# ABSTRACTS

## Wednesday 25 May 2022

Workshop 1 - CR Kennedy - Real world use cases of multiple scanning solutions

*Presented by Jennifer Clear and Francois Du Bois*

**Shaft Scanning Example.**
Technique and procedure developed by Paul Hancock from Ernest Henry in conjunction with CR Kennedy support.
A special jig designed to allow 2 Leica P40 scanners to be used simultaneously at 10m intervals with Scan & Go auto level platforms for the scanner to be level.
Then complete the 800m shaft survey registration in Leica REG360 with a QA process to make sure all scans are aligned correctly.
Combine all the scans together in a single file to be checked in Cyclone 3DR software for plumbness.
Repeat scans done around 6 months later with the same procedure, this time a comparison calculated in Cyclone 3DR between the 2 scans to see if there are any visible deformation portions of the shaft.

**Shed Volumes Example.**
After years of surveying the mining volume sheds in Townsville with extreme heat and challenging conditions due to strict OH&S regulations with a Leica P40 scanner, then a Leica RTC360 scanner to get correct volumes before being transferred to the ships for export. Initially using targets and then Cloud to Cloud to get the end results.
Then using a new technology still in the scanning environment but using the Leica BLK2GO scanner which uses SLAM (Simultaneous Localization & Mapping) allowing the capture to be done by just walking around the area and being light enough with an extended pole to cover the complete stockpile area, with less risk to people walking the stocks.
Then a comparison done with old and new simultaneously to prove the accuracy is not lost with the new technique.
Not only a major cost saving having fewer people in the environment but much safer as well.

**Scanner Project 2 month Monitoring Trial.**
A 2 month trail with a permanently mounted Riegl VZ-2000i scanner, scanning daily with a fixed schedule through all conditions of heat, rain etc.
Setup of installation and challenges to get scanned information back to a central server for further analysis.
Onboard capabilities of the scanner to conduct results directly after a scan is completed, using Riegl's new onboard Monitoring APP.
Ability to not only monitor the highwall but their prisms as well with amazing accuracy.
Then allowing Geotechnical team to investigate the differences using a web browser.
Plus running the data through Syperion Software for a complete monitoring analysis result.

Workshop 2 - CR Kennedy - Unmanned Arial Vehicle /Remote Piloted Aircraft applications in Industry

*Quentin Visentin, National Sales Manager Agricultural UAV and Sales Support Specialist for UAV QLD C.R. Kennedy*

Capturing our environment is a big challenge. Whether we are working on a construction site, on a plant, public safety or Agricultural applications. Reality Capture and agriculture means something different for each one of us. There is an infinite number of ways to capture and represent reality in a relevant way for each profession to understand it and extract the needed information and measurements.
This presentation will focus on the latest innovations in UAV/RPA (Drone) photogrammetry, Lidar scanning and Multi-spectral imagery workflows and Agricultural applications, showing how manufacturers are embedding cutting-edge technology into complete UAV solutions.
By a smart combination of high-performance hardware and intuitive software, the workflows for end-users are becoming easier and the highest technology is brought within anyone's reach. This presentation will discuss and show how using RPA (Remote Piloted Aircraft) will obtain accurate data, save time and money and increase safety within the work force.
There are many types of RPA available which a few will be discussed and what type of applications can be utilised with RPA's. The opportunities are vast, and many diverse companies are introducing the RPA as an integral part of their workflow.
Join this presentation to see how the latest developments for RPA (Remote Piloted Aircraft) can help maximise your productivity.

# Thursday 26 May 2022

**The Surveying Education Ecosystem**

*Dr Glen Campbell, University of Southern Queensland*

The demand for graduates in the surveying industry has been high for many years and keenly felt within the resources sector. The University of Southern Queensland (USQ) is the largest surveying program in Australia, mainly due to the flexibility of its study options. This flexibility allows approximately 90% of the surveying students to use distance education to complete their program of study. But what they study, how they study and why they study is dictated by forces and players that sometimes have competing interests. This presentation will describe the current higher education climate and how USQ is responding and adapting to the changes while continuing to provide quality surveying education can be delivered without removing skilled personnel from the workforce.

**Transitioning from static to live spatial data and its implications in the future of self-governance mining**

*Dan Ward, D Ward Mining*

Data capture in the mining industry has been exponentially evolving over the last 10 years. We are capturing data at an increased resolution and accuracy and transforming static data capture - where information is captured at a specific point in time, to live modelling and dynamic planning that is continuously adapting to this information in order to achieve the company's business goals. Automating the data capture process is fundamental in achieving these goals of advanced analytics and a "live mine" data model. As we advance further towards self-governance this data may start to be used by machine learning algorithms to optimise and influence future decision making. This paper will explore these concepts, and discuss the implementation and implications for Surveyors and organisations social license to operate when the decision making process becomes automated.

**Vale of Clwydd No.2 Colliery. Mine Sealing Investigation Surveys**

*Alan Mellor, Centennial Coal*

Case study of the review of some historical mine workings and locating the past infrastructure and verifying their location using modern techniques and equipment including RPAS and cavity scanning systems.

**Providing a true spatial digital twin for mining projects**

*Jay Thompson, Pointerra*

Spatial data is constantly being collected from a wide range of different sources. These remote sensing technologies are becoming more accessible and in turn spatial data acquisition will increase. An emphasis will be placed on understanding and consolidating valuable datasets in a single, common environment and doing so, create a spatial digital replica of real physical assets. Pointerra3D provides real-time data intelligence and analytics automating workflows to deliver answers and scalable insights required to successfully support mining operations. This presentation will explore three user stories:

- Automatic ingestion of raw and processed spatial data from a range of different sources consolidating into single environment
- Conformance to design modelling and reporting
- Aerial surveys over a mining lease is enhancing safety through journey management applications

**Three-dimensional unique identifiers for automatic georeferencing and co-registration of 3D point clouds in underground roadways**

*Dr Simit Raval, University of New South Wales*

Creation of a digital twin of an underground mining landscapes such as roadway or tunnel is now increasingly becoming possible using 3D reconstruction techniques applied with static/mobile laser scanners.. However, absolute positioning of 3D scans remains a challenge in an underground environment, due to the absence of a global positioning framework, limitations of active wireless positioning sensors, and difficulty in transferring datum from an open environment to an underground environment on a routine basis. Moreover, the surveying process is often time-consuming, arduous, error-prone and exposes mine personnel to risks. Furthermore, in the post-processing stage, a surveyor is typically required to manually reference 3D point clouds using distinguishable surveyed markers or tie-points. Visual browsing of point cloud to identify such tie-points is tedious, introduces human bias and often causes unnecessary operational delays. This study presents intrinsically safe and passive tags, termed “three-dimensional unique identifiers” or 3DUID, for automated georeferencing and coregistration of multi-temporal 3D point clouds. Each tag consists of a unique identity analogous to commonly used QR codes, has features for simplifying a surveying exercise and is automatically recognisable in a 3D point cloud. The 3DUID tags are required to be surveyed only once post-installation, thereafter, the collected point clouds can be automatically aligned to the referenced spatial framework without requiring the manual tie-point marking. Spatially registered point clouds can then be used for automated change detection, deformation monitoring, localisation and object detection with minimised human input, thereby, making the process friction-free. Our initial investigation show the successful application of the proposed technology on a point cloud of 850 m length acquired from a mobile scanner in an underground coal mine. The automated registration using 3DUID assisted technique has achieved 1.76 m accuracy for georeferencing and 0.16 m accuracy for coregistration.

**Underground Laser Scanning for Compliance to Design Analysis**

*Chris Crosby, Anglo American*

Currently, laser scanners are implemented at most Anglo American open pit operations, however there is very little use at underground operations due to numerous factors including; inadequate standardisation across underground operations, varied risk management processes for implementation of scanning solutions, reduced capital expenditure and the ability to articulate the business case and ultimately the value for implementation of scanning solutions.

In the long term it is expected all data collection will be completed by a combination of remotely operated vehicles and sensors mounted on mining equipment. As such, it is important to understand the use cases and application of SLAM (Simultaneous Localisation and Mapping) based mobile mapping in underground environments as opposed to traditional terrestrial laser scanning or data collection through use of total stations. This will ultimately eliminate the requirement for technical personnel to enter the mine and is a critical enabler of the Modern Mine.

Recently, a pilot project was undertaken at Aquila Coal Mine using the GeoSlam Zeb Horizon SLAM based laser scanner with the intent to satisfy key business objectives such as; reduced production delays via in-cycle compliance to design for development roadway widths, heights and alignment, provide rapid analysis of critical driveage for underground infrastructure, reduce technical personnel interactions with mining equipment, improve survey efficiency and reduce adhoc survey requests.

The Aquila survey team have successfully integrated laser scanning within their daily work management routines. Data processing in undertaken by GeoSlam's proprietary software with analysis completed in Maptek PointStudio via customised semi-autonomous workflows which can be tailored to defined metrics at the operation to report on compliance to design.

This report is then utilised as an in intervention and escalation of process performance where it is identified to be outside of the defined specifications. This report also facilitates analysis and improvement opportunities and provides leading indicators for safety and design improvement.

Alternative use cases are currently being explored at our underground Platinum operation, Amandelbult Complex in South Africa prior to global rollout at all underground assets.

# Friday 27 May 2022

**Real-time 3D Position Monitoring – a simple, low cost alternative**

*Michael Nicholson, Michael Nicholson Consulting*

Various forms of real-time or near real-time monitoring systems have been in existence for the last decade or more, however technical complexity, reliability and cost constraints have somewhat limited their use for mine monitoring applications. Similarly, near real-time GNSS based three-dimensional (3D) position monitoring is not a new concept, but up until recently hasn't been applied broadly to mining applications. This paper looks at the development of a low cost, infinitely scalable GNSS based, near real-time position monitoring system. The system was developed by Surveyors with a strong understanding of mine subsidence and monitoring applications and the paper will reference a wide variety of examples where the system has been implemented. The paper will include a review of the 3D position data quality, derivative data and importantly the various roles the system has in site management plans.

### Real time analysis and management of inaccessible cavities

*Daniel Nanthathammiko, Carlson*

Unstable cavities that are close to the surface or other underground drives and stopes can be problematic for any mine operation. This is amplified when the price of the commodity being mined is at an all-time high and mining of ore within old workings is essential for feasible costs to process and so on. A case study was performed with Fosterville Gold Mine to georeferenced and scan cavities/stopes on site that were areas of interest/issues for operations. Using the latest in cavity scanning hardware including IMU's and intelligent scan acquisition software, we were able to perform a campaign of scans that allowed the site to view the cavities and how those cavities interacted with the entire mining operations (importing DXF site models) all in real time for the most efficient and effective decisions to be made without impact on production. Exploration drilling provided us access to the cavities and stopes in which we were able to trace along the supplied drilling data for navigation verification. Imaging and video were logged to provide supporting data to all relevant site staff to best remediate each issue. At the completion of each scan, a solid was automatically created during scanning in which a volume was provided immediately. A decision to fill the stopes was immediately suggested. This was managed and monitored using the scan acquisition software to ensure the cavities were filled and that no leaks were encountered. This information was viewed real time with the ability to compare models in the field to minimise loss of time. Time spent to physically acquire the data was less than an hour for each deployment and scan. Processing time was non-existent due to the accurate georeferencing. Deliverables were utilised in the scan acquisition software with snas/solid data provided to site for archiving.

### Positioning Australia for the future

*Nicholas Brown, Geoscience Australia*

Geodesy is no longer an esoteric science; it is the foundation for good decision making. In recognition of this, in 2018, the Australian Commonwealth Government committed $224.9 million to Geoscience Australia for the Positioning Australia program to provide 10 cm accurate and reliable positioning to all Australians and accelerate the adoption and development of positioning technology and applications. This is a significant improvement from the 5–10 m accuracy that can currently be achieved using consumer positioning devices. In order to ensure Australian's can maximise the benefits of the precise positioning technology, geodetic scientists from Australia's Commonwealth, state, and territory governments have upgraded a number of elements of Australia's Geospatial Reference System over the past decade. This presentation will describe the upgrades to the static datum (from the Geocentric Datum of Australia 1994 (GDA94) to the Geocentric Datum of Australia 2020 (GDA2020)), the introduction of a time-dependent reference frame—the Australian Terrestrial Reference Frame 2014 (ATRF2014) and the Australian Plate Motion Model which allows for coordinates to be propagated between the static GDA2020 and the time-dependent ATRF2014. The presentation will also introduce a new reference surface for heights – the Australian Vertical Working Surface – which is more accurate than the Australian Height Datum.

**GeoSLAM scanning in Underground coal mining**

*Karl Harisson, Centennial Coal*

Clarence Colliery is located in the Western Coalfield of NSW approximately 1km north of the Clarence Village, 10km east of Lithgow and 2 hours west of Sydney. Clarence extracts coal from the Katoomba Seam to produce a low ash, high quality thermal coal product that is delivered to international and domestic customers. The mine lies wholly beneath the Newnes State Forest, a popular recreational destination. The Clarence mining lease shares is boundary in the north with Springvale which shares its boundary with Angus Place. Unlike Clarence, these two mines use longwall mining techniques extracting coal from the Lithgow seam some 100m deeper in the sequence. The eastern boundary of the Clarence mining lease is shared with the Blue Mountains National Park, a World Heritage Area of high conservation value. Clarence commenced operations in the late 1970s. Since this time, the Katoomba seam has been extracted using several mining methods with varying degrees of success. Longwall operations were carried out during the 1990s until 1997 where ongoing operational issues and high costs closed the mine. Centennial purchased the mine in 1998 and recommenced mining operations employing the bord and pillar, partial pillar extraction mining techniques. A Shortwall mining method will be introduced in 2023. This presentation will give a brief description of all the survey activities at Clarence including day to day survey work, traversing, subsidence and REA monitoring and laser scanning underground. I will focus on the laser scanning of the underground bin, which the scanner was purchased for, and other application we have found for the scanner.

**Harnessing the Remote in Remotely Piloted Aircraft: How teleoperations is shaping the future for drones in mining.**

*Rowan Kimber, Aviassist*

Drones have played a key role in improving processes in mining and removing personnel from dangerous environments. Leveraging technology one step further can see the pilot operating from the safety and comfort of an office environment.

**Sensors, applications and platforms supporting automation and remote operations in underground mining**

*Dr Mark Dunn, CSIRO*

This presentation describes the progress of research and development being undertaken by the CSIRO Mining Technology Group to advance the automation and remote operations capability of mining equipment in underground mining operations. This research delivers enabling technologies that are essential in achieving increase sustainability and productivity as well as providing a safer working environment for underground miner personnel. Details are presented on technical developments and results of large-scale experiments, field trials and indeed commercial applications conducted in various mines. These technologies include sensors for navigation, localisation and characterisation such as lidar, inertial measurement units, ground penetrating radar and photogrammetry. Details will be provided on the use cases of these sensors on production mining equipment at several Australian mines. A primary technical requirement of this sensing functionality is the means to accurately determine both the location and orientation of the equipment, people, and the environment in real-time. Test results of a production system utilising 50 individual lidars, multiple cameras, and high performance inertial sensors, are presented. Building on top of the sensor technology, platforms for modelling, data fusion and visualisation will be described, with the focus on providing real time, actionable information. The system automatically analyses the data to behave as an exception detection system rather than a new source of data to intensify the operator's information overload. There are presently no known alternative methods for providing the practical and accurate three-dimensional monitoring systems described in this application. This achievement represents a significant milestone in delivering a step change improvement in underground mining. Finally, an analysis of the applicability for these systems in application domains will be presented, with fields ranging from open cut and underground mining through to space in-situ resource utilisation.

**Open Pit Mining Optimisation – Using Drones & AI to automate as-built reporting and optimise Drill & Blast.**

*Christopher Clark, Rocketmine*

Survey workloads on opencut mining operations are only increasing and with the demand of more frequent geospatial data, surveyors are consistently under pressure to ensure they not only meet their regulatory compliance reporting, but management reporting too. Through the use software & drone workflows, mine surveyors can make use of modern tools & methodologies to automate their pit reporting obligations. These tools and methodologies are also useful in the optimisation of drilling and blasting which represents a major component of the overall mining cost. This presentation will look at some of the workflows and tools that can identify areas for improvement in mining practices and assist in predicting future outcomes.

**The benefits of Ground Control Points in Hovermap scanning**

*Ross Richter, Emesent*

Some new tools from Emesent allow pulling SLAM based lidar to control. I've been writing up accuracy reports comparing the SLAM lidar to check points. I'd like to present on ~4 cases where control was used to rectify the SLAM lidar units and the min/max error in these areas. Also highlighting worst case scenarios for SLAM (is smooth surfaces) with data to back it up