Terrestrial Laser Scanning

Laser scanning systems are used for the rapid acquisition of spatial data, which in turn can be utilised to model terrestrial features such as topography, structures, and vegetation. This technology is also now used in manufacturing, medicine, vehicular accidents, structural failures, subsidence monitoring, crime, the arts, and is capable of a wide range of measurements to almost any surface.

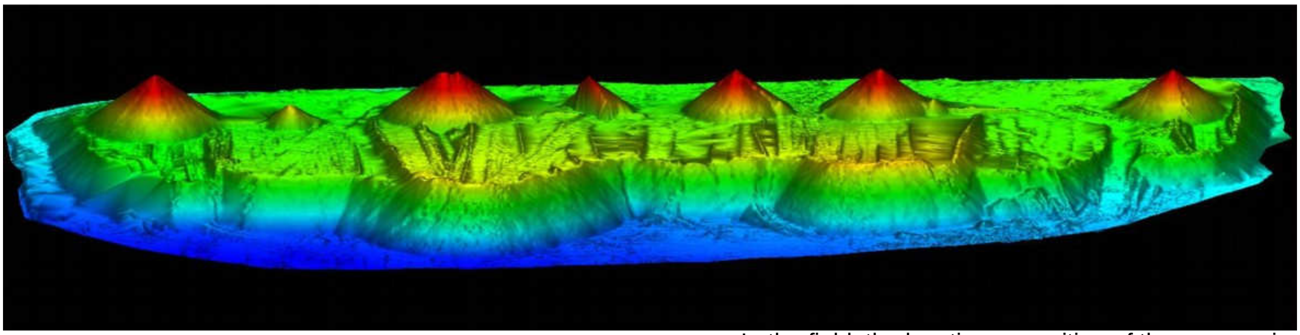
Some scanners can generate sub-millimetre accuracies, while others can acquire over 500,000 3D points per second.

Laser scanning is now being used in Thiess to quickly create 3D surface models of mining and bulk-earthworks operations as well as a range of structural features, plant, and on-site infrastructure.

Periodic scans of mining excavations and ROM stockpiles for example, allow surveyors to accurately calculate volumes of material moved while mining engineers are able to monitor site productivities, accurately reconcile the movement of materials, and assess features such as the condition and grades of ramps, benches, and haul roads.

This rapid-mapping technology promotes 'out-of-pit' survey activities as the laser system measures surfaces through the natural reflectivity of materials. Conventional survey methods relate to either measurement's taken to a retro-reflective prism, or remotely by a similar technology – a reflectorless total station. By comparison, both methods are very slow.

Laser scanning systems are a non-intrusive method of obtaining detailed and accurate spatial information. They can be used in situations where ground access is limited, prohibited to field crews, or where continuous



subsidence monitoring or productivity applications are required.

Through this technology three-dimensional data is being utilised more than ever. Terrestrial laser scanning equipment is changing the way we control and/or manage our work in the mining and construction industry and will in the future be adopted and utilised as a key tool to support our operations.

The Application

The following details relate to Thiess' terrestrial laser scanner, a Riegl LMS Z420i. Further details about this scanner can be reviewed at www.riegl.co.at

- Laser Scanning is a remote sensing technology which utilises a high powered (eye-safe) laser to measure the spatial position of a nominated surface or feature. A pulsed laser is triggered and then measured over the time it takes to return from a targeted surface. The return signal is dependent on the natural reflectivity of the targeted material. Water normally disperses this beam and so a return signal is not registered
- Measurements are generated at a rate of up to 12,000 points per second through a rotating field of view covering up to 360^0 horizontally and 80^0 vertically. This field of view can be further maximised by rotating the scanner through a tilt mount
- A typical scan takes 5 to 10 minutes
- The density of scanned points can be pre-nominated to generate say a 1m x 1m or 2m x 2m grid - or selected to be as dense as 30mm x 30mm at a range of 800m
- The resultant dataset from a scan is called a 'Point-Cloud'. High-density scans capture the full integrity of a complex surface and can often relate to millions of 3D points. During the post-processing phase, these points are decimated or 'thinned out' to provide more manageable file-sizes - while still retaining the full definition of the scanned surface
- The scanner has a ranging error of less than 10mm at a range of 500m, and can measure objects at a distance of up to 800m or more (depending on surface characteristics). One scan can therefore capture a radial zone of up to 1.6km
- A mining operation typically needs to be scanned from a number of different locations around a pit to cover the full scope of work.
- In the field, the location or position of the scanner is normally not coordinated. Special targets within or beyond the scanned region are pre-coordinated and then scanned, processed, and verified. These known points are directly linked to the 'point-cloud' from a scan and so many datasets from multiple set-ups can be registered together and transformed to a site grid
- A high-end digital camera can also be attached to the scanner and used to better define numerous features such as the strata in high-walls. Colours

from this photography can be assigned to the 3D data points. This process immediately brings a point-cloud to life. Alternatively, the geo-referenced photography can be draped over a triangulated surface model generated from a scan

- Data measured by the scanner can be exported into a range of file formats, such as those used by Vulcan and other site planning packages.

The Benefits

- TIMELINESS: A full survey of a mine and the related ROM/stockpiles can be completed in one to three days (depending on the size of the operation and the existing survey control network). Most active areas across our mine sites, which relate to EOM claims, can be scanned and processed in a day. A general rule for turnaround times in these environments is; one day of scanning requires up to half a day of post-processing
- SAFETY: Surveyors do not need to enter active mining areas to conduct their surface pick-ups with a scanner. This remote sensing technology also allows for example, busy roads and intersections to be scanned with very minimal traffic control and disruption to traffic. The near-infrared class-1 laser emitted by the scanner is totally eye safe
- ACCURACY: Results of our laser scanning across a number of operations have been verified and agreed against known survey data and surface models. Typical rated accuracies generated by the Z420i across a mine site can be better than +/- 30mm in xyz. But this is dependent on the accuracy of the control network - which is often established by GPS (+/-50mm). The distance to features beyond the control network targets can also impact on accuracy. The scanning process used on structures and plant items can generate accuracies better than 10mm
- COST: The capital cost of most long-range terrestrial scanners is in the order of $250k. In addition, a range of software and other survey instruments and equipment is required to support these systems. Downtime pertaining to training and fully understanding this technology can also be extensive, but the benefits are rewarding and cost-effective. While the 'return on investment' can be justified over two to three years, the real return comes from accurately measuring the wide scope of work Thiess are typically committed to. Where there is a demand to safely generate accurate surface models within a very short timeframe, no other mapping or survey application can compete with this application.

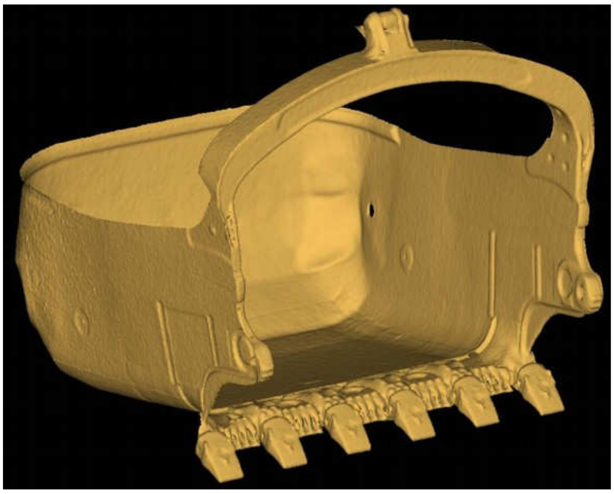
Operational Considerations

- Terrestrial laser scanners can capture rain and dust particles, but these points can be filtered and removed from a model in the post-processing phase
- The Riegl Z420i is a heavy instrument, but the weight of the unit helps to resist wind which can greatly impact on accuracy when the scanner is being used over longer distances
- Having to setup the appropriate network of reference targets can be time-consuming
- When compared to most other ground-based survey instruments, the capital cost of scanners could be regarded as being excessive
- Most disciplines dealing with digital models relating to topography or design features have not been exposed to datasets generated by laser scanners. They therefore have to come to terms with new processing procedures and software, and may even require more powerful hardware platforms.

3D Modelling

Beyond the typical requirements of processing surface models for mines and bulk-earthworks projects, a new application related to high-definition 3D models is evolving. This currently relates to the term 'Reverse Engineering'.

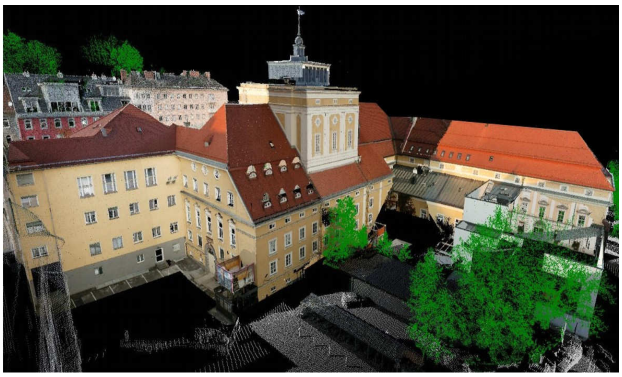
This is a more tedious process where existing features pertaining to plant, structures and a range of infrastructure is extracted from high density point clouds. As-constructed surveys of say processing plants or other facilities can be undertaken with a scanner, resulting in accurate and detailed models being extracted, which can then be utilised by many disciplines.



This process is labour and time intensive. The simplest feature may take a week to be modelled. Attached herein are some typical results and links to examples.

Colours assigned to 3D points. Model courtesy of Riegl

Trials & Links

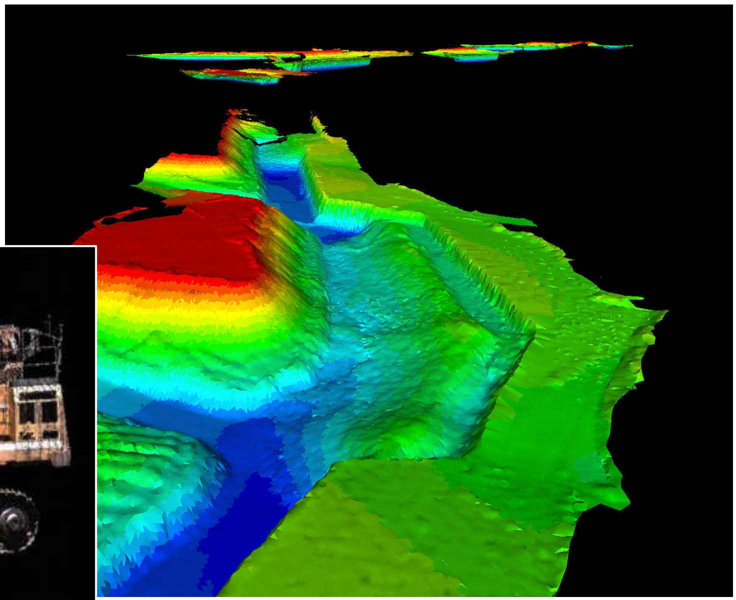


The Survey & Technology Applications group at South Bank initially undertook field trials of three scanners before selecting the Riegl Z420i. Related software applications were also trialled and in all, carefully considered in terms of one our core disciplines - mining. The range of equipment and options related to this technology are somewhat extensive and can be further assessed through some of the many web links.

Contacts

All enquires should be directed to Del Rains, Manager Survey & Technology Applications (07 3002 9750)

Models: Excavator with Colours Assigned to 3D Points.



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