BIOGRAPHICAL INFORMATION

Steve Shannon, P.E.
Systems Analyst
NorthWestern Energy

SPECIFIC RESPONSIBILITIES

Joined The Montana Power Company in 1998. Responsible for project management, system design, and application development for AM/FM and related projects at NorthWestern Energy - Montana.

PAST EXPERIENCE

1992 – 1998: Worked as Software Engineer at Tetragenics, at that time a wholly owned subsidiary of The Montana Power Company.

EDUCATIONAL INFORMATION

B.S. – Engineering Science, Montana Tech
M.S. – Engineering Science, Montana Tech

PROFESSIONAL MEMBERSHIPS

GITA

Charles Marlin
Senior Consultant
Graphic Technologies, Inc.

SPECIFIC RESPONSIBILITIES

Assist prospective customers in defining their requirements.
Manage projects.
Write and implement applications.

PAST EXPERIENCE

Worked at Intergraph from March 1982 to October 2001, except for a hiatus in 1988-90. Held positions of Customer Engineer, Regional Technical Director, Executive Director of the International Graphic Users Group (IGUG), and Executive Manager for Utilities Customer Services.

Taught mathematics at Chattanooga State Technical Community College.

EDUCATIONAL INFORMATION

Bachelor's degree in Mathematics, Harvard College

PROFESSIONAL MEMBERSHIPS

GITA
St. Elmo Maze Builders

NORTHWESTERN ENERGY IMPROVES VEGETATION MANAGEMENT EFFICIENCY WITH GPS AND MOBILE APPLICATION

Steve Shannon
Systems Analyst
NorthWestern Energy
40 E Broadway
Butte, MT 59701
Telephone: (406) 497-2578
Fax: (406) 497-2048
E-Mail: steven.shannon@northwestern.com

Charlie Marlin
Senior Consultant
Graphic Technologies, Inc.
9668 Madison Blvd, Suite 4
Madison, AL 35758
Telephone: (256) 774-5247
Fax: (256) 774-2889
E-mail: charles.marlin@gti-us.com

Paper Presentation

Audience Rank: All

Learning Objectives:

1. Understand how information technology enables more efficient vegetation management.
2. Learn how field workers use touch screen laptops with GPS.
3. Discover how Northwestern Energy’s work process changed to improve.

Track: Mobile

ABSTRACT

NorthWestern Energy reduced vegetation management costs with GPS and a mobile GIS viewer. Previously, tree crews in bucket trucks inspected every circuit, trimming as they went.

Now, a scout carries a touch-screen laptop, and GPS centers him on the map. The scout marks problem trees on the screen. Later, the vegetation management supervisor prints trim maps with the bad spots clearly marked. The tree crews drive directly from spot to spot, stopping only to trim.

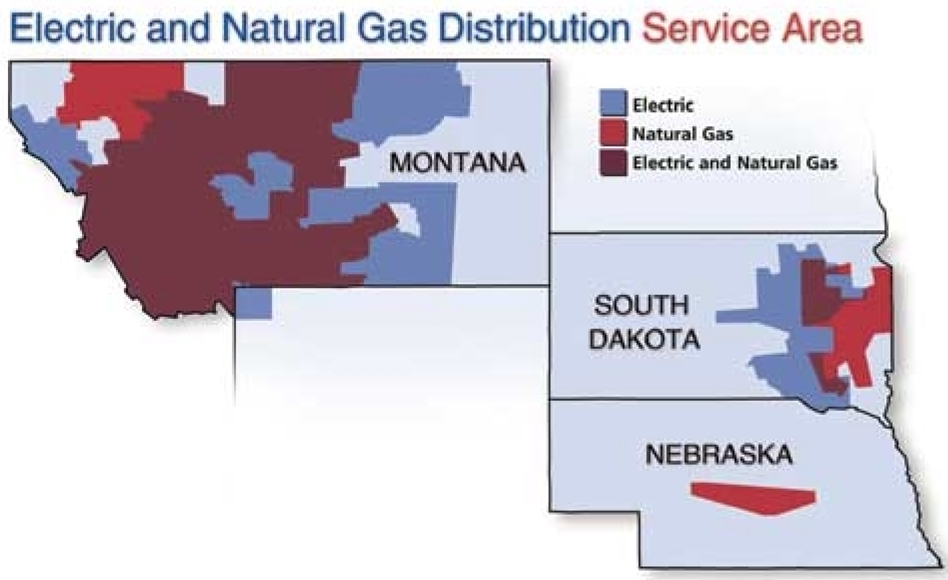
NORTHWESTERN ENERGY IMPROVES VEGETATION MANAGEMENT EFFICIENCY WITH GPS AND MOBILE APPLICATION

OUTLINE

1. NorthWestern Energy
2. The old process
3. So what's wrong with that?
4. The new process
5. Budget thoughts
6. Looking ahead
7. How did we write the application?
8. Conclusion

NORTHWESTERN ENERGY

NorthWestern Energy is an electric and natural gas transmission and distribution company, serving customers in Montana, South Dakota, and Nebraska. The scope of this paper is limited to the Montana operation. In Montana, we serve about 295,000 electric and 156,000 gas customers. The Montana service territory is 107,000 square miles, about two thirds of the area of the state of Montana. Our customer density is slightly greater than four customers per square mile, a number lower than most utilities. We literally have 2½ times more cattle than people in our service area. A map of the territory follows:



Over the last few years, we have been asked to control our budgets without reducing safety or reliability. In short, we were asked to improve efficiency. One way we improved efficiency was by improving the vegetation management process.

Our Superintendent of Operations, John Carmody, and our Right of Way Maintenance Supervisor, Scott Bernhardt, redesigned the work process to maximize the effect of vegetation management dollars. A key factor in the new work flow was the use of an easy to use custom application that we wrote in-house, tied to an inexpensive GIS map viewer - GTViewer. For a better understanding of the process improvements, we need to understand the old process.

THE OLD PROCESS

In the past, the staff assigned to vegetation management included one Right of Way Maintenance Supervisor and two Right of Way Maintenance Specialists. Contract tree trimming crews were hired as needed.

The supervisor chose which circuits to trim, based on history, a general knowledge of amount of vegetation growth for that year, and input from line crews. Then, the supervisor asked the local drafter to plot a circuit map for each circuit to be trimmed. The supervisor or one of the specialists handed the map to a contract tree trimming crew and they drove the entire circuit in a bucket truck, inspecting as they drove, and stopping to trim trees as encountered. The specialists would oversee and follow up the crews as needed, such as dealing with landowner concerns.

The overall organizing concept was for a highly paid crew in an expensive bucket truck to perform a full sweep of each circuit. Throughout the process two people and a bucket truck were on the clock. The amount of money paid for the services of the contract tree crews was the main cost factor in the process. Circuit length and ease of access, rather than the need for trimming, drove the budget.

SO WHAT'S WRONG WITH THAT?

First, circuits don't always follow roads. They veer off across mountain ranges, they cross streams and rivers, and worst of all, they cut right through private property or forest service land where off road travel is difficult. Often, more than one circuit runs along a single road or even on the same line of poles. Inspecting those circuits by following them will result in inspecting the same section of line twice. In any case, driving a circuit in a bucket truck is a very inefficient means of either inspecting or trimming the circuit.

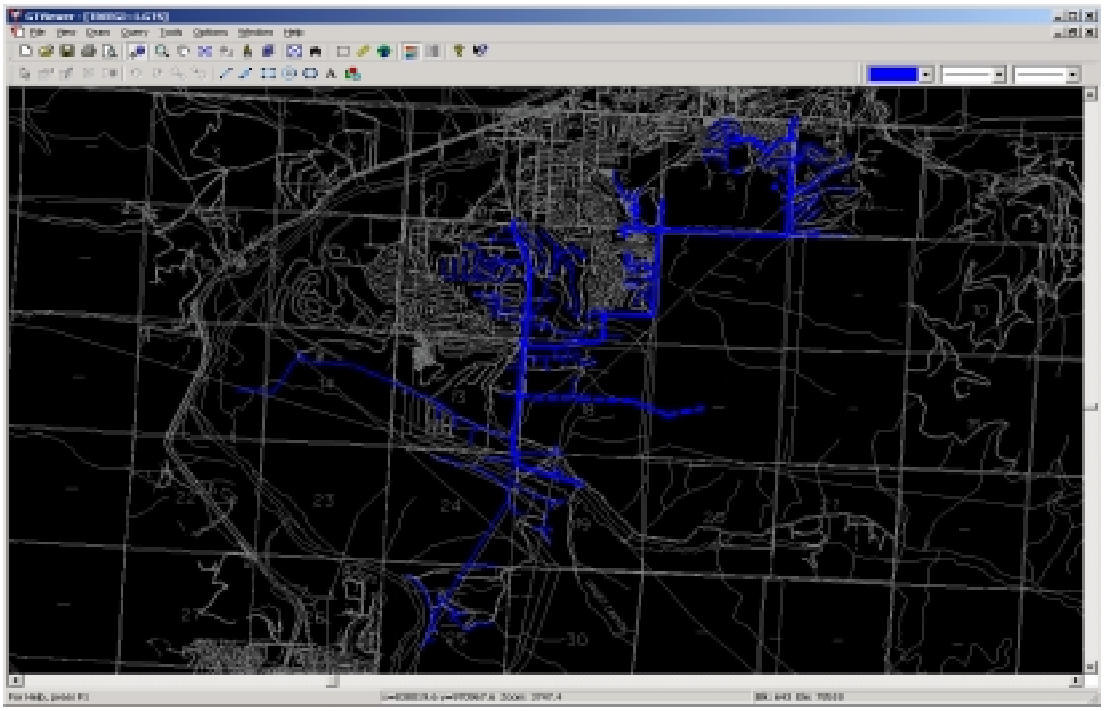
Second, not all of a circuit needs to be trimmed or even inspected. Having two contractors in a bucket truck driving along the circuit in areas with no vegetation has a high cost and zero payback, a combination we usually want to avoid.

Finally, one set of eyes looking for trees growing into a circuit is enough. Two sets of eyes, all looking at the same trees and lines, are unnecessarily expensive.

THE NEW PROCESS

Under the new process, the full time staff assigned to vegetation management is the same: one Right of Way Supervisor, and two Right of Way Specialists. Now, however, light duty linemen (linemen who are temporarily unable to perform their regular duties) supplement the effort of the two specialists and take over the inspection duties that the tree trimming crew performed before.

The process is quite different. As before, the supervisor assigns areas to the specialists. Rather than going to the division drafter, each specialist downloads the current GIS extract for his area directly to a laptop computer. Custom queries in GTViewer allow the specialists to highlight one circuit at a time.



Then each inspector inspects one circuit at a time, following the circuit in a pickup truck rather than a bucket truck. He sets a laptop on the seat beside him, connected to an inexpensive GPS. GTViewer and the tree trimming application are running on the laptop. GPS keep the screen centered on the current position. When the inspector sees a problem spot, he selects one of the buttons or function keys (F2 through F5) to indicate the priority of the vegetation encroachment.

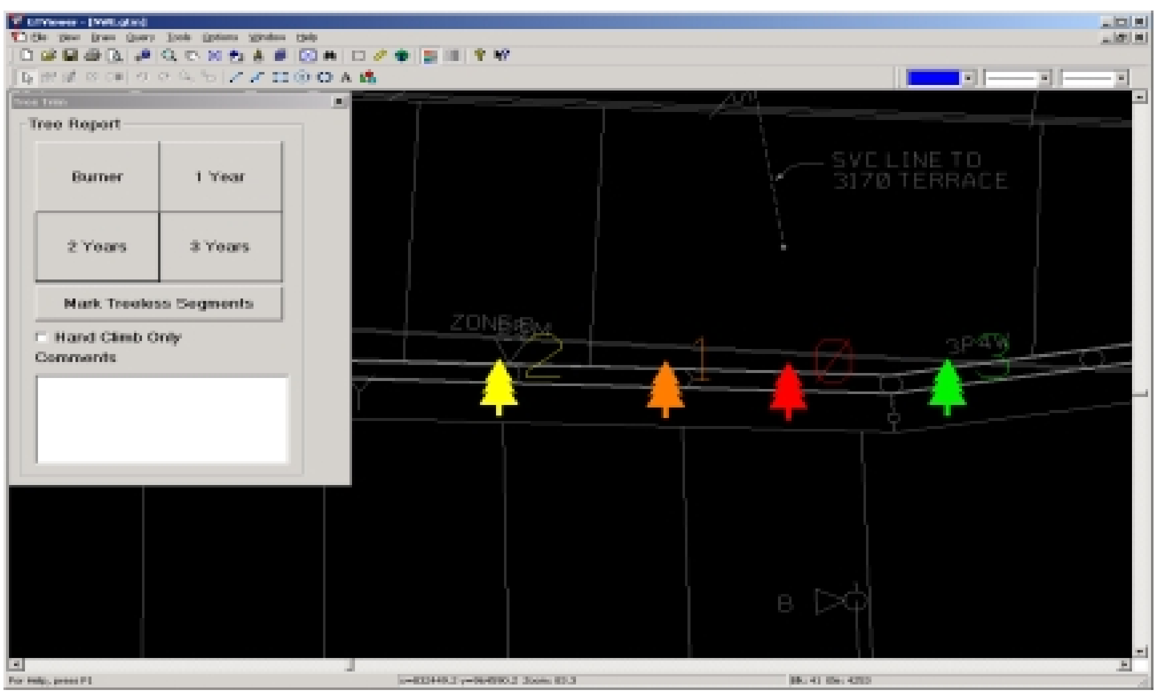
Then the inspector selects the circuit at the spot on the map where the vegetation interferes with the line. Two things happen:

First, the application reads the stored information about the selected line, merges it with data from the form, and uses that information to create a data record. The data record includes the circuit name, the SAP functional location, the priority of vegetation encroachment, a Boolean field that indicates if the tree needs to be climbed rather than using the bucket, a comment, the date and time of inspection, and the map coordinates. If other attributes are needed in the future, they can be easily added.

Second, the application also places a graphic marker with two components: a tree symbol, color coded to the priority (with red the highest and green the lowest) and next to it, a numeral that reflects the priority. The graphic record is placed on the map at the exact point the inspector touches. The priorities are “Burner”, “1 Year”, “2 Years”, and “3 Years”, , with “Burner” being the highest priority. The numeric value written to the data record is an estimate of the number of years, 0-3, before trimming is required. A burner, priority ‘0’, means that physical contact exists or is imminent between the vegetation and the line. A burner needs attention right now. A priority ‘1’ means that the vegetation will probably need trimming within a year. ‘2’ means that the inspector feels we have two years before the vegetation touches the line, and a '3' means that the vegetation will probably not touch the line for at least three years but we need to occasionally check it.

The data and graphics are written to a special layer in the application called the "session graphics" layer. Although GTViewer is primarily a view only application, the user can import, export, edit, or delete the contents of this layer at will. In the new work flow, the preferred method is to inspect one circuit at a time, export the session graphics as a GTG file, and then e-mail the file to the supervisor. The supervisor saves the file for each circuit separately, but he also imports all the files into a single GTViewer session to see the big picture. Because two or three circuits can overlap a small area, there may be many trees that need trimming in one area even though the data files only show a few trees for each circuit. By seeing a map that shows all of the trees that need trimming and their priority, he can best decide where to send the contract crews. Work can be assigned by geographical area, using the street map that is printed along with the map of trees to determine the most efficient way of getting around. The contract crews can omit entire stretches of circuit if no trees have been marked on the map.

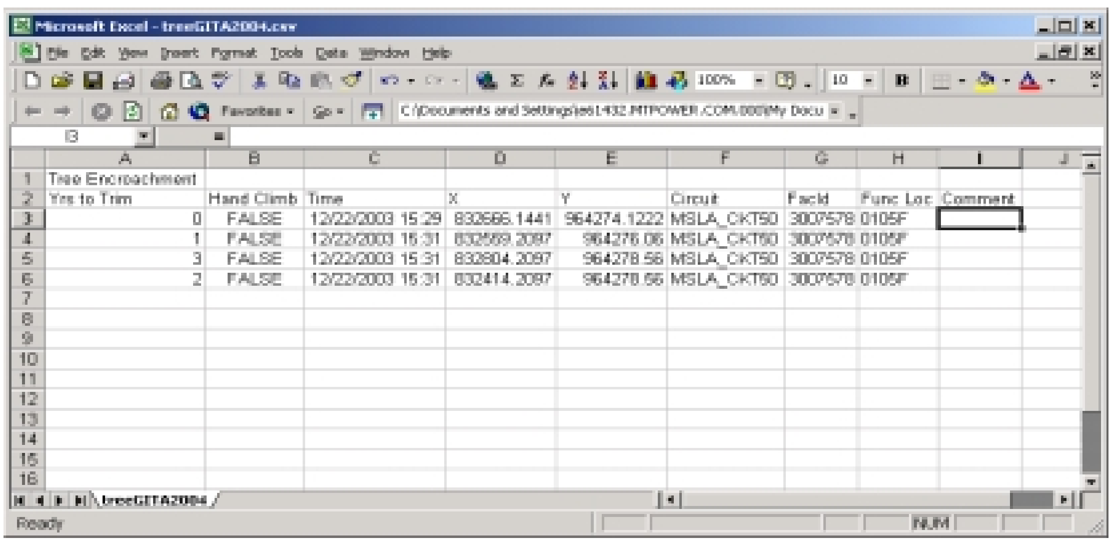
Best of all, the supervisor has a comprehensive picture of what work needs to be done, its priority, and where, specifically, the work is located. Using this comprehensive picture, he assigns work to the crews so that the most urgent problems are addressed right away.



The crews also work a bit differently. They get maps as before, but now, because the problem spots are printed on the map, they can drive directly to the place where they will work. Using a GTViewer feature called "Emphasize Session

Graphics" makes the trees really stand out. An actual map is appended to the end of this document. The trees retain their bright colors but everything else on the map is slightly muted. That makes it easy for the crews to see exactly where to drive to get to the highest concentration of trees. The crew may trim trees from as many as three different circuits while they are in one area of town. When that work is completed, they drive directly to the next concentration of problem trees as shown on the map.

These changes have made a difference in several ways. First, the crew trucks can drive directly from job to job and eliminate hours of windshield time looking for vegetation problems and deciding whether to stop. Crew truck hours are the most expensive hours in the process, so a more efficient use of this cost component results in lower costs overall. Second, the supervisor has enough information to prioritize the work. The most urgent tasks can be done first. But also, he can look ahead and forecast how much work will be needed. Instead of sending crews on a full sweep of the service territory on a rotating three-year schedule, he can reduce or even eliminate crew trips to areas that have no need, and concentrate them on areas where the need is greater. Third, it allows the supervisor to plan crew routes more efficiently. Knowing the density and the priority of needed work, he can assign work in a manner that allows the crews to trim more trees and spend less time traveling. Overall, it moves him closer to the work. The supervisor can forecast his tree trimming needs more accurately.



At any time, the supervisor can export a CSV data file with all the trees, the circuits they affect, the date they were inspected, the location, and the priority. This data file can be manipulated easily in Access or Excel and used to determine the effectiveness of the vegetation maintenance program.

BUDGET THOUGHTS

Because we just adopted this process, the full impact of the process change is not yet known. Three different tree trimming scenarios exist. The first is the area with heavy, fast growing vegetation, where we must maintain aesthetics. These areas are usually residential neighborhoods with lots of trees growing closely together along a boulevard or in an alley. Our service trucks pass these areas all the time during their usual work, so they already know what needs to be trimmed. When we trim these areas we will probably always just send in a crew in a bucket truck to follow the alley or boulevard. For these areas, an inspection is not needed. In other words, we already know there are a bunch of big trees in the line, counting them would just hold up the work and cost extra.

The second is the area where trees seldom need trimming. The inspection process can help us initially identify those areas, but once they areas are known, they also will not benefit from a further inspection process. For these areas, the initial inspection, with the results captured for future reference in GIS, pays off year after year by preventing future inspections.

The last scenario exists where trees grow unpredictably or in areas that our service people don't visit often. This scenario will benefit most from this inspection program because it helps us to identify specific places where spot tree trimming needs to be performed. For these areas, sending out a lone inspector once a year to spot individual trees that need trimming makes a lot of sense. We think the savings realized here will probably amount to about three percent of the yearly tree trimming budget.

LOOKING AHEAD

An additional feature for this application will allow the user to sketch a line showing where no trees exist. This will be used to mark areas where the inspector won't even have to inspect in the near future. I also want to write a function to import the data back into our GIS system for historical reference.

HOW DID WE WRITE THE APPLICATION?

GTViewer was developed with the idea that it could be extended by the user. Sample code and an API for writing custom applications are available from the vendor. Once the Superintendent of Operations and the Right of Way Supervisor had a feel for how they wanted the work flow, I was able to put together the initial application in less than two days with help from Joey Rogers of GTI, the author of GTViewer. The Tree Trimming application was written as an application extension (OCX file) in Visual Basic. Once it has been installed, it appears on the Query menu in GTViewer. The user starts the application and just leaves it running in the background. Until the function key or screen button for priority is pressed, it does nothing. Once it has been activated by choosing the priority, it waits for the user to select an overhead conductor. The application receives a message each time the mouse is clicked or the screen is poked. The message includes the identifying characteristics of the line, such as circuit name and functional location, as well as the Montana State Plane coordinate for the location. Then the application writes to the GTViewer screen using an API call and saves a linked data record using another API call. Then, the application goes back to the waiting mode, ready to be selected again. All along, the GPS software component for GTViewer is receiving a stream of data from the GPS receiver and adjusting the map so that the driver is centered in the view.

CONCLUSION

This case study provides an example of a combination of technical innovation with changes in how work is done. It took a new generation of hardware and software, as well as a willingness to try something different.

The impetus to create this application was the financial stress of a reducing budget. It's probably safe to say that without the pressure of a reduction in funds, the new process might never have come about. On the other hand, without the tools that GIS and GTViewer provide, we could not have easily created this new work flow. Now that it has been done, however, you (the reader) can take the idea and improve your operation without undergoing our motivation by stress that led to the discovery of a better way to manage vegetation. My goal is to look for other low hanging fruit that deliver years of payback with only a few days of development time.

John Carmody and Scott Bernhardt came up with the overall work flow idea based on an idea that they had. They asked for my input to see how GIS could make this work flow effective. Based on the work flow they described I wrote a proof of concept application and Scott tested it. My goal was to write a simple application that could be used by anyone without needing computer skills other than starting the application. Based on users' feedback we have been able to evolve the application into a fast but small application that anyone can use. We have even demonstrated it to the Montana Public Service Commission to show them how we are doing more with less.

We have a few other applications like this one. One is for inspecting gas lines for leaks and for recording cathodic protection reads. Another traces gas or electric lines and generates a list of customers who would be affected by a valve closure or fuse or cutout opening. One of the highest pay-back applications automatically generates the files needed to perform gas flow analysis from the data that is stored in GIS. The application runs within the viewer. In the past we had to build the models in AutoCAD (which is incrementally very expensive) and then use a custom application inside AutoCAD to generate the data files for use in WinFlow. Or, we could build the model from the ground up in WinFlow. That took even longer and had little lasting value. Both options required thousands of dollars of software on each engineer's computer. They also required multiple drawings, one for each gas network. Now, we can generate the models directly from our GIS data using an application that has little or no incremental cost per computer. Errors in the GIS data become evident very quickly during analysis and the engineers become involved in correcting the GIS data. In addition, where it used to take a couple of weeks to build a model, we can create a model (even with the GIS data clean-up time) in a couple of days. Once the data has been cleaned up, we will be able to generate the models in minutes.

Actual map showing trees in line