

Power Line Corridor Mapping: The Lidar Solution

The North American electric power distribution network comprises a vast infrastructure of interconnected grids and power lines that generate and transport electricity to millions of homes and businesses. "In the U.S. [the] transmission grid system alone consists of nearly 160,000 miles of high voltage transmission lines."¹

According to the North American Electric Reliability Council (NERC), over 7,000 miles of new transmission lines are proposed with over 10,000 miles to be added within 2002-2011. Clearly, there is a tremendous opportunity to capitalize on the growing demand for power line mapping in North America.

Power line corridors are often in areas that are not easily accessible. As a result, these corridors have historically been difficult to survey. But lidar (Light Detection and Ranging) operating from an airborne platform, has become one of the most widely accepted technologies for surveying, mapping and monitoring new and existing power line corridors. Aerial surveying and mapping initiatives using lidar have been gathering information since 1998 on power grid systems in order to conduct reliability and performance studies, while also determining the rights-of-way for newly proposed lines.

A surveying company in Alberta, Canada recently used Optech's Airborne Laser Terrain Mapper (ALTM) to test its effectiveness in this application. Optech's ALTM uses an active laser sensor to scan timed pulses of light across a target on the ground—in this case, a power transmission corridor.

The surveying company chose the ALTM for reasons of flexibility and its demonstrated ability to rapidly acquire relative elevation accuracies of better than ± 15 cm. The objective of this survey mission was to gather accurate power line position data as it applies to catenary curves, line clearance, and rights-of-way.

¹Federal Energy Regulatory Commission Form 1, 2001, Edison Electric Institute Construction Expenditure.

The survey mission demonstrated how lidar technology works, and specifically, how Optech's ALTM was programmed to collect accurate position information along an existing power line corridor at a low-cost. The acquired data can be seamlessly integrated into existing databases, and is crucial to performing thermal capacity studies, analyzing rebuild/reconductor projects, generating as-built records and depicting clearance violations from vegetation and other objects.

Analyzing Catenary Curves in Power Lines

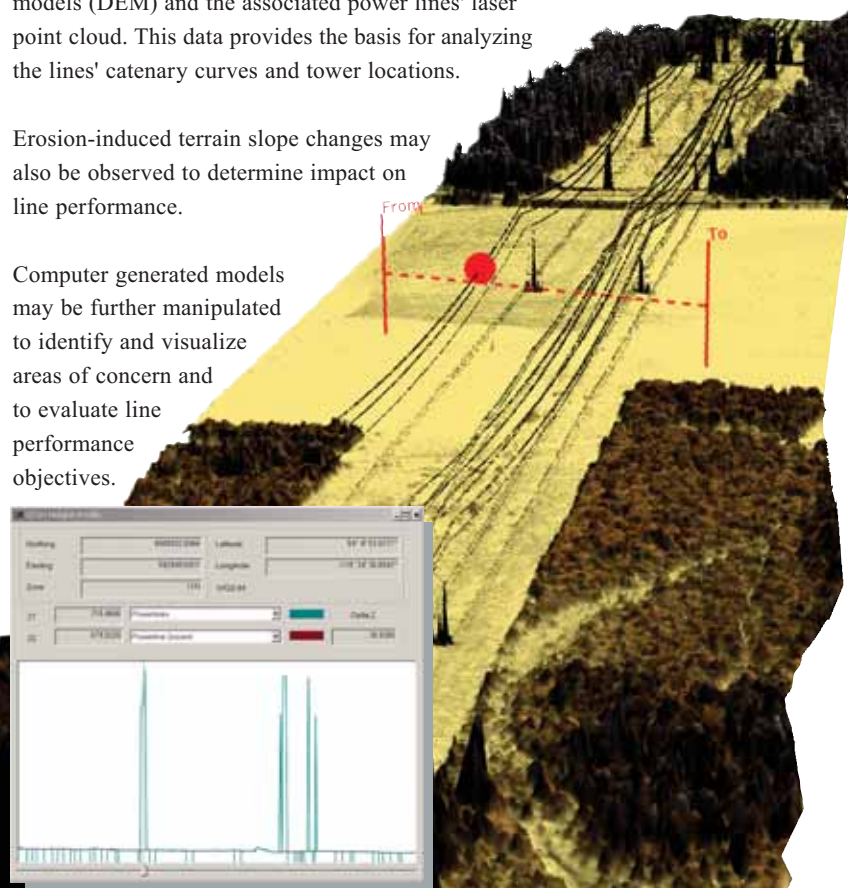
One factor that affects power line performance is the maximum operating temperature of the lines. Data must be acquired, processed and analyzed to determine the incremental effect that higher temperatures have on power lines, and whether tower locations and their associated line spans have violated any design criteria specific to temperature.

Lidar data can be used to generate digital elevation models (DEM) and the associated power lines' laser point cloud. This data provides the basis for analyzing the lines' catenary curves and tower locations.

Erosion-induced terrain slope changes may also be observed to determine impact on line performance.

Computer generated models may be further manipulated to identify and visualize areas of concern and to evaluate line performance objectives.

Power line point data with draped image; image generated using QT Viewer. Inset: height analysis software showing pole height at 30 metres.



Detecting Line Clearance Violations

Detecting areas prone to line/vegetation clearance violations is also a safety concern. Vegetation may interfere with supply conductors and should be trimmed or removed to mitigate the risks of inferior line performance, "flash-over" and disastrous results such as forest fires. ALTM lidar data accurately depicts wires, structures and vegetation, and provides a basis to determine the minimum specified safety clearance information.

Now, accurate line-to-ground clearance information derived from lidar data can be made available to operators of heavy equipment, thus helping to avoid contact with high voltage wires.

Defining Corridor Right-of-Way

Terrain information derived from lidar has become an established tool in defining the "line of best fit" for newly proposed power line corridors, thereby minimizing impact on the surrounding environment. The ALTM's accurate 3D terrain data enables planners to cost effectively map the route that optimizes performance objectives, including the optimal location of towers.

Power Line Corridor Survey Parameters

Corridor Size	11 km long x 210 m wide
Flight Lines	2
Spot Spacing	X = 0.3 m; Y = 0.9 m
Laser Pulse Repetition Frequency (PRF)	50 kHz
Scan Frequency	40 Hz
Scan Angle	16° (FOV)
Beam Divergence	Narrow
Flying Height	750 m AGL
Data Collection Time (laser ON time)	2.5 minutes
Processing Time	2.5 hours
Points	~3.1 million in 5 km strip
Aircraft / Speed	Fixed-wing / 140 knots

Below: Digital Elevation Model (DEM) and Active Laser Photo (ALP) showing 50% of surveyed power line corridor.

All images from the Calgary area. All data collected by Optech Incorporated.



- Optech's ALTM 2050 quickly collected accurate power line position data.
- A "bundled solution" processed and output point data in graphic format, allowing for analysis, interpretation and manipulation.
- The survey was completed at a fraction of the cost of conventional power line surveying techniques.
- The ALTM enabled the survey company to quickly deliver the data required by the electric power industry to study and analyze the power line components of a large infrastructure.



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