Automated Field Design: How to improve the facility design process

A briefing for Distribution Utility Executives

gsi works
GeoSpatial Innovations, Inc.

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1 Overview

1.1. Challenges Facing Utilities

The majority of large North American distribution utilities are facing increased pressure to drive operational efficiency and regulatory compliance. Each of these areas is massive undertakings unto themselves and just as daunting to understand. If we just look at operational efficiency, how does a distribution utility improve its operations while driving down costs? One approach is to look into processes that have large cost impacts on operations and identify ways to make them more efficient.

One area that every utility company spends large amounts of money on is the Design and Build process that supports expanding and maintaining the vast amount of distribution assets. This is an excellent process to consider improving as it touches many areas of the company from engineering, to field services, to asset management. If a utility can drive a 10% improvement for this process, millions of dollars per year can be saved through labor costs, material savings, and contractor fees.

1.2. Understanding the process

Before an existing process like Design and Build can be improved, it is imperative to understand the entire process by looking outside the traditional silos within a distribution company. Many companies have been able to improve the overall process by following the information. If we do this, we find a wide variety of issues like information bottle necks, duplication, and even black wholes that swallow information, never to be seen again.

Now the purpose of this paper is not to tackle the entire Design and Build process, but to focus on the tasks that could deliver a sizable gain in efficiency. By looking at the entire work flow we should be able to see information "issues" that may exist.

Figure 1 illustrates a typical high-level workflow that has been observed at several major distribution utilities here in North America. You can see how each task transitions from one group in the organization to another. The call-outs indicate just a few of the areas that any distribution utility can ask the question, "How do we do this better".

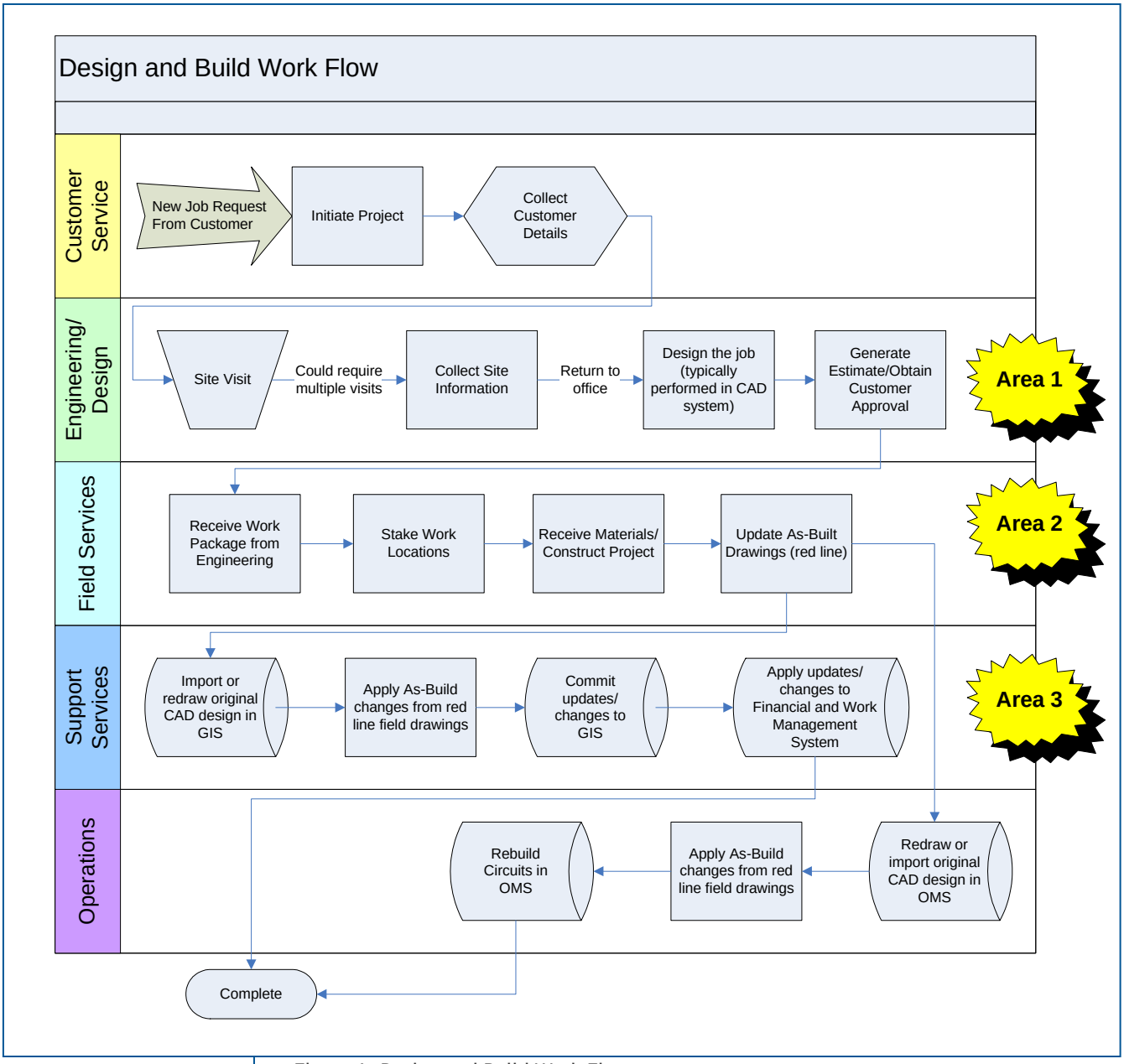

Figure 1: Design and Build Work Flow

Issue 1 identifies several tasks performed by the engineering or field technician that could be improved with technology. Is it possible to reduce the number of site visits to come up with an accurate estimate for the project? Can information in the field be collected digitally? Can GPS (Global Positioning Satellite) provide a faster, more accurate and optimized design?

Issue 2 identifies the potential to streamline the staking task. Can survey costs be reduced by utilizing GPS capabilities?

Issue 3 identifies information duplication and even the potential to lose information between what was originally designed and what was eventually constructed. As part of a quality assurance program, could the engineer or field technician perform the as-built

documentation once construction was complete? Could this information be captured digitally? Could support cost savings be realized if the design and as-built information was synchronized between the field computer and the GIS?

1.3. "Low Hanging Fruit"

We can now see that several areas of the Design and Build process can be improved by making changes to the process and applying technology to enable those changes. GPS can be one of those technologies that allow a utility to reduce cost and improve design.

GPS enabled field computing has been around for some time now and is used extensively in the survey and construction industries. However, many utility companies have been slow to adopt the use of this technology when it comes to designing new facilities like line extensions, service connections and relocation projects. Utilities that are using GPS enabled field design are receiving benefits through a more efficient design process, as well as reduction in construction costs through optimized designs and more accurate location information. This accurate, up-front information provided by the designers reduces the time it takes to record the facilities back in the asset management system.

It is important to understand that GPS today still presents some technological challenges. Satellites must be within the line-of-sight of a GPS device in order to work, so GPS coverage may be spotting in "urban canyons" or in heavy tree canopies. An effective field design capability requires at least sub-meter GPS accuracy when staking rural line designs in the field, which dictates more expensive GPS receivers. And at this point in the technology lifecycle, only a few GPS equipment manufacturers provide rugged, reliable devices appropriate for utility use.

1.4. Technology has Caught Up

At the same time distribution utilities have been struggling with ways to get their workforce more mobile, the technology industry has been evolving and offering new solutions that address these issues. The maturity of mobile devices has provided software developer a stable environment to begin creating high-order applications for low-cost PDAs and GPS units that many utility companies are now taking advantage of. Real-time differential calculations for GPS receivers are now a proven and reliable way to get sub-meter accuracy when doing GPS field design. This means that the field technician can accurately stake a job at the same time he is designing it. However, getting the information back and forth between the office systems and the field devices remains problematic.

Technical difficulties around the synchronization process are now being addressed using standard synchronization tools being offered by companies like Microsoft. The same tools that allow you to synchronize your PDA or Smart Phone are now being used to track transactions on a GPS unit. Devices offered by companies like Trimble have advanced to

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the point of integrated blue tooth capabilities, Wi-Fi, and cell phone connections, as well as cradling the device to transfer data between the unit and the office GIS.

These developments provide the foundation toward increased mobile device use for more than just getting email when you are out of the office. This new capability is called Automated Field Design or AFD. The need for simple, easy to use design tools in the field, combined with background processes that keep the information flowing are what field users need. In fact, as business processes move to the field, distribution utilities can now effectively drive change, which lie at the heart of operational efficiency.

In short, the key elements for an AFD transformation are in place now:

- Business issues and regulator pressure are mounting.
- Distribution utilities see field design capabilities as best practice.
- Early adopters have shown the way.
- Software and Hardware vendors are working together to build products that drive value.
- And, most importantly, AFD offers distribution utilities a way to drive operational efficiencies that contribute directly to the bottom line.

2 Why is AFD Compelling?

2.1. Creating Business Value with AFD

As we already touched on, to understand how AFD creates value for a distribution utility, it's important to understand the entire workflow that surrounds it. Only by understanding how the current business practice is executed will the company know how the adoption of AFD technology will work best.

The best way to understand how a process works is to follow the information. A design project will follow four (4) high-level basic steps; initiate, design, construct, and close. Each step needs to receive information as well as give information to the next step. When these steps are documented for a particular process, utilities usually find breaks in the flow of information. A valid AFD will support at least 3 of these steps if not all. Figure 2 illustrates these steps and how AFD provides a positive impact:

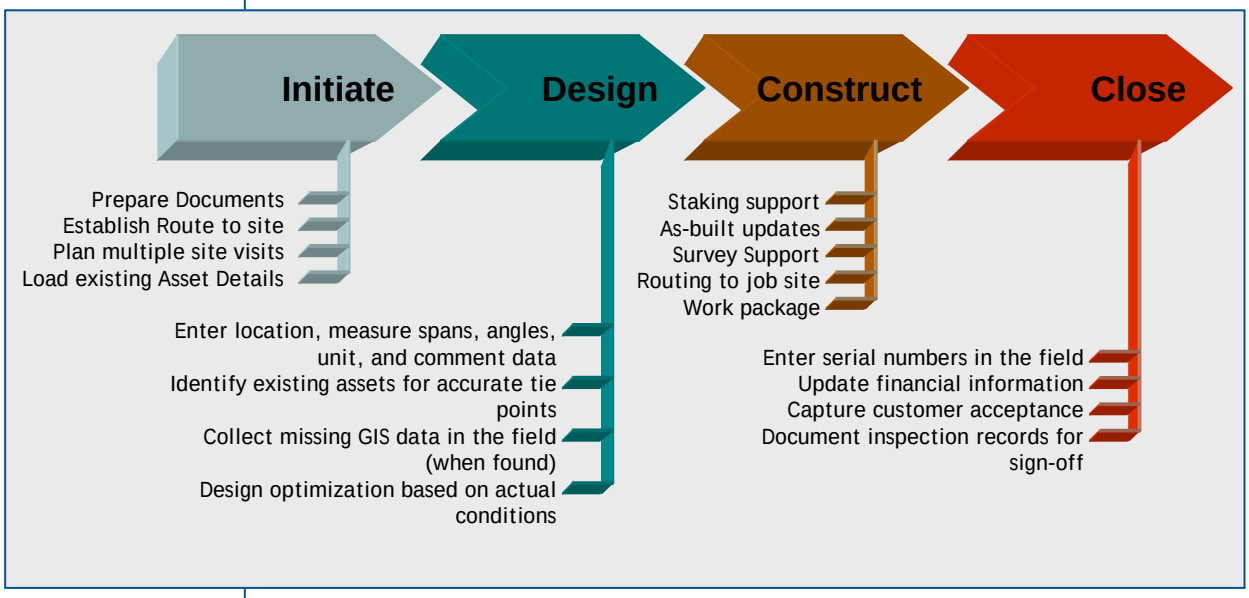

Figure 2: AFD Workflow Impacts

By re-designing processes enabled by technology, distribution utilities can drive value by pushing information to the field. Utilities spend substantial amounts of money on GIS and asset database but many times the information can't get to where it is needed the most. A successful deployment of AFD technology can fill the gaps in your current workflows and drive value with current, accurate and actionable information.

2.2. Process Change to enable the Field Worker

The easiest way to determine how to change your current processes is to follow the information. When you consider the design process, most of this work is performed in the office. However, what does a designer need to know before he or she can design something? They need to see the lay of the land and what obstacles may be in the way. You can only do so much with a map. 9 out 10 times they will hop in the car and go out to see what the customer needs. If we follow the information, the designer will most likely go out with a paper map and some notes taken during a phone conversation. Why not take a digital version of the map and some pre-routed directions that tells them how to get there? Once onsite, the designer will draw a sketch of what he sees and measure the distances and angles for the proposed design using a wheel or tape. Why not capture coordinates using a GPS enabled device that has a simple user interface to place locations, units, quantities and related information for the optimal design?

Again, following the information we see that the sketch and notes have to be transposed into the GIS and Work Management System once back in the office. Why not synchronize the digital data collected in the field with the office systems?

When you really start to look into this process you will find it is not so much a process change but a transformation to a new way of designing facilities.

This change should include;

- Business requirements that are needed to enable this new process
- Information requirements that show when they are needed and how to get the information to the right place
- Usability requirements (field activities are different than office activities due to the environment). The field application should be simple and fit on a hand-held device.

3 What is an AFD?

3.1. What Does an AFD Look Like?

At its basic elements, AFD is all about enabling information to flow between the office and the field. That sounds simple enough but when it comes to designing facilities for a distribution utility, this can be a tall order. This capability needs to be simple to use for the field worker and powerful enough to support demanding office system requirements.

To accomplish this means having the ability to model a complex system like a GIS on a small, hand-held device. It should have configuration tools that provide mapping between the office systems and what is to be collected, updated or deleted from the field. This does not mean having to duplicate the system on the field device. Only the necessary information needs to be populated at the time of use.

An AFD is able to change its data structure easily and efficiently so new documents and information can be synchronized with the office. It's a cultural, managerial and IT issue that needs to be addressed from all aspects in order for this new capability to have an effect on the business.

3.2. Establishing the Foundation of an AFD

An AFD contains 4 fundamental elements: data model, server applications, device applications and synchronization tools (see Figure 2). These elements allow a utility to build a process that leverages field automation as well as returning the information back to the office systems.

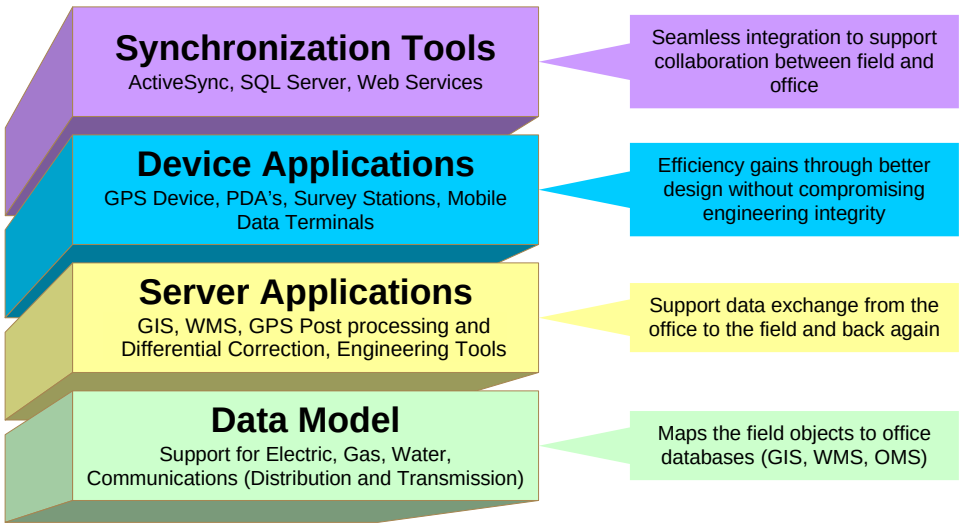

Figure 2: Key Terms & Definitions

4 What the Process Change Opportunity Looks Like

4.1. How Utilities Benefit from AFD

Moving from theory to AFD reality requires that a utility set goals at an enterprise level. That is, make sure all the regions utilize the same tools and standards to drive fundamental change within a common business process. These goals will capitalize on existing investments in existing infrastructure, GIS database development and design tools that are used in the office. This approach is not to reinvent an asset database but to gain greater value from those investments.

Where do you start? By this point in the AFD evaluation process you should have a good idea of the different job types going on and their projected numbers. For example, a large IOU may be performing 800 to 1,000 overhead line extensions in one year. If the design process for these job types can be reduced by just 2 hours, a utility of this size could save millions over the current process.

Take a look at the overall workflow of the project and pay particular attention to information that flows into and out of each application. Many times these areas are overlooked and duplicate entry is required to finish the workflow. In some cases, the information stalls out and is never passed on. Benefits can be found in pushing the information where it needs to go without duplicating the effort. These new found efficiencies can help you set new goals for the operation that can be measured and held accountable.

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Much like saving time spent in this process, material savings can be derived by using better design techniques. By having the technician design a job in the field and seeing the potential route the new facilities will take, performing an optimized design will save on materials. For example, if a technician can save the cost of 1 pole and 1 anchor per year at a cost of $2,000 and you have 150 technicians performing this work, a savings of $300,000 per year on materials can be realized.

4.2. Creating Funding for Process Change

The potential savings described in the previous section can add up to a substantial amount. Based on the type of projects you do in one year and the number of staff you have doing them will determine this exact amount. Many of the utilities looking into this technology are finding the potential return on investment (ROI) over a 5 year period can be greater than 50% and in some cases is over 70%. In the majority of cases the payoff for this investment is less than one year. With these numbers, finding funding should be very straight forward.

4.3. Case Study: Large Mid-West Utility

In this example, a predominately rural electric distribution company needs to improve their design process while enabling the design data to flow between field activities and office activities. A back-office synchronization application was provided that allowed this utility to pass compatible unit information from the field to the office design application. In addition to the back-office tools, this utility also utilized hand-held GPS units running Windows Mobile PC and GSI's PocketDesigner application that allowed the technician to capture locations, units, span lengths, and other relative asset information directly on the unit during the initial site visit.

This utility now has these tools deployed to over 500 technicians and contractors throughout their service territory. AFD is driving more than $4 million of benefits per year through more efficient processes, back-office processing and material savings.

In addition to these substantial dollar benefits, the utility is also recognizing intangible benefits associated with this approach. The following areas represent these benefits.

Increased Safety

- No need to carry heavy survey equipment through rugged terrain.
- Less brush clearing required by field tech for line-of-sight survey work.
- Provides the ability to avoid dangerous terrains and field obstacles.
- Provides an electronic mapping program (Streets and Trips) for field navigation.
- Can be used during storm restoration as a field data collection device and mapping tool.

Increased Job Design Efficiency – Improved Customer Service

- Field notes can be collected and documented quicker and more consistently.
- Electronic maps can be used for more efficient route selection.
- Available communication devices can facilitate real time appointment scheduling.
- Data transfer can be made electronic eliminating paper notes that can be lost or illegible.

Unlike other recent initiatives this utility attempted to control costs, AFD saved total project time with out compromising the engineering integrity of the job.

4.4. Case Study: A Successful Northeast IOU

In this example, the distribution utility needed to change its design workflow to help reduce costs associated to designing new facilities and well as drive material savings from an optimized design performed in the field. The utility utilized hand-held GPS units that enabled the technicians to establish a design for the facilities that was optimized based on the lay-of-the-land that offered a better route from the tap point to the service drop. PocketDesigner allowed this utility to realize substantial material savings through fewer poles, fewer guys and optimal span lengths.

In order to establish a credible business case for AFD, the utility executed a pilot study that measured the effect of AFD over the traditional methods used for facility design. The pilot study focused on specific job types that included secondary/service orders, primary line extensions, highway relocation projects, and re-conductoring projects.

The benefit analysis would focus on several key areas of the design process to measure the effect AFD had on these specific tasks. The tasks measured were job preparation, field design activities, GIS integration for returning design data, and survey/staking efforts. The following table represents the findings of the analysis.

Benefit Analysis

150 Number of Designers
$35 Designer Loaded Rate

		Current Process				AFD Process		
		Number of Designers	Hours Per Day (Avg.)	Days Per Year (Avg.)	Total Cost Per Year	Savings w/AFD (%)	Total Cost Per Year	Annual Savings w/Pocket Designer
Job Preparation	Gather contact info, backdrop maps, plan job routing, find job location	150	0.25	150	$196,875	10	$177,188	$19,688
Field Job Design	Enter location, measure spans and angles, position, unit, and comment data at job site	150	3	150	$2,362,500	20	$1,890,000	$472,500
GIS Interaction	Enter location, position, unit, and comment data into GIS	150	2	150	$1,575,000	50	$787,500	$787,500
Survey Line	Set up transit, clear brush, use site rods, outside contractors	150	6	10	$315,000	75	$78,750	$236,250
					$4,449,375		**$2,933,438**	**$1,515,938**

Table 1: Benefits Calculation

This utility is currently in the evaluation stage but plans to role the application out to more than 150 users throughout their territory.

In order to illustrate the results of the pilot study, Figure 3 represents the cost benefits curve. This analysis is based on 32% of the implementation costs coming in Year one and 68% of the costs coming in year two. The cost figures used in this calculation include internal IT costs of 1 FTE to support the project each year after implementation of the system, as well as hardware purchases for the hand-held GPS units.

The implementation schedule used for the analysis assumes 10% of the potential benefits from AFD in year one. Year two would recognize 50% of the potential benefits and year three recognizing 80%. Year four and beyond would recognize all the benefits as long as sufficient change management practices have been utilized. An additional $300k per year in material savings was also used as part of the calculation.

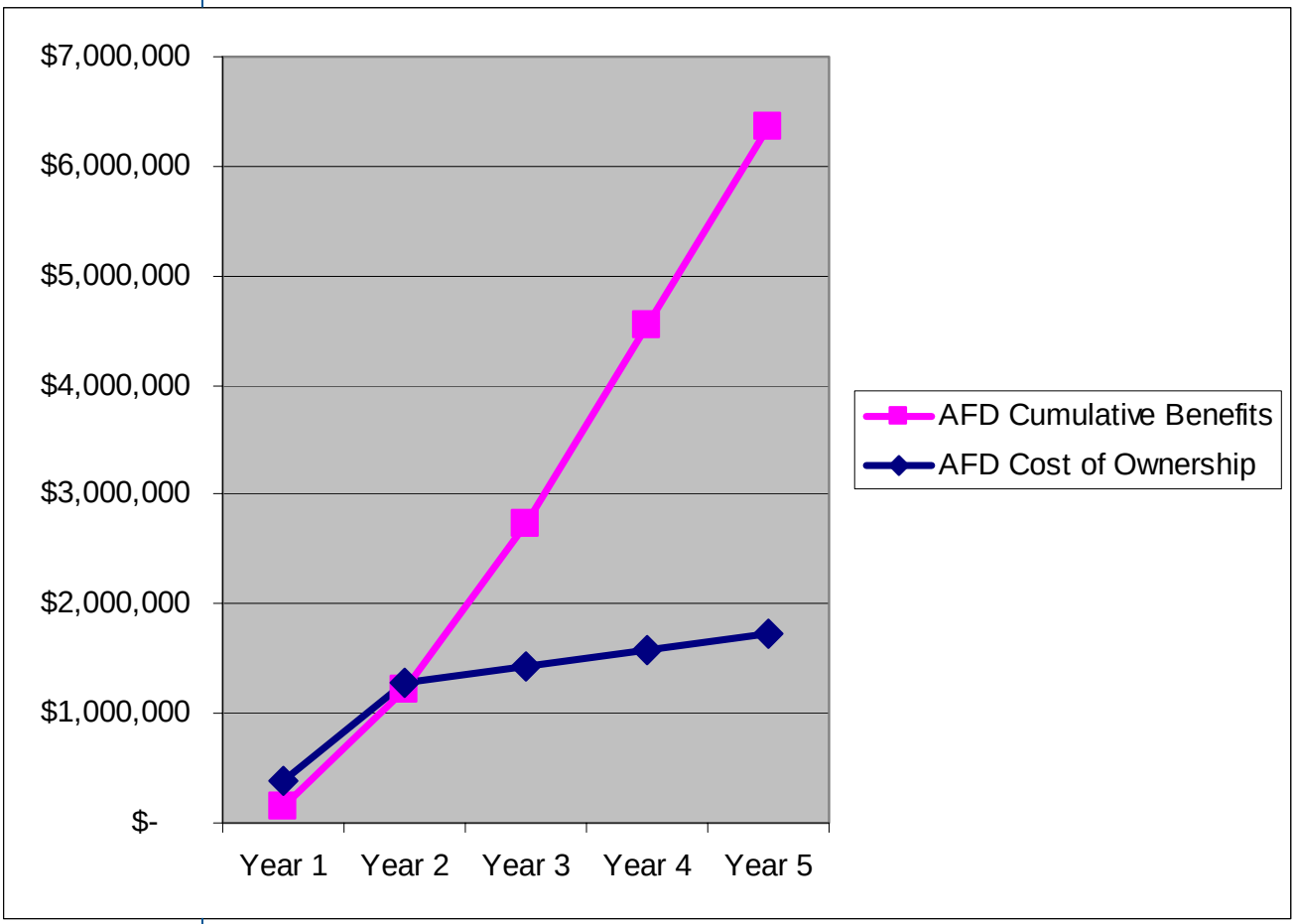


Figure 3: Cost Benefit Curve

This analysis shows the bread-even point coming in year two using a conservative calculation. The ROI is calculated at **73%** based on the following equation;

5 year average savings from Automated Field Design

_____ = *Average ROI*

Capital Investment

$$\frac{(6{,}354{,}188/5)}{1{,}730{,}135} = 73\%$$

4.5. Critical Success Factors

As with all enabling technology, a critical success factor is the ability of the utility to change based on new processes. The success of the technology will be based on the utilities ability to train, motivate, and provide adequate incentives that enable its people to respond to the challenges beyond their current roles and responsibilities. Most people react positively to the opportunity to broaden their participation in a particular process, especially if it brings value to their customers. However, this only works if they see the alignment of the operations objectives with their own personal growth and success.

Another key success factor is the leadership behind the change. A process change like this will take several years to reach its full potential. The leadership of the organization must remain committed and be visible to the entire staff. Sufficient measurements must be put in place to monitor the success or failure of the initiative.

5 Conclusion

As utilities continue to face increased pressure to drive operational efficiency, a long look is needed at the current business processes to find areas that can be improved. This improvement should be focused on making direct cost impacts on the business. In the case discussed here, portions of the Design and Build process for a distribution utility can receive substantial gains by applying process changes that effect information sharing between the office and the field. Benefits far out way the cost to make this change and allows utilities to capitalize on previous technology investments.

Emerging technologies exist today that can enable this process change by applying Global Positioning System (GPS) to solve the problems attributed to obtaining precision measurement in the field. This technology also solves the problem of synchronizing information between the field and the office that make it easy for an engineer or field technician to move between the two environments easily and efficiently.

About the Author

John Gartside is Vice President of GSI's Utility Practice. He is responsible for providing business development and strategic consulting support to our customers that will help them realize true benefits from technology. He has been recognized for driving results, managing performance, innovative thinking, and the ability to bring a true understanding of how technology affects the bottom line of an organization. Mr. Gartside is a 23 year veteran of the utility IT industry – including 6 years with GE Energy as head of their utility consulting practice. He possesses a deep understanding of how utilities operate and provides valuable direction to clients for navigating the complex environment of operational software. He can be contacted at jgartside@gsiworks.com or by calling (412) 835-1406.

About Geospatial Innovations, Inc

GSI helps electric, natural gas, and water/wastewater distribution company's harness emerging technologies for superior asset management. That's our way of saying we help utilities get the job done in the field.

GSI has developed a suite of field software tools that leverage GPS, mobile and wireless communication technologies for specific utility business processes:

- GSI PocketDesigner is used for designing new overhead or underground electric lines, pipelines, or cables while in the field. The system consists of:
  - Field software that runs on a mobile computer with integrated Global Positioning System (GPS) technology, allowing engineers to quickly capture locations of structures and cables and complete paperless design by adding construction units and field notes.
  - Round-trip Integration of field design data with traditional desktop design systems such as Itron Staker or LD-Pro, and NISC Staker

  Business Value: reduce windshield time, more accurate estimates, and material savings through optimized designs, improved workflow.

- GSI PocketCollector is used by electric and natural gas utilities for field data management of network assets. The system consists of:
  - Field software that runs on a mobile computer with integrated Global Positioning System (GPS) technology, enabling field personnel to use a user-defined schema in collecting entities, attributes and choice values specific to a business process or work area.
  - Round-trip Integration of field data and GE Energy Smallworld GIS and ESRI GIS through a plug-in or data exchange wizard.

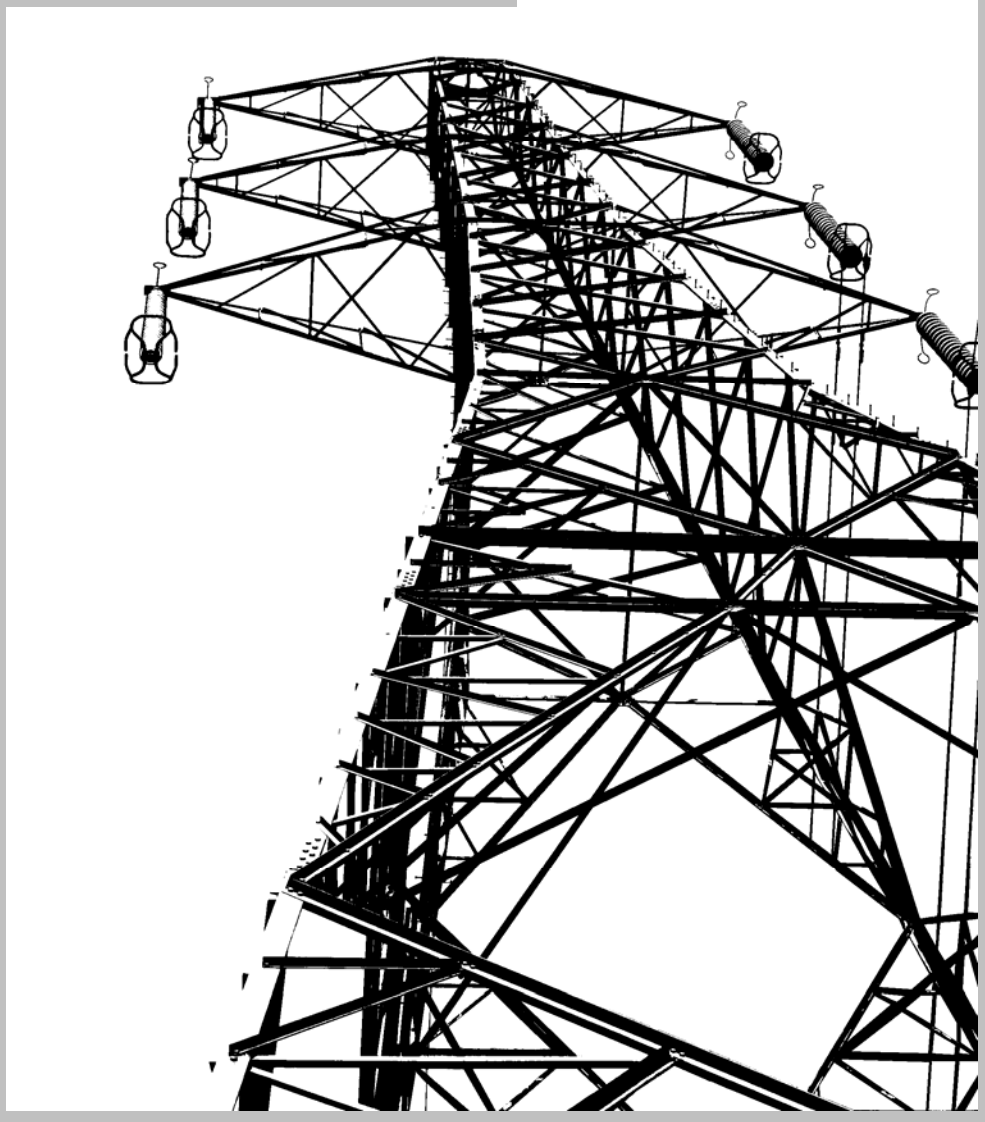
  Business Value: capture critical information easier, rapid field validation of the GIS, simple user interface, and seamless integration with the office systems.

- GSI PocketScout for damage assessment.
  - Field software that runs on a mobile computer and supports Global Positioning System (GPS) technology, making it easier for assessors to record equipment damage and crew requirements, and to quickly communicate the assessment data to dispatchers or crews without radio traffic.
  - Web portal that provides functionality for assigning incidents and hazards to scouts as well as tools for estimating restoration time based on field assessment and printing work packets.
  - SystemBridge to outage management system to download incidents and hazards.

  Business Value: better coordination, improved communication with field staff, more accurate ETR's, get the lights back on faster.

These mobile tools are complemented with back-office server components for GPS post-processing differential correction, bridging data to external systems, and view/update/export functions. GSI is a Trimble Authorized Business Partner, GE Energy Value Added Reseller, and ESRI Business Partner.

For more information, visit our website at
http://www.gsiworks.com



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