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Aerial Surveys Calculate Vegetation Growth

By Bryan Hooper and **Tom Bailey,** BC Hydro

PLS-CADD modeling of line sag and tree growth is the greatest thing for vegetation management since the chain saw.

The August 2003 blackout in the Northeast may have been a wakeup call for many utility vegetation management (UVM) divisions, but BC Hydro (Vancouver, British Columbia, Canada) has been improving on its UVM program for years. In collaboration with the British Columbia Transmission Corp. (BCTC; Vancouver), the utility is discovering more cost-effective ways to keep the network safe and free of trees and brush encroachment.

The province of British Columbia covers 366,000 sq miles, making it roughly 100,000 sq miles larger than Texas. The region includes more than 14 biogeoclimatic zones—everything from rain forests with more than 100 inches of rain per year to Canada's only desert in the south to tundra in the north. In transmission lines alone, ground crews clear roughly one-fifth of the transmission system's approximately 18,000 km of wire from 69 kV to 500 kV (around 3500 km) each year. Most challenging is the mountainous ter-

A helicopter, equipped with a LiDAR scanning laser, measures precise line clearances from vegetation.

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rain, which spans the Canadian province from southeast to northwest from the Rockies to the Coast Mountains on the Pacific.

In 2002, BCTC and BC Hydro piloted a LiDAR-based (light detection and ranging) project to investigate new vegetation management tools to better understand, assess and manage the relationship of vegetation to its transmission assets. Survey data captured via LiDAR technology was integrated with PLS-CADD, a computer modeling and design computer program developed by Power Line Systems. Although this was not a novel concept, a feature recently developed and added to the PLS-CADD software was new. The feature allowed for survey points identified as vegetation to be assessed for both grow-in and/or falling tree clearance compliance. This process, developed jointly by BC Hydro (now BC Transmission Corp.) and Powerline Systems, was the subject of an article featured in the September 2003 issue of *T&D World*.

The pilot project was an overwhelming success. The Vegetation Management team, which is responsible for executing the ongoing transmission vegetation-maintenance program, was amazed at the amount of highly accurate and detailed information available. Plan and profile drawings could be produced that pinpointed the location of any vegetation points in violation of inputted clearance requirements.

Removing the Guesswork

One of the biggest challenges UVM faces is identifying where vegetation growth will encroach the allowable safe operating clearances to the conductors at their maximum designed sag and swung positions. In the past, this has been essentially an educated guess. The PLS-CADD-produced plan and profile drawings have proven to be a great planning tool. Not only do the drawings provide exact detail on what needs immediate removal, but they give data that can be used to plan future clearing cycle needs. This is significant, especially considering British Columbia's measured tree growth rates on the transmission corridor average up to 4.3 meters (14.1 ft) per year in a single growing season. The norm for "hardwood" species on the coast is 1 to 2 meters per year and 10 cm per year in the northern section of the province.

Line Sagging

The LiDAR/PLS-CADD combination enables designers to model the critical positions of the conductors based on actual as-is tensions. This eliminates reliance of presumed initial conductor stringing and creep values. Also, with PLS-CADD models, unequal or unbalanced ice and snow loading positions can be predicted and vegetation clearances provided for.

Field Friendly

A key benefit of the aerial surveys is being able to produce useful mapping and data information for field crews. BC Hydro/BCTC decided to base the modeling program on traditional PLS-CADD plan and profile sheets to graphically present the information. Vegetation points that are determined to be grow-ins or falling tree violations are depicted on the profile sheet with different symbols and colors. This enables the field crews to quickly distinguish the difference. In addition to the drawings, a report that lists each vegetation clearance violation, its position and geometric details can be produced and either printed out as a reference tool or exported to a spreadsheet or database file for further manipulation of the data.

What's Next?

Many have said the LiDAR/PLS-CADD system is the best thing to hit transmission vegetation management since the chain saw. As with any new technology, the LiDAR/PLS-CADD system is being implemented on a case-by-case basis. If all goes as planned, vegetation management people will be able to determine the exact permissible height of every tree in every span for every circuit on the BCTC Hydro transmission system without guessing. The recent successes also point to wider deployment of the system for other system maintenance and inspection purposes. Next-generation LiDAR laser scanners will be beefed up to higher pulse rates (40,000 Hz) and a "multi-return" process, which will further increase the accuracy and confidence of the survey data.

Also in development is another collaboration of the BCTC/BC Hydro Power Line System that will further aid vegetation management. This feature will produce plan view drawings with vegetation clearance "iso-lines" plotted on them. These contour-like iso-lines will represent

The Merger of Two Technologies

LiDAR laser surveys are performed by a helicopter equipped with sophisticated equipment that flies over the subject area. The equipment consists of a precise navigation system and a scanning laser. The laser transmits light pulses (about 10,000 Hz) and measures reflection times. Distances to objects are calculated and then combined with the precise positional data from the navigation system. This provides the LiDAR survey points with their coordinate values accurate to ±0.25m absolute and ±0.15m relative. The LiDAR supplier classifies the survey points into several categories—such as ground, structure, conductor and vegetation—in a post-flight process. The survey points are provided for client use as ASCII files that are readily incorporated into the PLS-CADD model.

The PLS-CADD design software, developed by Power Line Systems, features conductor-to-vegetation clearance analysis using LiDAR-supplied vegetation points. PLS-CADD already had the ability to establish conductor positions under a variety of ice, wind and temperature conditions. In addition, it had the ability to perform clearance analyses to an assortment of categories of survey points each with unique conductor clearance requirements. Vegetation management professionals worked with Power Line Systems to develop a method to identify vegetation points that violated designer-prescribed horizontal and vertical clearance-to-conductor values as well as a method to identify trees that would come within a designer-prescribed clearance value if the tree fell. The capabilities were achieved by assigning horizontal and vertical clearance values for each type of survey point—roads, ground and vegetation. Safe clearance calculations were established based on the required electrical clearance, an allowance for vegetation growth and an additional safety margin. The modeling program could then identify "grow-in violations"—vegetation points that encroached this zone of safety.

Monitoring vegetation growth is a challenge on 500-kV lines, which traverse over steep granite outcroppings and long vertical drops.

The sag variance and closeness to the ground on the "up-hill" spans require vegetation removal on two-year cycles.

> **"The accurate and detailed information and mapping can assist in better planning and more accurate depiction for vegetation control."**

a connection of ground points that have equal minimum clearances to the transmission conductors. The isolines can be plotted at user-specified increments, depending on line clearance requirements. Vegetation crews then will be able to determine the maximum safe height of vegetation on an ongoing basis without the need for new LiDAR survey data each year.

Conclusion

The joining of two technologies, LiDAR aerial surveying and PLS-CADD computer-based modeling, has proven beneficial to BC Hydro/BCTC vegetation management. The accurate and detailed information and mapping can assist in better planning and more accurate depiction for vegetation control. Contractors can work from more specific information, which increases productivity. Working from a standard set of specifications can bring uniformity to the overall management of clearing and removal operations. These factors translate into cost savings, more uniform control and, perhaps most important, the ability to keep the system safe and reliable. ■

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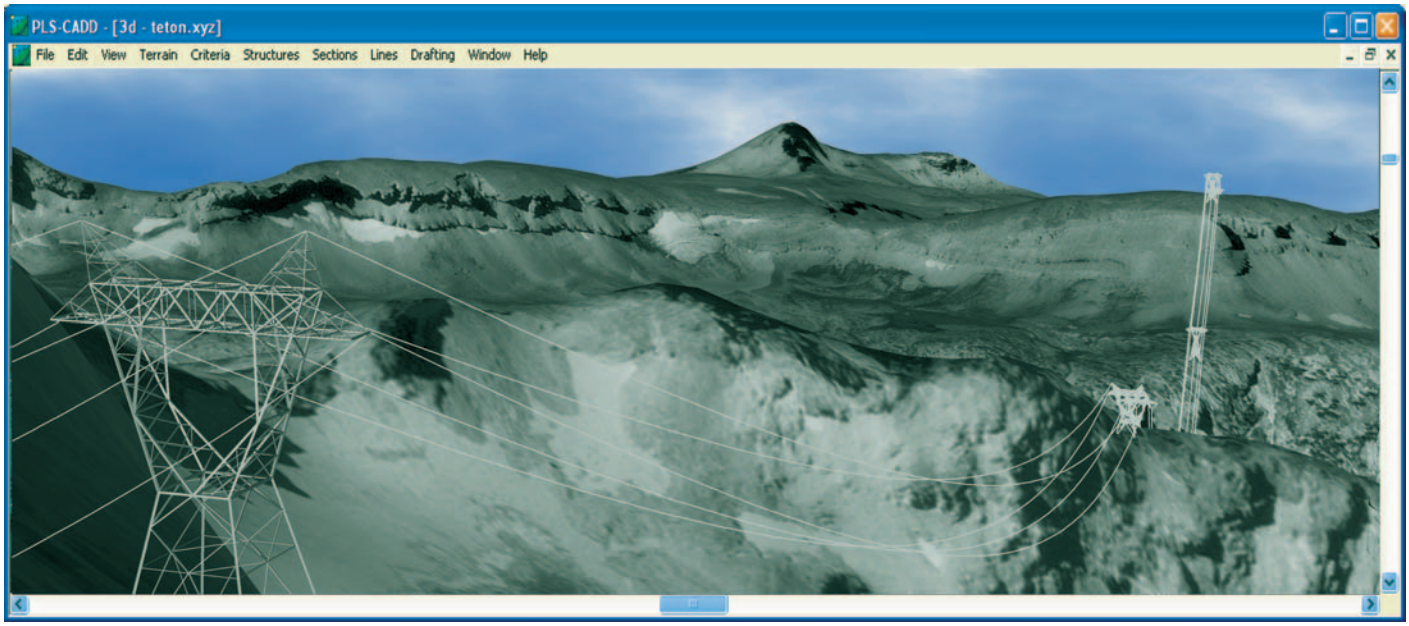

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