Mitigation of the Impacts of Climate Change

A Surveyor's Role

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Key words: Surveyors' role in addressing the impacts of climate change

Key words: Terrestrial & Mobile Laser Scanning Technology

SUMMARY

Bushfires, possibly exacerbated by climate change, are a real threat to Australia. Catastrophic events appeared more frequent and extreme danger periods are getting longer and earlier in summer.

This paper outlines recent projects undertaken in Australia in developing a terrestrial and later a mobile scanning system linked to a high degree end-to-end automation system to identify dangerous non-conforming electrical conductor spans which potentially could start bushfires destroying homes or worst, resulting in fatalities.

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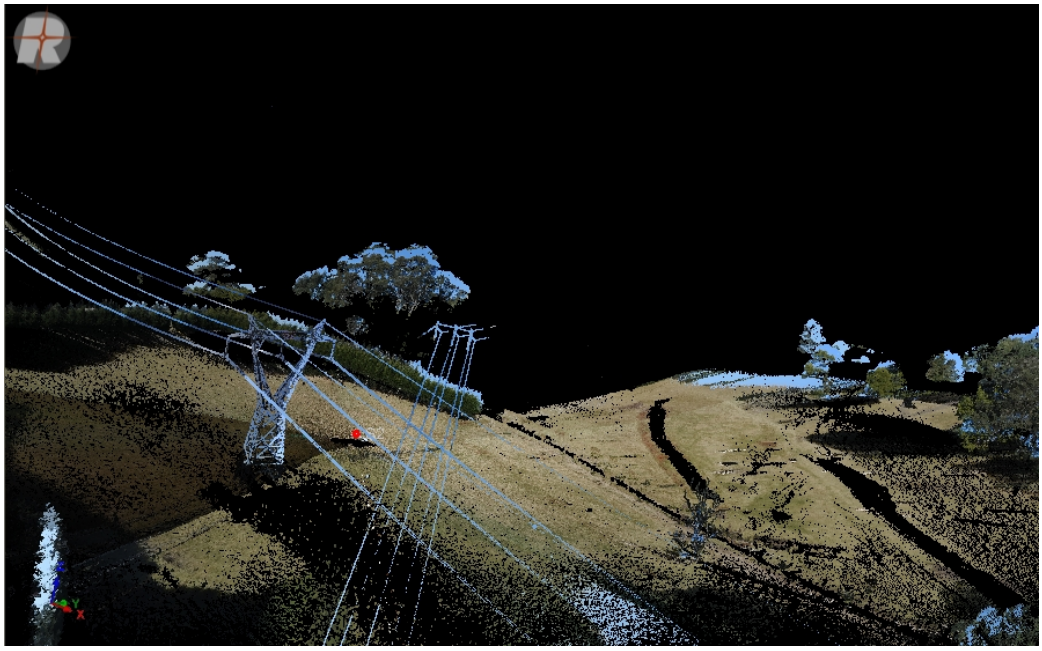

MITIGATION OF THE IMPACTS OF CLIMATE CHANGE

A SURVEYOR'S ROLE

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1. Introduction

Climate Change is real, particularly, in one of the driest continent on earth such as Australia.

During the last two decades, we saw a gradual increase in drought conditions resulting in less rainfall and the drying out of vegetation and soils. Over the centuries, wild fires (bushfires as they are known in Australia) are common features of the Australian landscape. However, many studies in Australia have now provided evidence that climate change has increased the risk of conditions that make bushfires possible. A 2009 catastrophic event, known as The Black Saturday Bushfires which started on the 7th of February 2009 in Victoria, Australia, burned through hundreds of hectares of bushland, destroyed homes and private properties. Worst of all, a total of 173 people were confirmed to have died as a result of these fires.

A Royal Commission on the Black Saturday Fires was subsequently conducted by the Victorian Government with families of victims, witnesses and experts making submissions or being called before the Commission. A final report was released to the public in July 2010 and extracts of the findings and recommendations are detailed as follows:

"Although the proportion of fires that are caused by electricity infrastructure is low—possibly about 1.5 per cent of all ignitions in normal circumstances—on days of extreme fire danger the percentage of fires linked to electrical assets rises dramatically. Thus, electricity-caused fires are most likely to occur when the risk of a fire getting out of control and having deadly consequences is greatest.

Victoria's electricity assets are ageing, and the age of the assets contributed to three of the electricity-caused fires on 7 February 2009—the Kilmore East, Coleraine and Horsham fires. Distribution businesses' capacity to respond to an ageing network is,

however, constrained by the electricity industry's economic regulatory regime. The regime favours the status quo and makes it difficult to bring about substantial reform. As components of the distribution network age and approach the end of their engineering life, there will probably be an increase in the number of fires resulting from asset failures unless urgent preventive steps are taken.

The Commission considers that now is the time to start replacing the ageing electricity infrastructure and to make major changes to its operation and management. The seriousness of the risk and the need to protect human life are imperatives Victorians cannot ignore. The number of fire starts involving electricity assets remains unacceptably high—at more than 200 a year. Although it is not possible to eliminate the risk posed by electricity assets, the State and the distribution businesses should take the opportunity to invest in improved infrastructure and substantially remove one of the primary causes of catastrophic fires in Victoria during the past 40 years.

The Commission considers that Energy Safe Victoria needs to take a more proactive role as the electricity industry safety regulator. In the past it has taken a largely passive role, focusing on confirming distribution businesses' bushfire mitigation plans and line clearance plans. It has not assessed in detail whether safety objectives contained in the Electricity Safety Act 1998 are actually being achieved. The Electricity Safety Management Scheme regime has undergone important changes recently. It is now compulsory for the distribution businesses to participate in the regime and specify how they will meet their obligations under the Electricity Safety Act. Energy Safe Victoria should now also have access to more of the data needed to assess the circumstances of fires caused by failed distribution infrastructure and 'near misses', so that it can identify trends and take these into account in the development of bushfire prevention strategies.

The above Final Report identified arson being the common cause, but also alluded to the fact that in Australia a major factor in bushfires is the clashing of overhead conductors in the rural areas during extreme weather conditions when high ambient temperature and gale force strength dry northerly wind were the norm. As a result of these findings, more attentions are drawn to the clearance space between conductors or between conductors and vegetation that has grown into the separation space.

This is where surveyors are called to assist with high tech laser scanning technology to detect dangerous spans of overhead wires that are likely to fail under such conditions. Once identified immediate remedial maintenance can be undertaken to ensure safe clearances between conductors or between conductors and vegetation are maintained.

This paper outlines recent projects undertaken in developing a terrestrial and later a mobile laser scanning system linked to a high degree end-to-end automation system to identify these dangerous non-conforming electrical conductor spans.

2. Application of Terrestrial Laser Technology for Bushfire Mitigation and Network Electrical Modelling

With a small population on a large continent, the electricity supply in Australia, particularly in the State of Victoria, consists generally of an overhead network which in High Bushfire Risk Area (HBRA) imposes a significant threat. Further, this network involves large kilometres of Single Wire Earth Return (SWER) powerlines and together with Low Voltage (LV) lines, they are the common assets that have caused ignitions.

For the low voltage (LV) conductors, this clashing between conductors issue can be mostly addressed by the installation of spreaders at the appropriate intervals; however, it is difficult to do the same for circuit-to-circuit conductors. For safety and reliability of the network, it is critical that these conductors are properly kept apart.

Similarly the interaction between electrical and vegetation is a cause of fire ignition. The following pictures, extracted out of YouTube, illustrate the danger of these clashing:

(Acknowledgment: You Tube – "How Powerlines Start Bushfires" by Voltcommissar)

With the best intention of design and construction, power poles are meant to be upright. However due to the deterioration of their structures, aging materials and in-situ soil conditions, the poles could lean over thus increasing the span sags and resulting in clearances being breached. This problem is further worsened during the peak summer season when there are significant load differences between the upper (66kV or 22kV) and lower circuit conductors (low voltage, e.g. 240 volts).

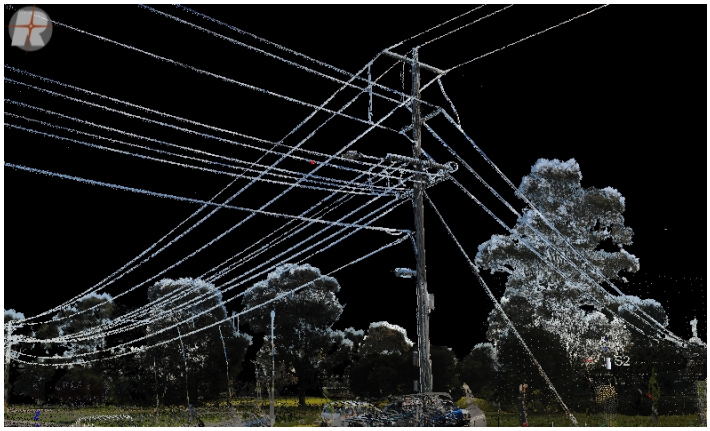
Being forefront with major new surveying technology, Utility Asset management (UAM) has acquired a Riegl TLS scanner (Model VZ1000) a long-range scanner that is accurate to ±15mm and records up to 40,000 points per second. It can scan objects up to a kilometre away on a clear line of sight. Generally, the 360^0 scans take anywhere between twenty minutes at each set up depending on the level of details needed. Significant training regimes and R&D work followed with the prime objective being to apply laser scanning in bushfire mitigation and network modellings.

The following are scanned images from sample projects that were undertaken in both the States of Victoria and New South Wales. Scans were coordinated by GPS in the same way as conventional surveys, however the simplicity of scanning has reduced field time significantly plus providing a 3D model accurate to conventional surveys.

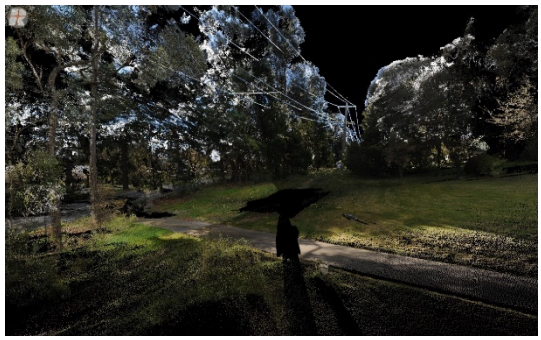
In summary, we believe that laser scanning transformed all field conditions and measurements into a scalable model for interrogation and analysis back in the office.

The end result of these projects was that numerous sections of the electrical feeders were found to be under-performing with regards to clearances, particularly at tee-offs where there was a plethora of wires. Remedial work was undertaken immediately to eliminate the hazards.

2.1 Circuit-to-Circuit - Identification of Non-Conforming Spans



2.2 Conductors to Vegetation - Identification of Non-Conforming Spans

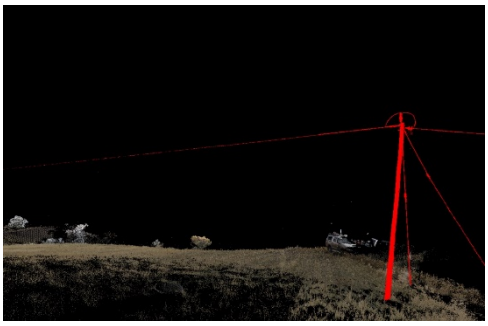


2.3 Scanning through Railway Corridors.

2.4 Single Wire Earth Return (SWER)

Investigation of SWER single wire interacting with trees that may have started the event, burning down 2700 hectares of timber plantation.

SAMPLE OF DATA COLLECTION ON SWER LINE (7/3.0 SC/GZ) SMALL WIRE. DISTANCES POSSIBLE FROM ONE SCAN SETUP WITH SUCH SMALL WIRE ARE APPROX. 400m



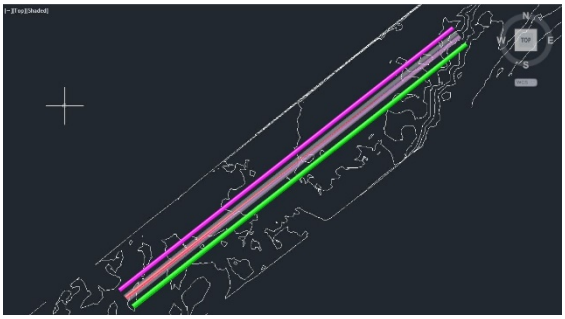
2.5 Field Data Capture

Field data capture encompasses all field-related data recorded by the laser scanning units. The Riegl Laser scanner captures images for all network assets, vegetation, and ground profile and associated features within a specified corridor as well as imagery of the corridor. Field data capture yielded accuracies of ±100mm absolute and 10 to 15mm relative accuracy.

2.6 Identification of Non-Conforming Spans Using Software PLS-CADD

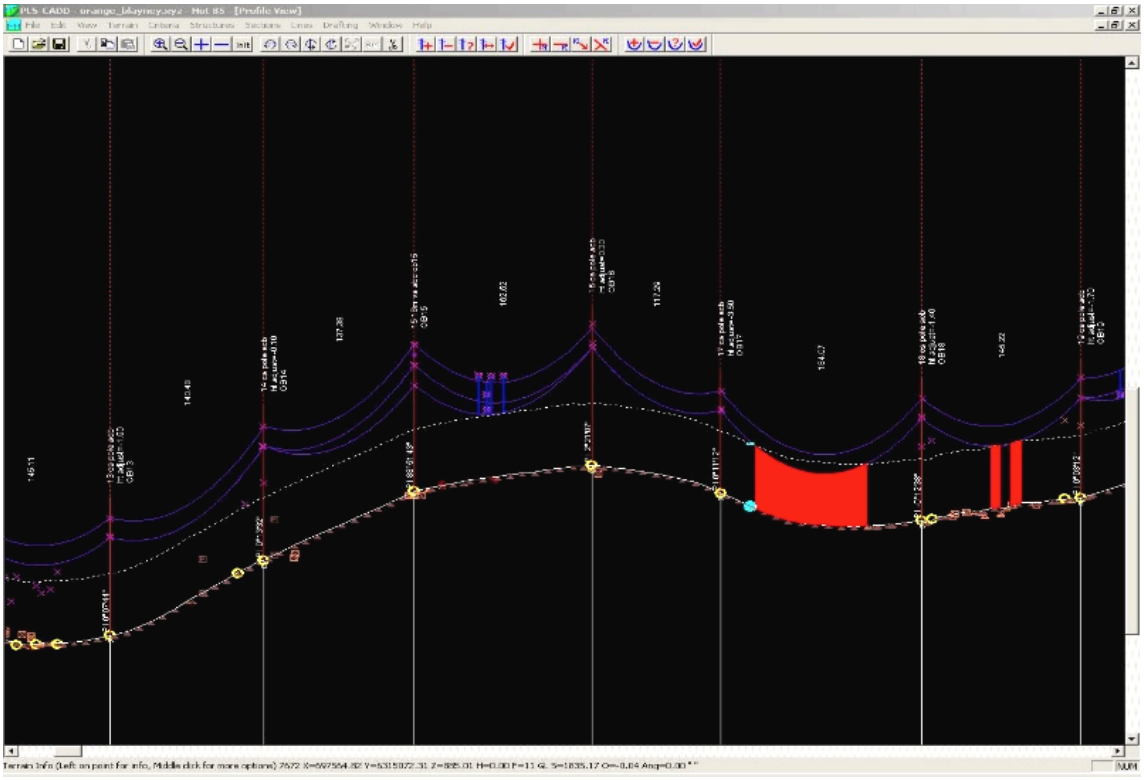
Following detailed cleansing and manipulation, conductor catenary data was processed and output as vector data in an appropriate computer assisted design format in order to facilitate a variety of engineering analysis outputs. This captured data defines conductor catenaries, vegetation density and the ground profile and facilitated the separations of Ground Clearance, Circuit-to-circuit Clearance, and Vegetation Encroachments using a powerline design software PLS-CADD. Even phase-to-phase clearance can be computered provided the image is clear enough.

POSSIBLE CLASHING CONDUCTORS ON 66kV LINE DETECTED USING VECTORISED CATENARY BASED ON SCAN DATA, IN AUTOCAD ENVIRONENT.



VECTORISED CATENARIES WITH BUFFERS TO SIMULATE CLASHING ON ALL PHASES

Non-conforming spans are then identified as illustrated in RED by the following powerline profile drawing.



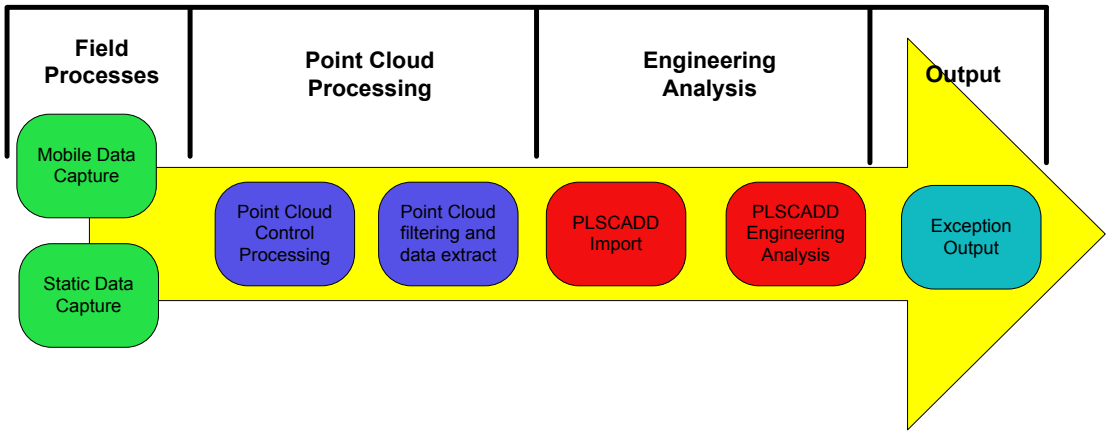
Once identified, the culpable spans can be redesigned using the same digital data to initiate site work to rectify the dangerous situations. A network condition and risk modeling can also be undertaken as the captured data are able to be easily integrated into Corporate Asset Management System.

2.7 Data Management Strategy

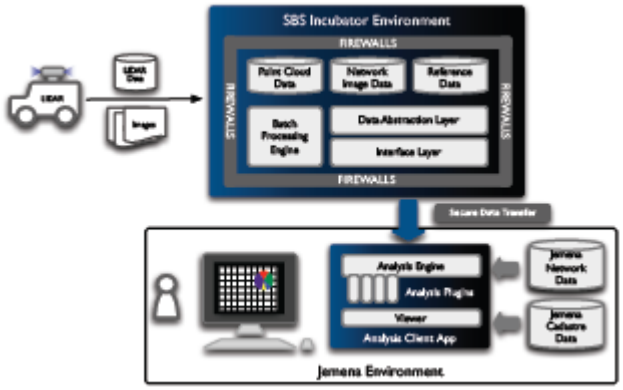
Our experience is that capturing the data is the easy part of the process. The complex phase is when point cloud data needs to be filtered, cleansed and vectorised to allow intelligent analysis using powerline design software, such as PLSCADD.

We have post-processed and integrated this data into corporate asset management/GIS systems, such as Small World and are currently conducting R&D work on the automation of point clouds to identify "alien" objects within the "NO GO ZONES", Conductor-to-Ground and Circuit-to-circuit clearances, different conductor temperature scenarios etc. These skills will be used in the preparation of data for to carry out the necessary analysis.

The diagram below provides an overview of the data process flows.



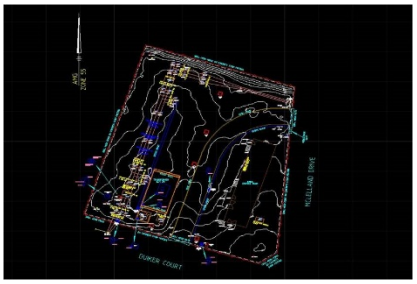
Overview



Laser data and associated imagery is captured using Riegl Laser survey equipment and uploaded to the secure supplier data management environment. This environment provides a batch analysis engine, data abstraction layer and secure interface layer. An analysis client application, deployed to selected workstations will allow analysts to view the captured data and perform analysis against the data as well as client's network and cadastre data.

3. Other Uses in an Electrical Environment for Planning & Design

Indoor Electrical Sub-station (Photo & Scanned Image in full RWB colours Overlayed)



4. A Way for the Future - Mobile Laser Scanning

Although a high level technology, terrestrial laser scanning is a slow process, particularly when there are significant numbers in pole population that need to be scanned. We have now turned our attention to mobile scanning which has been proven to be an efficient and cost effective way to continue with such projects.

UAM is in the process of acquiring a Mobile Scanning System to meet this challenge. The targeted system will have twin laser scanners mounted on a vehicle travelling at speed up to 80km/hour scanning the conductors and all street furniture. It is also intended that the captured data will be automated for analysis via PLS-CADD software.

The use of airborne LIDAR mounted under aircrafts or helicopters is another form of "vehicle". However, our experience is that at times problems were encountered as a result of the direct overhead (non-oblique) scanning and the speed of the aircraft which rendered

small conductors not “picked up”/defined sufficiently clear enough to be used for analysis.

5. Conclusion

Most nations believe that climate change is happening and are devising programs to alleviate the threat. We must adapt to the new environment that we live in.

Surveyors do not seek to influence political debate on policies of greenhouse gas reduction or the implementation of a CO^2 Emission Trading Scheme, rather our interest is to see that any impacts resulting from climate change are mitigated and managed.

In Australia, surveyors have a major role on climate change by guiding planning process and the direction of housing developments to ensure that they are away from high bushfire risk areas.

The laser scanning technology outlined in this paper will further assist this role by ensuring that bushfires do not occur through man-made structures.

Biographical Notes

Francis Tham is a graduate in Land Surveying from the Royal Melbourne Institute of Technology (RMIT) University and a Licensed Surveyor registered under State Legislation via Surveyors Boards to undertake cadastral surveys in the States of Victoria and New South Wales, Australia. Memberships include the Institution of Surveyors for both abovementioned States.

He belongs to a unique group of surveyors whose primary involvement has been in the electrical industry. For over 35 years he applied his surveying knowledge in the electricity transmission and distribution networks and systems. A practitioner on infrastructure corridor easements and bushfires prevention. He was the former Secretary of the Victorian Tree Clearance Consultative Committee as well as the former Secretary of the Powerline Relocation Committee, both of which were formed by legislation two decades ago to address the bushfire threats in the State of Victoria, Australia.

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- You Tube – "How Powerlines Start Bushfires" by Voltcommissar