Title: Michigan Forest Inventory system (MiFI)

Award Category: Information Communications Technology (ICT) Innovations

State: Michigan

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Executive Summary

The Michigan Department of Natural Resources' (DNR) Forest Resources Division (FRD) is charged with managing 4 million acres of state forest land to support economic, environmental and recreational needs of Michigan residents and businesses. Part of this management plan includes the annual inventory of 10% (400,000 acres) of the state forest each year. This is part of a strategic, continuous 10-year cycle to complete a comprehensive review of the entire state forest system. This review cycle helps resource managers propose treatments to keep forests healthy and commercially viable for timber harvesting and recreational purposes.

Prior to 2014, this inventory process was labor and paper intensive and would take up 40% of a state forester's time over a 12-month period. There are 80 state forester employees operating in remote field offices across the State of Michigan with many duties beyond inventorying our forest land. The DNR asked DTMB to help automate this inventory process so state foresters could reduce this 40% commitment to 20% - returning 20% to pursue other important tasks. The secondary goal was to build upon a data management platform that captures forest assets in a central data repository, complimented with geospatial assets that can be leveraged across state government

In 2014, The State of Michigan launched the Michigan Forest Inventory system (MiFI). This new system transformed a paper-based inventory process into a fully automated, mobile enabled solution that allows state foresters to complete all field work with a portable lap-top device and software that uses attribute data for every acre in the state forest. With this system, staff can:

- Electronically evaluate forest parcels, measuring forest density, wood type and age for commercial purposes.
- Record attributes about the health of the tree canopy and soil conditions (erosion). Biologists use this data to prescribe treatment options.
- Update data attributes for other conditions not associated with trees, such as forest roads, bridges, culverts and other forest infrastructure to assist in long-range infrastructure upgrades.

The MiFI application combines mobile technology, state-of-the art tablets and geospatial data to make our foresters much more efficient in collecting and acting upon data associated with the maintenance of 4 million acres of state forest land. This approach is light-years ahead of the traditional model where workers recorded the data on paper and then drove back to a field office to enter the data into a stand-alone legacy application.

Separate applications for timber health, timber commercial specifications and forest infrastructure have been eliminated and consolidated into a single purpose data repository that manages all aspects of forest management. This tool has extended the reach and productivity of each of our 80 foresters and has returned additional time to their work schedule to help remedy issues discovered during these targeted site visits.

Project Concept

FRD spent several months in 2013 working alongside representatives from industry, and state, federal and local governments, and conservation groups to develop a 5-year strategic plan (2014-18) to guide decisions and actions governing the health of Michigan's state forest resources. The following is one of the stated plan objectives:

"Embrace cutting-edge technology to enhance the effectiveness and efficiency of work on timber sales, forest inventory, the Commercial Forest Program and burn permits. Aging technology must be updated in order to yield the benefits of technological advancements and improve efficiency".

This objective was turned into a technology project compelling the DNR and the Department of Technology, Management and Budget (DTMB) to examine the current "as-is" process for collecting forest information and identify redundancies and practices better suited to automation. After completion of an 8-week workshop, this joint team made recommendations for:

- Retiring stand-alone collection systems and

- Developing a single-point collection system that could be used with mobile technology in the field by state foresters to collect information that could complement the stated strategic outcomes identified in the plan.

These recommendations became the MiFI Project. The MiFI project charter mandated a mobile "collector" application be developed that could update data into a single repository in both real-time and off-line conditions. As a starting point, it was decided to extend our investment within the ESRI ArcGIS platform. This platform had already established a base set of data layers that defined the boundaries of the state forest.

This project allowed the DNR to upgrade from a desktop platform to the ArcGIS server. This server is a service layer technology that provides object access protocol (SOAP) with which we can enhance our initial data layer with GIS processes. This allows us to include maps and polygons which we use to capture or modify coordinates identifying forest and road boundaries while on-site.

The MiFI application uses our base data and lets foresters add data attributes that had previously been stored separately (tree stands, treatments, site conditions and roads). This project complimented a broader strategic vision of consolidating data assets in one place which would assist in providing more open data sets to the public via our open data portal.

This same effort aligned with the state's Executive Directive 2013-1 which mandated more open data and better data sharing between state agencies. The MiFi project began in March 2014, and was launched in October 2014. The project was 100% in-sourced to state of Michigan staff. A dedicated project manager was assigned and we followed the state's unified information technology project management protocol (SUITE) to track progress and secure customer agreement on acceptance criteria for each project deliverable. Within the project development lifecycle, stage exits are in

place to ensure the application meets architectural, security and accessibility requirements.

The project team consisted of a project manager, 3 business analysts from the DNR/FRD, and a part-time architect to help configure our SQL server 2008 with the ArcGIS server. We had two developers (GIS and .Net C#) and a part-time quality assurance resource that helped manage software builds and software versioning via Team Foundation Server.

When the project launched in October, 2014, we had invested $295,000 in billable technology hours, $25,000 for software and server costs, and $150,000 to outfit 80 FRD staffs with new portable Tough-Pad devices for office and field work. The total project cost $475,000 and was funded using restricted funds obtained via timber sale revenues.

Communication and project awareness was efficient, as we had FRD field staff involved in both design and testing. This complete engagement made our users willing to adopt the new technology with a minimum of resistance.

Finally, the anticipated outcomes of this project are all being tracked within the DNR's public facing scorecard, with measures for 1) Timber economy jobs, 2) Acres of state forests receiving active habitat management or maintenance, and 3) State forest acres assessed for Emerald ash borer impacts.

Significance

The scope of the MiFI project was to create a technology solution to assist the FRD staff in completing inventory assignments more quickly and efficiently for 400,000 acres of forest land each year. This scope:

- Addressed the need for collecting better data attributes about the forest, and

- Leveraged GIS technology to add new data layers, with each layer adding new information about the forest (tree type, forest location, roads and trails, topography, vegetation, minerals etc.).

The completed project yielded multiple benefits to a diverse collection of stakeholders. The Michigan forest and timber industry have been early benefactors. Timber is periodically offered for sale from Michigan state-managed forest land. Sales are conducted for the purposes of harvesting mature and over mature trees, responding to past or predicted insect and disease outbreaks, salvaging fire-damaged trees, enhancing wildlife habitat and improving health of forest trees. Significant measures of the project include:

- On-site, real-time forest inventory is helping the FRD develop timber sale forecasts and bid proposals 2 month's sooner than pre-automation.

- This new system allows FRD to prepare timber bid specifications much faster for contractors authorized to bid on removing trees in designated areas.

- This quicker turn-around helps the DNR better forecast revenues from timber sales which are essential in preparing fiscal year spending plans and budget appropriation requests.

This project supports Governor Rick Snyder's 2013 Forest Products Summit by increasing the economic contribution of forest products with faster time-to-market harvest bids and accurate inventory and location of harvestable tree stands.

The MiFI project is distinctive from similar projects focused on data collection. The project supports data collection by foresters in the field using 100% mobile technology - from the Tough-pads used to enter the data, to the GIS tools used to collect data attributes. This data is then used across the DNR by land managers to effect better decision making concerning the natural resources of the land.

Another distinction is the innovative way we engaged our customers in requirements gathering. We used an agile process to define and execute requirements at a faster pace. Rather than meeting in conference rooms, the requirements gathering meetings occurred in rather rustic cabins located near large forest areas that housed our end users (FRD staff). The requirements (product back-log) were captured and tracked in Microsoft Team Foundation server (TFS) using the "scrum board" feature. This same platform was used to store code and ensure version control.

The MiFI project rolled-out to our foresters in October 2014. We have already received great feedback from these workers and have witnessed successful implementation.

- FRD staff head into the woods and "click" on the MiFI application icon from their Tough Pad. Based on their location, they "check-out" forest inventory attributional records which include GIS maps with Geospatial data attributes.

- Using ArcGIS, a technology solution developed by ESRI, staff can redraw forest boundaries, modify maps to include new roads, culverts etc. and calculate forest inventory (tree type, density, age), and calculate estimates of harvestable wood.

Our new single source data system has the added benefit of helping foresters make correlations not possible before. Our biologists and foresters can make initial recommendations for reducing the spread of emerald ash borer infection by using the data to recommend treatments including clearcutting, selective thinning, prescribed fires, tree planting, or no treatment at all.

The MiFI project has made a permanent change within the DNR on the role mobile technology can have for their workers. From a technology standpoint, we retired 80 office-based PC's and outfitted each FRD staff person with a state-of-the art Windows 10 rugged tablet (Tough-pad). This mobile solution allows for both field work and office work on one device.

Mobility standards dictate a responsive design so DNR staff can access MiFI using any bowser and any device. Adhering to DTMB's published technology roadmap, this native mobile application was developed using Apache Cordova to provide cross-platform capabilities (Windows, Android), with code developed in sustainable technologies that include AngularJS, JQuery Mobile and C#. These technologies are aligned with our technology roadmap and ensure future generations of developers will be working in a stable and universal platform.

Impact

The MiFI system, in production for 18 months, has enabled the FRD and the broader DNR realize multiple benefits in a short time, for a modest investment of $475,000.

The environment prior to MiFI can be characterized as labor intensive, semi-accurate and autonomous (no data sharing). Before MiFI launch, state foresters headed into the woods with paper maps, paper survey documents and hand-held measuring tools developed in the 20th century. In perfect conditions, a forester could only record data on 10 acres per 8-hour shift. This limitation made it impossible for the DNR to hit its annual goal of measuring 400,000 acres of land each year. Once the data was collected, it would take this same worker an additional 16 hours to transcribe notes and data observations, then manually key them into stand-alone database systems. These legacy applications were supported with retired technology (power builder, SQL 2003) and were expensive to maintain, let-alone modify. Inclusion of non-structured data, such as photographs was not possible. This environment was very limiting for the highly trained FRD staff who could do so much more if they had better technology and data.

MiFI has made state government better in multiple ways, with both immediate and long-term benefits.

Worker efficiency. FRD staffs have abandoned manual data collection and now use technology to compile a "complete" picture of a section of land. One visit captures multiple attributes: Tree species, canopy health, board-feet, density, topography, infrastructure, illegal dumping, supplemented with precise latitude/longitude coordinates and digital pictures. This was not possible prior to the MiFi project.

Each worker can measure 30% more area during an 8-hour site visit, dramatically increasing our ability to measure 400,000 acres each year with 80 FRD staff. This time savings is critical as it offers more flexibility in hitting inventory targets. During busy fire seasons, inventory work is suspended. MiFI minimizes this time constraint by allowing more work to be completed off-season. To ensure on-going adoption, the DNR has built on-line training modules for staff to help understand the system. This is ideal since it's problematic to coordinate training for field staffs located across the state.

Looking ahead, the DNR is positioned to reduce its 10-year forest inventory cycle by 2-3 years using this new technology and increased worker efficiency.

Economic development. The DNR issues about 800 timber sale bids a year, which generates $43,000,000 in annual revenue. With MiFi in operation for 18 months, it is clear that FRD staff are able to prepare timber sale bid packages at a faster rate with more relevant data for prospective bidders. The inclusion of pictures and geospatial coordinates has been widely praised by the industry in helping them locate and evaluate proposed stands for harvesting.

About 90,000 jobs in the state are supported by the Michigan forest products industry, which generates approximately $17 billion annually. Approximately 25% of the raw material used by the industry comes from state forest land.

Long-term goals of increasing the economic footprint of the forest industry are being realized. In October 2015, ARAUCO announced they would build a new manufacturing facility for particleboard in northern Michigan. The company will invest $325 million and create a projected 250 jobs upon completion of a particleboard manufacturing plant by the end of 2018.

Big Data, Open Data. Using a combination of aerial photography and field surveys, the DNR continually maintains a detailed GIS database of our state forest lands. The DNR uses this data to produce new GIS layers – over 400 data layers provide unique snapshots of our land for different customer groups. These layers include information on forest health and development, sensitive and important ecological areas, along with recreational activity data. This information is processed daily and published to the State of Michigan's open data portal, allowing for free and immediate access to the information. There has been a proliferation of "home-grown" mobile applications developed for visitors to Michigan state forests lands. Information on trails, forest roads, land cover, and other outdoor recreational information are readily consumed by hikers and outdoor adventurists. The past year has seen over 12,000 users of our open data portal. Long-term, our base data layers will continue to be updated and provide relevant information for our tourism industry for generations to come. This will position Michigan's DNR as a leader in open and transparent government.

Emergency Management. The MiFI application and associated data layers will help the DNR better track forest land that contains conditions (dead trees) susceptible to forest fire. This forecasting element will save millions of dollars by allowing the DNR to proactively manage potential fire events before they happen.

What the DNR had not contemplated was how their Enterprise GIS platform would be leveraged to help state government and our citizens manage a crisis that has continued to dominate news headlines for months. The Flint water crisis has exposed water infrastructure issues not only in Michigan, but nationally. Lead containments from aged pipes in the City of Flint has leached into citizens' drinking water. The same data collector tools developed and used for MiFI, is currently being used by field workers in the city of Flint going door to door to identify water service lines in basements. This will help direct targeted water service line pipe replacements based on information contained in the DNR's GIS.

The MiFi application contains multiple elements in support of innovative information communication technologies. Mobile and geographic information technologies are the cornerstones of the application. Our next generation digital storage (NGDI) is an on-site cloud hosting solution we use to store MiFI data. A sundry of new maps and detailed data layers are available to citizens on our mobile website. These same data assets promote an interoperable government by exposing the data to other agencies / governmental units via web services.

Michigan believes the MiFI application is a worthy candidate for consideration in the ICT innovation category.