, designing the data model, building the database, and acquiring the data. This database development/management task required that the resulting database would support the electric, gas, water, wastewater and administrative divisions data needs, as well as the future integration to Outage Management, Network Modeling, Customer Information and Customer Support Web applications. In achieving this data management objective, the ODPU was faced with two primary challenges: i.) The Data Challenge: How to take the data they had and get it to support the system and business needs at a reasonable cost, and ii.) The Management Challenge: How to get the various parties (vendors, ODPU divisions, etc.) to collaborate so they would productively achieve that goal.

<u>The Data Challenge:</u>
With the goal of achieving a complete and accurate data set that would support, field location operations, Network Analysis, Outage Management, and a CIS Interface, the database development and capture consisted of numerous general obstacles such as:

- In order to help minimize cost, the off-the-shelf GIS data models for each utility type was used; however, they did not always meet the ODPU division specific business needs and the ODPU had a limited budget to modify them.
- Legacy systems to which the GIS would integrate such as the CIS and Finance Work Order System did not always have a common key field.
- Database development required knowledge in four distinct types of asset data (electric, gas, water and wastewater).

However, at the core of the data challenge was the content, format, and quality of the legacy data, which for the most part, was maintained separately by each division. Each data set presented a unique situation and challenge as follows:

Legacy Electric Data:
The electric asset data existed in the form of AutoCAD Circuit maps with some supplemental attribute information, such as transformer data, also provided via MS Access databases. The attribute information provided only the basics (wire size, material, phase, etc.) and the circuit information reflected in the AutoCAD files was not topologically correct and therefore could not directly assist with the connectivity required to support Network Analysis and Outage Management. As only primary conductor and devices (switches, fuses, transformers, etc,) existed spatially, structure locations (poles, pads, etc.) as well as the entire secondary network and associated assets (streetlights, secondary, etc.) needed to be located and their attribute information identified.

Legacy Gas Data:
The gas asset data existed in the form of AutoCAD maps and reflected most gas features including service lines. However, the network connectivity reflected in AutoCAD, as well as the location of some asset data, was considered suspect and likely would not meet the future business needs. The location problems were further complicated by the fact that the base mapping was tiled but did not necessarily share a common spatial reference. The maps were originally digitized from suspect tax maps and did not always edge match. In addition, they were not located on a coordinate system and therefore could not be projected onto the GIS's State Plane system without substantial spatial adjustment.

Legacy Water Data:
The water asset data existed in the form of AutoCAD maps with similar tiling, coordinate and base mapping issues as the Gas data. The legacy data reflected most features with the exception of service lines. Like gas, the network connectivity reflected in AutoCAD as well

as the location of some asset data was considered suspect and likely would not meet the future business needs. The water data also consisted of numerous supplemental data sources including:

- A database containing preventative maintenance work orders,
- A database specifically for Cross Connection Control Devices, and
- Databases containing historical information on, water quality complaints, main failures and water sampling.

Legacy Wastewater Data:
Wastewater asset data was in much the same condition as the gas and water asset data sets, i.e., AutoCAD data with insufficient connectivity, location of assets, and the omission of some asset data. It also included a database that contained manhole inspections results and another that had information on grease traps. However, the wastewater division had begun a separate initiative to field collect and verify key asset data. At the heart of this effort was determining the location of their manholes via GPS.

Customer & Meter Data:
The GIS was intended to assist customer representatives in efficiently locating current customers and addressing their complaints, locating new requests for service, etc. In addition, it was required to provide customer data such as load/demand information to the Network Analysis and OMS systems. To do this customer, premise and meter information was required. That data, for all four utilities, was stored and maintained in the Administrative Division's ORCOM system which was a non-graphic database system. With no spatial information in either the ORCOM or legacy AutoCAD files, the data challenge was to acquire the spatial information within the GIS and then link it to ORCOM so that ORCOM could share information with GIS.

Legacy Landbase Data:
All four divisions shared a common AutoCAD based basemap/landbase which contained a significant amount of detail such as streets, building footprints, lotlines, etc. However, some cadastral information such as utility right-of-ways was maintained separately by each department and not always via AutoCAD. A greater challenge was the accuracy of the landbase, especially in reference to the business need to precisely locate assets.

<u>The Management Challenge:</u>
The management challenge posed a much more qualitative problem, and one that could not be solved with a technical solution. In answering the question of how to get the parties to achieve the data challenge, the ODPU faced challenges on three fronts.

Internal Challenge (within the ODPU):
Each of the five divisions had to buy into the project, participate in achieving its goals, and of course be satisfied with the results. Naturally each division wanted the new system to have the same look and feel as the legacy systems and to have as much of its legacy data as possible be included in, or integrated with, the GIS, and then to get that accomplished with the minimum amount of distraction to its resources. With resources, who had a limited knowledge in GIS, the ODPU had to acquire specialized knowledge in new technologies

such as ArcFM, GPS, SDE, ArcIMS, etc. This training as well as other project tasks, such as reviewing and accepting converted data, had to be accomplished under the constraint that each division typically had only 1-2 staff qualified to perform these tasks. Resources that were assigned to the project had to accomplish their regular work as well as project work. If an unusual cold spell occurred while they were away getting trained on the GIS, then training would have to be rescheduled. (This actually occurred.) Further challenging the internal management of the project was the fact that it was to be managed and coordinated by the electric division staff who had to approach the overall project with a non-division bias.

Project Team Challenge:
Rather than a single vendor to implement the entire GIS system, the ODPU had to manage two vendors, an Implementation Vendor to build the system and a Data Collection\Conversion Vendor to convert the data. The vendors needed to have experience and knowledge in electric, gas, water and wastewater as well as GIS. Furthermore, vendor interdependencies had to be managed as each vendor had deliverable deadlines that would impact the other's schedule. For example, the Data Collection\Conversion Vendor relied upon the Implementation vendor to deliver the data models on time so that they could complete data conversion.

External Challenges (Outside ODPU and Project Team):
With a limited budget, the ODPU recognized the potential of establishing and managing relationships with external agencies with which they could potentially share, common data, resources and costs.

MEETING THE CHALLENGES

The ODPU met their data and management challenges by instilling a collaborative mindset and methodology. Management challenges were addressed first as it laid the groundwork for conducting the entire project, and once in place, helped tremendously with the Data Challenge which was met by tackling the effort in the three separate stages, Data Model Design, Data Capture, and QA/QC of Converted Data.

Meeting the Management Challenge
With three groups to manage, the ODPU recognized that a successful project kick-off was key to establishing a cohesive collaborative effort. The groundwork laid at the kick-off meeting along with several follow-up initiatives helped establish and maintain cooperation with and among the ODPU Divisions, Vendors and External Agencies.

Internally:
The director, key users, and potential project contributors of each ODPU division attended the kick-off meeting. At the meeting, the implementation vendor was tasked with reviewing a detailed project plan with an emphasis on where each division would contribute. That review included detailed examples of what they would be expected to review and, where necessary, the type of training they would receive before they had to participate. Each division director was asked to accept responsibility to have their staff, participate in workshops and review/accept deliverables that addressed, the Data Model, Data Conversion Specifications, Data Collection Support, Data QA/QC, and the Maintenance Process. Most importantly, each

division was required to identify which resource was responsible for contributing to, and ultimately approving, the key deliverables. In addition to establishing division resource and input requirements, the groundwork for controlling project costs was also laid by reviewing the project scope in detail. This was done with a specific focus on the cost constraints, such as the need to not radically deviate from the ‘off-the-shelf’ data models.

Outside of the kick-off groundwork, several other actions were taken to help ensure a solid collaborative foundation among the departments. A new position was created which established a ‘ODPU GIS guru’. That person would become a GIS expert on maintaining the GIS data and provide general assistance to all divisions both during the project and after. The monthly project status reports were provided to division directors so they could track progress and division related issues. The directors were also copied on all deliverables that were applicable to their division. Finally, the project was structured such that each division received GIS training early and the pilot effort encompassed data from each division. This allowed all divisions to, get involved in the project early, buy into the solution/system, and help give direction via constructive feedback on the pilot.

Vendors:
The ODPU invested heavily in selecting vendors. They made sure they chose an implementation vendor who had experience not only in GIS implementation but also in the four utility types. Recognizing there would likely be field collection involved with the data capture element of the project, the ODPU chose a local vendor who had worked with the wastewater, water and gas divisions and therefore had an established reputation and knew their territory, data and business processes. The vendor selection also had the added benefit of instilling confidence and buy-in of the water, wastewater and gas divisions.

Collaboration between the two vendors began well before the kick-off meeting itself. In order to devise the project plan that was to be reviewed at the kick-off meeting, the two vendors met and discussed the plan numerous times. Both the conversion and implementation vendor project managers and key technical staff attended the kick-off meeting. The collaborative focus in reviewing the detailed plan was to note task and schedule dependencies between the two vendors. The ODPU asked that each vendor acknowledge and accept responsibility for their deliverables and the impact any delay might have. The ODPU also laid the ground rule that there would be ‘no finger pointing’ between the two vendors.

Outside of the kick-off groundwork, the vendors shared monthly status reports, and as later sections of this paper indicate, collaborated on the technical challenge of developing the database.

Externally:
The ODPU established a cooperative agreement with Orangeburg County well before the GIS project began. The ODPU shared approximately $50,000 in cost with the county who developed and shared orthophotos and a digital landbase. The ODPU also planned to share its GIS asset data with the county but had to reconsider that offer after 9/11 due to security concerns. The data sharing will now likely be limited to a small set of above ground features.

Coupled with an additional investment that acquired 1:200 orthopotos for downtown Orangeburg, the ODPU's collaboration solved the first piece of the data acquisitions puzzle by economically providing the ODPU with the detailed and accurate base mapping they required for their GIS.

Meeting the Data Challenge

With a solid project management foundation built on cooperation in place, the project team was able to meet the data challenge and manage cost and quality, via three steps, Data Model Design, Data Capture, Data QA/QC.

Data Model Design

The Implementation Vendor was tasked with creating, electric, gas, water, wastewater and administrative (landbase) data models. However, it was very much a collaborative effort that involved each ODPU division, who brought expertise to their own model, as well as, the collection\conversion vendor, who tested the model during pilot field collection/conversion and provided feedback on the model.

For each of the five models, the implementation vendor began with the 'off-the-shelf' model provided by the system vendor. With a cost control objective of sticking as close to the off-the-shelf model as possible, the implementation vendor modified the model based on the legacy source information provided by the ODPU. This initial draft model typically met 80-90% of the ODPU's needs. A workshop was then held with the given division as well as the collection\conversion vendor to review all key features, relationships, attributes and domains. A physical data model was generated and the resulting model was then reviewed and accepted by the ODPU as a pilot data model. The collection\conversion vendor then tested the model via a pilot conversion. Adjustments in the data model were made when unusual or exceptions were found in the pilot area. The conversion\collection vendor and the implementer worked together to ensure that data model reflected what was being located in the field. ODPU further tested the model in their review of the converted pilot data. Modifications from this process were then fed back into a final 'production' data model.

Data Capture

The largest technical aspect of data capture revolved around the reliability of the legacy data for completeness and locational accuracy of assets. The collection\conversion vendor and the ODPU reviewed this issue and determined that the existing AutoCAD maps had enough inaccuracies to justify using Global Positioning Systems (GPS) to locate all above ground features. In addition, the AutoCAD maps, and especially the electric maps, were missing enough features to justify a field collection of above ground assets. Although time consuming and labor intensive, both parties agreed that a process which supplemented the existing AutoCAD data via GPS and field collection was necessary and would be invaluable for the life of the ODPU GIS.

Based on this general approach, the implementation vendor was tasked with establishing the following conversion specifications which established the quality parameters around which data would be converted.

Acceptance Criteria: This document defined the quality level that was expected of the data deliveries and outlined how each data delivery would be measured for, system compatibility, attribute accuracy, locational accuracy, aesthetic accuracy, and connectivity.

Source Matrix: This specification not only defined how the source data was to be used, it also established a hierarchy describing which source takes priority over another. Specifically, the source matrix:

- Listed and described all source data involved in conversion
- Defined which entities/attributes in the physical data model were to be addressed during conversion
- Defined the rules that were to be applied for those entities/attributes that were programmatically derived
- Defined which source should be used in populating each attribute in the data model
- Defined the source priority that should be used for each entity/attribute, where source data overlap.

Map Standards: This document described and showed what the final 'map' was to look like by defining the symbols, lines, and text that were to be used to represent the various combinations of features, attributes, and values. It included graphic characteristics such as, the size of the symbols/text, the thickness of lines, and the frequency of annotation placement.

The implementation vendor, collection\conversion vendor and the ODPU all collaborated on development of these specifications via workshops and reviews of drafts. The spirit was for the collection\conversion vendor to approve the specifications rather than having them 'imposed' upon them. Establishing these specifications was important to the quality control and assurance as they provided a clear set of common expectations that all three parties understood.

With the conversion rules in place, the collection\conversion vendor began the field collection effort. The GPS effort utilized mapping grade, sub-meter accurate, GPS equipment to locate all above ground features. (Meters, Valves, Hydrants, Poles, Manholes, etc.) Each GPS point was collected with a minimum of 20 positions with a PDOP of under 6.0. For points that were hard to reach because of tree canopy or other potential causes of multi-path error a Lasercraft Laser was used to provide an offset bearing and distance. The data was then differentially corrected utilizing the State's Geodetic Survey base station located approximately 50 miles away. This GPS as well as other field-collected information was combined with AutoCAD and other legacy data and converted into the target GIS data model.

By locating all of the above ground features the ODPU not only increased the quality of their mapping system but also gained added value by performing a field verification of all of their assets. For example the Wastewater division and the conversion\collection vendor located over 1,000 manholes that were not accounted for in the legacy ACAD data. In performing this data collection/conversion effort, the collection\conversion vendor and the ODPU collaborated in numerous ways to manage quality and costs, examples of which included the following:

- ODPU field personnel were coupled with the vendor's field staff. By working closely, the ODPU learned powerful navigation and GPS collection techniques that will be utilized once the ODPU takes ownership of the system, and the data collection\conversion vendor, received expert knowledge from ODPU about its system. This collaboration also helped each division build confidence in the field collection effort. By participating in the collection and having intimate knowledge that it was collected correctly, each ODPU division could concentrate their QC effort on those portions of the data that weren't derived from the field.
- The field verification was coupled with the ODPU's routine inspections where problems with assets were identified. These inspections and notes provided valuable information and documentation required by state regulations.
- The ODPU loaned equipment to the vendor such as golf carts and GPS units; they also provided office space, Internet access and 24 hour a day access to their facilities. By being on-site, the collection\conversion vendor was able to easily resolve source issues that arose by speaking directly with the division expert or in some cases investigating the issue via supplemental source information such as, service cards, as-builts, etc. It also provided the collection\conversion vendor the opportunity to quickly adjust delivered data based on feedback received from the ODPU during the QA/QC effort.
- The conversion\collection vendor, who is also a primary provider of engineering services for the ODPU, was able to apply the GIS/GPS knowledge, data, and processes outside of the realm of GIS data collection such that it became a very valuable and accurate tool for the ODPU's engineering and planning functions.

Even when the best-laid plans went astray, the three parties reviewed the situation with a cooperative approach. This was the case with regards to the size of the pilot. The pilot effort, which encompassed all four utility types, was very ambitious in and of itself. It was even more ambitious with regard to size and the detail which was to be field collected. (The electric field collection included nearly all attributes that could be collected, down to the size and material of down guys.) Recognizing that the original plan was a bit aggressive, the project team agreed that the pilot extents could be reduced and still achieve its ultimate goal of testing both the data conversion process and the GIS functionality for all four divisions.

QA/QC of Converted Data

Delivery of converted data was separated into a pilot data delivery for each of the four utility types followed by subsequent batch deliveries. With each data delivery, the project had to ensure that the data adhered to the specifications and met the acceptance criteria that was outlined as part of the data capture phase. Since the ODPU had limited resources and GIS data quality assurance expertise, the ODPU tasked the implementation vendor with assisting them by:

- Developing a test plan which outlined how the data was to be verified against the specifications and acceptance criteria

- Developing the QA/QC process and tools that would be used including a mechanism by which to track errors and measure quality against the acceptance criteria
- Performing the (non-field verification) QA/QC on the electric, gas, water and wastewater pilot data sets
- Providing training on the QA/QC process to the ODPU so they could perform the effort on post-pilot data deliveries.

This approach not only helped free up ODPU resources; it allowed for a more gradual training in aspects of the GIS. In addition, it allowed the divisions to concentrate their limited resources on the field collection collaboration effort but not compromise data quality.

While the implementation vendor's QA/QC of the pilot data sets acted as a 'check and balance' for the collection\conversion vendor's data, the two vendors collaborated throughout the QA/QC effort. The collection\conversion vendor provided interim deliveries of data. These 'unofficial' early deliveries provided critical feedback that was used to adjust the collection\conversion vendor's process (and in some cases the implementer's data model). This helped ensure that the official deliveries, which were reviewed by the ODPU division users, were of a higher quality that would better satisfy the end users. Once a given division's pilot data QA/QC was completed by the implementation vendor, a quality assessment was compiled which, listed all the data errors that were found, summarized the quality of the delivery against the acceptance criteria, and recommended a way-forward. With the collection\conversion vendor participating on-site, the implementation vendor reviewed the results with the ODPU division.

CONCLUDING REMARKS

As with any project, cooperation among the contributing parties is critical to success. With the complexity and costs involved in a GIS database development and implementation project, the need for collaboration is even more critical. The ODPU recognized that their data development and management went beyond just a technical solution and required collaboration with and amongst each ODPU division, vendors and the county. By fostering cooperation among all parties early, as well as throughout the project, the ODPU instilled a collaborative spirit which lead to the successful establishment of a GIS data model and populated database for their electric, gas, water, wastewater and administrative divisions.