

BIOGRAPHICAL INFORMATION

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Specific Responsibilities

Mr. Solberg oversees the continuing development of MiniMax's product line including StakeOut and GIS integration.

Past Experience

Yada Systems – Mr. Solberg focused on the development of color shading algorithms for the automotive paint industry.

Educational Information

Mr. Solberg graduated from North Dakota State University in Electrical Engineering.

UPDATING YOUR GIS USING FIELD ENGINEERING TOOLS

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ABSTRACT

Many utilities find themselves having invested a significant amount of time and money building a GIS and now need an efficient way to keep that investment up to date as they add new designs and construction. This paper discusses technology that allows utilities to bring their GIS data into the field on a tablet PC and then design jobs, gather GPS, perform engineering calculations and estimate costs from the field. The field updates are then synchronized back to a central GIS repository, avoiding duplicate data entry and reducing the potential for human errors. The tablet PC's pen-based interface has a high adoption rate among field users, even those with little or no computer experience. In addition to improving communication and accuracy, the field design process is often faster than traditional methods, allowing one utility to increase their efficiency in the field by 1600%. In other words the team was able to design a large job in only 6.25% of the time a similar job had taken previously.

INTRODUCTION

By leveraging a field design system and an interface to your GIS, data in the field can be twice as valuable. The second advantage is simplifying the process of keeping your GIS data current with proposed and newly constructed field designs.

GIS DATA MAINTENANCE PHASES

In order to fully capitalize on the investment in a GIS as a strategic system, maintaining the data it holds is as critical as integrating it with other systems and processes. The task of populating the GIS comes in two phases. The initial population of the GIS is typically accomplished through field collection and can take anywhere from one to five years. However a problem with this approach that stems from the continuous construction that occurs during the field collection phase. Ultimately, a field collection process alone just creates a snapshot representation of your field assets. Ongoing plant modifications and new construction create a continual need for maintenance on the initial field-collected data.

The second phase of GIS data collection is ongoing maintenance, due to several sources, each with unique frequency attributes. For example, city and county governments may make changes to the land base, political boundaries or government facilities. Many utilities have a procedure to handle such changes, but due to their infrequent nature, this process rarely requires automation or even a standard procedure. However, new construction, development of new plats and roads and address changes require a procedure and can be automated depending on their frequency. But finally, it is the daily work on the utility infrastructure through upgrades, retirement, repairs and construction that necessitates an automated process to capture the field design, and the resulting GIS data changes. With each completed work order, data collected from a field inventory gets

farther away from reflecting the actual plant assets. The daily frequency and the fact that the source of these changes is internal to a utility creates an opportunity for a large return on investment (ROI) by implementing an automated process to update the GIS data from a field-based, automated design system.

DATA MAINTENANCE SOURCES

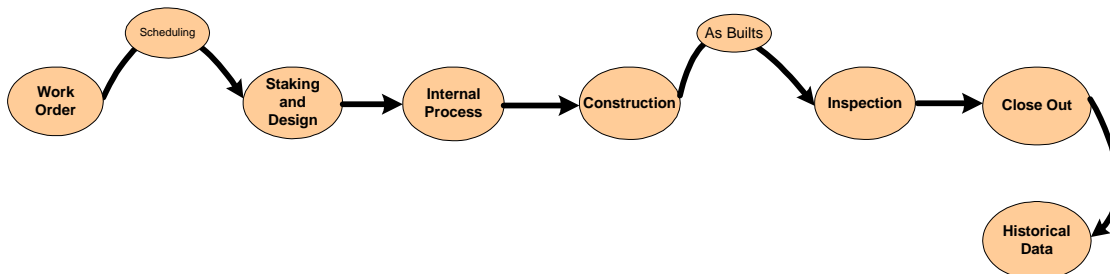
Frequency	Process	Automated	Source	Data Examples
Infrequent Annual	Maybe	No	City, county	Political boundaries, land base, hydrology, government facilities
Semi- frequent	Yes	Maybe	Developers City, other utilities	New plats, new roads, road changes, address changes
Frequent Daily	Yes	Yes High ROI	Internal work	Utility infrastructure changes; daily work, work plan construction and disaster work

DATA MAINTENANCE PROCEDURES

Existing GIS maintenance processes often include duplication of effort. One approach is to reference staking sheets and manually re-digitize the data, duplicating the work invested by the design engineer who created the design in the first place. Additionally GPS data and other highly accurate measurements collected in the field for engineering purposes is typically lost. The second path is to re-inventory the entire territory, an expensive proposition that means a utility will again relying on outdated data for 1-5 years. More importantly, both approaches require manually re-manipulating data that was collected during the field design.

A field-based design system is an excellent real source of high quality data for the maintenance of GIS. In addition, the ability to do the actual design work in the field, the environment in which the assets are positioned, can be referenced for the description, greatly contributes to the overall accuracy of the design. This is because a major portion of the value of a GIS system comes not just from maps, but the relationship between the physical entities that are represented. Designing in the office from memory means the relationship between physical entities can be overlooked or imprecisely portrayed.

WORK ORDER LIFE CYCLE



With an approach of GIS data maintenance from a field design system, designs are processed through the normal work order handling process. It begins with bringing the entire relevant set of GIS data to the field. Jobs are designed using the existing GIS data, and other related data sets in a field based automated design software. The designs are processed through the normal work order handling process and can be adjusted to reflect As-Built construction changes. The designs are then previewed and inspected before being posted to the GIS system. The posted data is now available for a cartographer to perform quality analysis and clean-up.

As the designs flow through the work order process, the GIS system can be used to analyze and visualize the status of work at various stages as well as visualize work order relationships and territorial dependencies. By acquiring data from the work order/design system, real-time important changes are available for immediate analysis in the GIS. For example, it can sometimes take over a year for a design to move from original sketch to close out. However, the need to reference designs or construction in progress may arise several times before the new job is closed out. Being able to reference proposed changes increases accuracy and reduces the time needed to get a current picture of a work order's status.

Concerns about the quality of the posted data can be addressed through internal quality control procedures. By carrying the design changes through the work order process, adjustments that reflect the as-built construction should be made before the final data is posted to the GIS, but are available for reference while pending. In office design engineers and cartographers can clean-up the data by previewing and posting the final design to the GIS system. Requiring this edit/approval step prior to posting ensures quality assurance rules are applied without duplicate data entry of the field design work.

TECHNOLOGY AND EQUIPMENT

There are several elements that must come together to achieve these benefits. In addition to GIS software, a standard interface framework, such as MultiSpeak™ is required. The solution also needs field based GIS viewing software, field based work order design software, work order management and synchronization technology and a work order to GIS automation process.

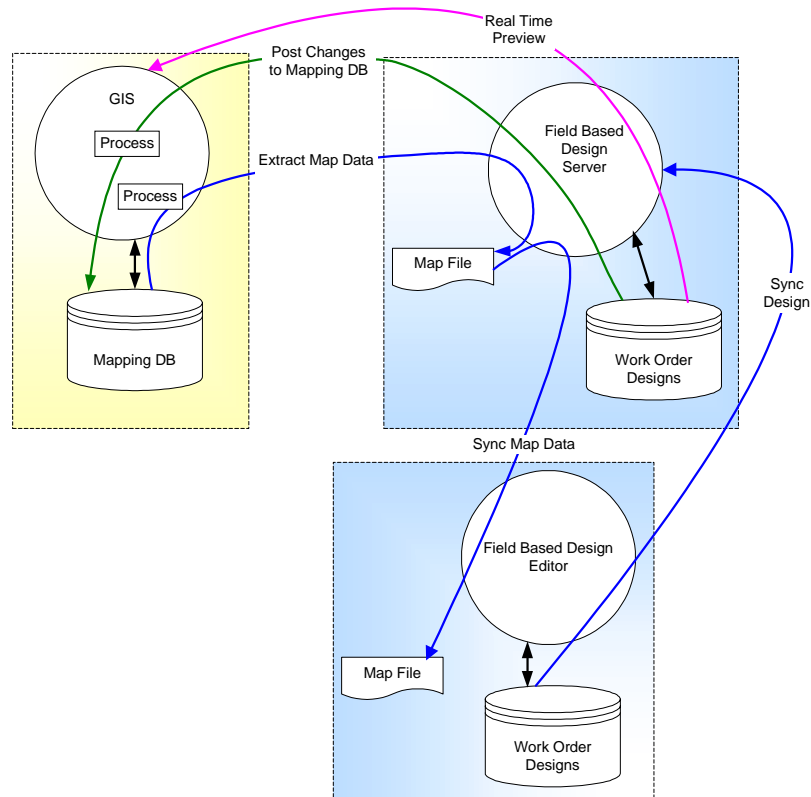
The hardware used to create this approach's benefits, see BENEFITS AND RETURN ON INVESTMENT, involves pen-based field computers or laptops. Real-time differential GPS receivers, laser range finders, Ethernet and 802.11 wireless Ethernet, PC workstations and PC servers.

THE POSTING AUTOMATION PROCESS

The key to benefit from this approach is the Work Order to GIS automated data maintenance process. This process begins with a query for the work orders/designs that are ready for GIS transfer. The design is then previewed for accuracy and applied to the GIS database. The data in the design is then translated into the GIS data model taking into consideration retirements, additions and modifications. Any quality assurance rules are then applied. At this point, a cartographer can make adjustments and add any

additional data that has been acquired externally. The editing session is then saved to the GIS Mapping Database. Finally, an automatic notification is sent to the Work Order system to move the work order to the next status in the work order process.

The ROI of this approach comes from eliminating the duplicate data entry process as well as having to reconcile field changes with the GIS.



APPLYING THE TECHNOLOGY

The in-field deployed design process approach leverages experienced field personnel to achieve one primary goal: getting the job done correctly the first time. As-built changes, site revisits and inferred conditions ultimately result in higher costs. Bringing the utility’s GIS data to the field allows design engineers to validate information, use GPS tools for location purposes, and fix or work around environmental conditions that may not be apparent back in the office. Soil conditions, obstructions, land use and other site conditions can lead to significant design changes.

Using GPS in conjunction with laser range finders – provided there is an effective user interface – dramatically shortens field staking time, allowing users to acquire GPS directly ‘from the truck.’ Where this is not possible, wireless technology can be employed to ‘lighten the load.’ Using a wireless-equipped laser range finder, users can control the field design software using the laser’s display and controls and ‘shoot’ the truck’s GPS antenna to acquire GPS locations without having to backpack a GPS receiver.

Field work can be dispatched using work order management tools built into the field design software. Users can synchronize up to a central server, obtain their work for the day, update their computers with changes – including new and revised standards, construction units, staking sheet changes, material updates, cost data and GIS updates – and get to work much more quickly and efficiently. As the work goes through various

design statuses, other systems can be quickly updated with the changes. Permits can be automatically filled out and submitted electronically, underground locate requests can be produced and faxed or emailed to clearing centers and the in-house GIS can be spatially updated with the work flow as it happens in real time. During the work order process the GIS can be updated, not only with status changes, but also with the proposed designs. This enables utility personnel to see jobs in various stages of planning, scheduling and construction.

After construction is complete the as-built design must be permanently committed to the GIS data set. This generally involves a GIS technician previewing the design, validating the data with the as-built construction notations and going through the posting process. The as-built design exists as an independent edit session, or GIS version. The appropriate data from the design is translated into the GIS model, including retirements, additions to plant and system modifications. Often times the field engineer annotates the design with information – such as fences, trees, ‘mean dog’ notes and other construction-specific data – that, although highly relevant to the construction crews, is not germane to the utility’s GIS. This information is typically ignored. The relevant information is posted to the GIS and standard quality assurance rules are applied. The GIS technician then makes any appropriate cartographic adjustments to make the final product ‘look good’ as well as add any additional data acquired from external sources, such as construction crew notes. The GIS field version is then saved to the GIS database. After the GIS import process is complete the work order system advances the work order to the next status in the utility’s work order process.

BENEFITS AND RETURN ON INVESTMENT

Leveraging field based design systems into a GIS benefits the design process itself. Engineers can bring the entire set of GIS features to the field to use as the basis for design. This helps orient and inform the designer with existing information and provides an in-field opportunity to verify the GIS data. Designing in the field results in the final designs reflecting a high degree of positional accuracy. When field measurement tools such as GPS and laser range finders are added, the accuracy is again improved.

By streamlining changes to designs through the work order process significant efficiencies can be obtained. According to Jerry Dennis of San Luis Valley REC they were able to, “increase our efficiency 1600%. In other words, we were able to stake 100% of a large job in only 6.25% of the time it had taken previously.” The benefits at other utilities are similar.

Cost Benefit Analysis (2003 Forecasted Numbers)									
Work Order Task	Small Job 5 Pole Job Revamps		Medium Job 15 Pole Job Developments		New Residence		Large Job 30 pole Job AWP's		
	Manual	StakeOut	Manual	StakeOut	Manual	StakeOut	Manual	StakeOut	
Mapping (Minutes)									
Update maps	30	20	30	20	25	15	45	30	
Reduced error rates	15	10	20	15	15	10	30	25	

Finally, using a field based design system with a GIS can help lower the barrier for a utility to begin implementing a GIS. Many utilities are put off by the large up front cost

of setting up and populating a GIS. Using the data from a field design tool will not create a complete GIS, but it will start down the path of having some intelligent map data available. Thus building the GIS over time and reaping an early ROI. For those utilities already working on their GIS deployment, the field designed work orders can be used to collect some of the field data. There is even more productivity to be gained through analyzing data in a GIS, but having a plan for automated data maintenance before starting a GIS project allows utilities to reap value from a GIS in the near-term, even before the comprehensive implementation is complete.

Utilities are under increasing pressure to do more with less. Automating the process of transferring information from a field design and work order system into the GIS system increases accuracy, removes redundant data entry, and speeds the return on the GIS investment. Updating the GIS on a frequent basis and adding visibility into designs, provides the opportunity for advanced analysis on how a utility's infrastructure is developed and maintained. By leveraging field based design technology, design work done in the field can now go twice as far.