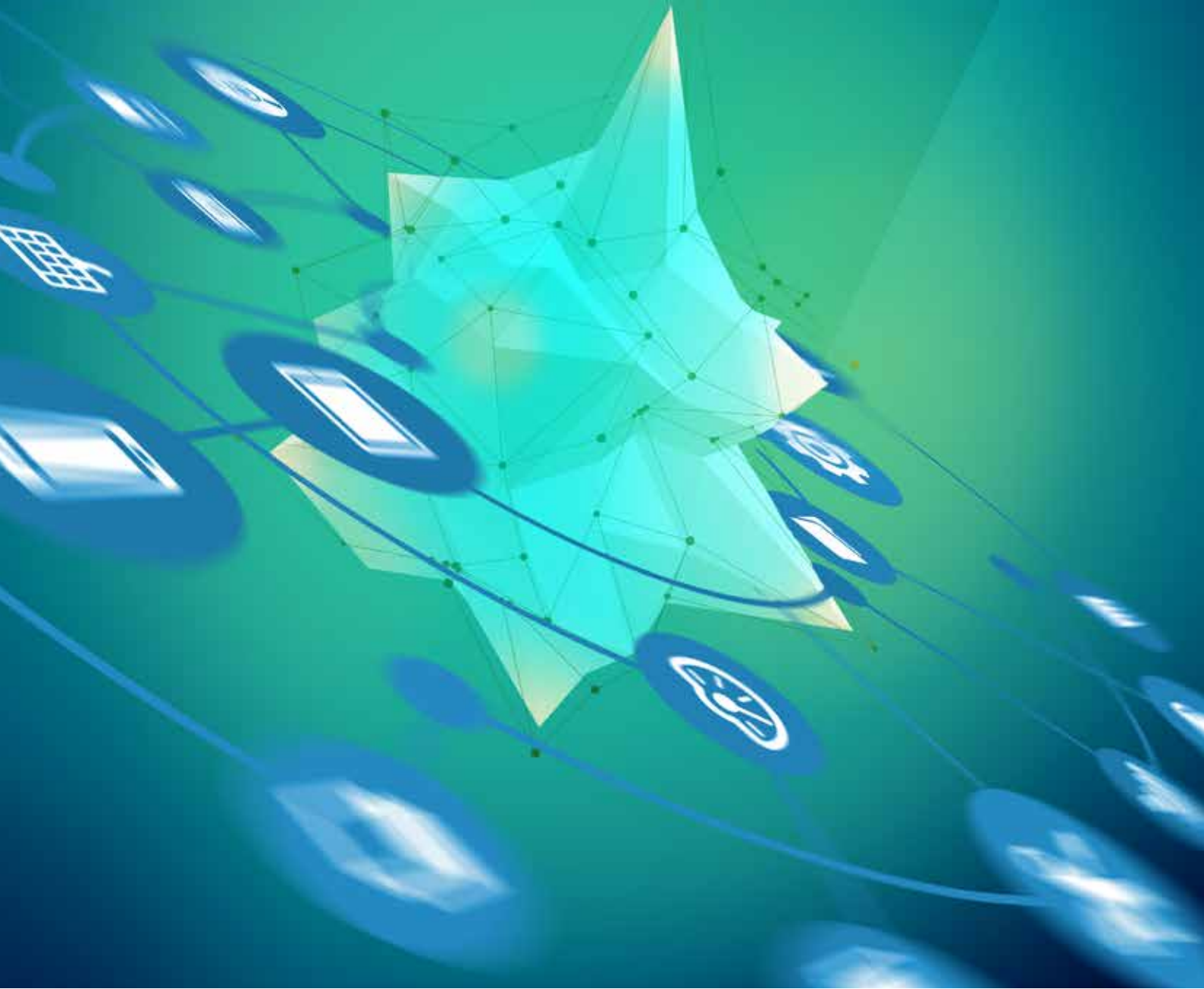


HxGN LIVE
Edition



REPORTER

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HEXAGON
GEOSYSTEMS

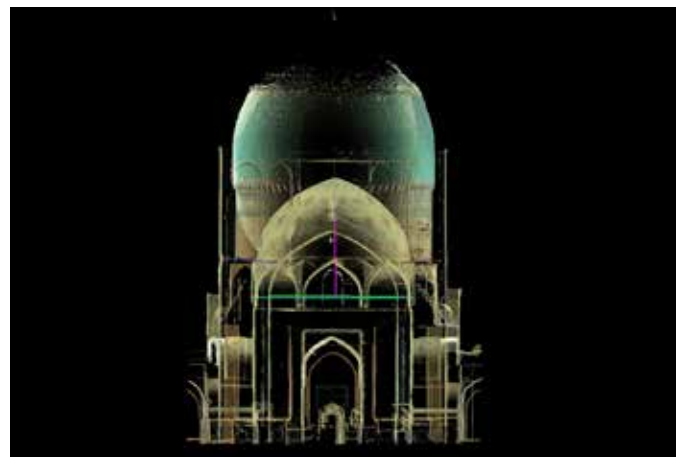
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An in-depth look into the use of UAVs in mining environments



28 PRESERVING MANKIND'S PAST FROM MOTHER NATURE'S QUAKES

Laser scanning for historical documentation in Uzbekistan



President's Message

We've spoken a lot about Digital Realities – from what they are to what can be accomplished with them. For every successful project, it's critical to have a true digital representation of the real world at the core. Let's take Digital Realities to the next level, though, and integrate technologies for even greater interactions and engagement.

In this edition you can read how Mexico City's New International Airport, known as the 'Airport of the Future,' is a great example of such digital representations made from integrated technologies. The Consortium IUYET, involved in the construction of the airport and a connecting railroad, used a wide array of laser scanning, GNSS and digital measurement tools to produce 3D models resulting in a safer and smarter facility.

ZOM, a leading residential developer in the U.S., discovered how construction documentation from Multivista is a simple and highly efficient process with online accessibility. For its latest development, a luxury apartment complex in Miami, ZOM was able to digitalise operations and share the valuable progression data to the entire ecosystem of capital partners, architects, contractors, inspectors and other stakeholders involved in the project.

Our HxGN SmartNet, the GNSS correction services built on the world's largest reference station network, is bringing the construction industry closer to achieving its full digitalisation potential. Recognising efficiency and productivity gains, contractors are able to operate in complete Digital Realities connected to their stakeholders.

With the inspiration and desire to pursue what is possible in the future, you are now empowered to reach that next level of Digital Realities.

Advancing industries. Progressing technologies. Evolving business. This is what we're dedicated to, and we look forward to having you along with us for this journey. Enjoy your read.

A handwritten signature in blue ink, appearing to read 'J. Dold'.

Jürgen Dold

President, Hexagon Geosystems



50 DIGITALISING CONSTRUCTION

New cloud solution and web interface helping to digitalise the construction industry



FROM HARBOURSCAPE TO CITYSCAPE

Karina Lumholt  Case Study

Transforming an inner harbour from industrial harbour to urban space in Denmark

Harbours have always shaped the development of the urban landscape of harbour cities and have been the centre of commercial, industrial and sometimes also military activities.

During industrialisation, many large heavy industry enterprises were built on the harbour area, but since the 1960s, goods are to a large extent transported by container ships. These require new high-capacity container ports, and many of the large industrial manufacturers have gradually moved away from the harbour areas, leaving the spaces abandoned and decaying.

Today, one of the main tasks of urban planning is therefore to transform harbour wastelands into urban space and recreational areas with a view of preserving the industrial heritage and the harbour's environment. The reintegration of disused harbours into attractive urban space takes place all over the world, for instance in San Francisco, USA, in Marseille, France and the "Hafencity" in Hamburg, Germany.

AARHUS DOCKLANDS

The Urban Mediaspace Aarhus construction project is part of the transformation of Aarhus

inner harbour from industrial harbour to urban space. One of the purposes of this 270 million Euros project is to generate coherence between the city and the waterfront. The project consists of a number of elements: Dokk1 public library and culture centre (opened in June 2015), waterfront spaces, automatic car park, opening of the remaining part of Aarhus River, restructuring the infrastructure of the harbour, and climate protection of the city centre.

The project will have great influence on the harbour area and urban life. The area is convenient for Aarhus city centre, Aarhus Cathedral, the pedestrian zone and the river surroundings. This makes Urban Mediaspace Aarhus and the new waterfront spaces a natural meeting point and excursion spot.

Kølkær Entreprenør has been working on the project for 3.5 years. The 1.35 million Euros enterprise comprises for earth moving activities for cabling, sewerage and drainage work.

Kaare Kølkær from Kølkær Entreprenør has been working with the iXE 3D excavator solution from Leica Geosystems for the entire project.



“The Urban Mediaspace Aarhus construction project has been very different from the jobs we normally perform,” said Kølær. “It has been interesting and very complex to work on a city renovation job like this. Sometimes there has been no documentation of old sewers, foundations and pipes because we are working in an old harbour, and we have experienced many unforeseen incidents when we started digging.”

Kølær says that the GPS signal has worked very well even among the tall buildings.

“We could even set off for wells using the GPS. We have only used the total station when we worked in very narrow alleys,” says Kølær.

GOOD USE OF THE LOG SYSTEM

Another challenge has been working so close to the water table. On January 3, 2017, a storm caused the so-called 100-year flood in Denmark with unusual high water levels. Kølær had worked on a dam that was completely washed away.

“I made good use of the Leica iEX 3D solution’s logging system, so that I could quickly rebuild my work on the dam,” said Kølær.

All in all, the logging function has been very useful on this particular project.


“A project like this is not very fast moving. There have been long periods of waiting for other companies to complete their tasks. The area has not been closed for traffic, and the work has been done in small steps. Sometimes I have not worked here for a month, and I can’t remember everything, so the log function has been of great help for me on such a large project that extends over several years,” said Kølær.

AARHUS 2017 EUROPEAN CAPITAL OF CULTURE

Dokk1 and Aarhus Harbour were at the very centre of the spectacular opening ceremony of Aarhus as European Capital of Culture 2017 took place 21 January 2017. Celebrating the city’s Viking heritage founded around the natural harbour in the 8th century and up till today, where Aarhus harbour will play a new important role in Denmark’s second-largest city.

THE MOUNTAIN CALLS

Benjamin Federmann

 Case Study

Using an UAV to measure the depth of a lake in Switzerland

Situated at 848 metres above sea level, the Klöntalersee inspired the Zurich artist Conrad Meyer to draw the first modern high mountain panorama in 1655. Created by a rockslide ages ago and flanked by the 2,900 m-high mountain massif Glärnisch, the lake is still a stunning attraction for tourists and artists due its ravishing beauty.

Not only poets and painters, though, recognised the potential of the 3.3 square kilometre large mere, which is fed by the surrounding mountain brooks like the Klön. In 1908, the Klöntalersee was impounded on its eastside between Rhodannberg and Sackberg by an earth mound to generate electricity for the surrounding villages and companies.

Due the now 220 m-long and 21.5 m-high earth bulk dam, the lake can carry about 39.8 million cubic metres of water, which can be used to generate electricity if demand fluctuates and during peak times.

FROM AIR TO WATER

With their groundbreaking approach to combine hydrography and photogrammetry, the IngenieurTeam GEO GmbH planned to survey the area by using their sounding boat "Surveyor," the industrial Unmanned Aerial Vehicle (UAV) Aibot X6 as well as state-of-the-art positioning technology from Leica Geosystems in the Swiss canton of Glarus. The goal was to generate a 3D-model for accurate and inch-step precise calculation and simulation of the actual holding capacity.

After all preparatory measures, approval processes and planning had been completed, the experts from Karlsruhe travelled with their sonar equipped vessel "Surveyor" to the more than 220 km distant lake into the Swiss mountains to map the lakes soiling situation at a regular water gauge. All measurements done by the vessel and the Aibot X6 were recorded in the Swiss national coordinate system "LV03."

With 172 planned recording lines, the 6 m-long vessel set sail to create a detailed picture of the lakes soil using its Reson SeaBat 8101 Multibeam echosounder. The fathometer emits acoustic

signals at an angle of 150 degrees and calculates the depth of the water by measuring the elapsed time of the echo. Due to 101 beams per ping at a frequency of 30 pings per second, the hydrographs receive high-precision data of the bed with a graticule of 3,030 single points per second. With an overlap of one third of every measuring track, the experts ensure that an accuracy of less than 10 cm is achieved during their measurement.

Before data can be gathered, though, the measuring system must be calibrated precisely in order to avoid disturbance factors and to correctly determine the results. The sensor technology must be adjusted before every deployment to subtract both linear movements of the vessel as well as rotation around its axles to impede any falsification. A further step for the hydrographs to get a clear and detailed view of the lakes cause is to factor the waters sound velocity into the calculation, which changes depending on temperature and suspended particles and becomes especially important in lentic water.

After the boat launched and calibrated, the crew put out to sea on a 2.5 hour-long first cruise to get a first impression of the lake's character and began to create the first sonar data of the soil. Following the planned routes and under consideration of the lake's depth and texture, the highly skilled hydrographs on the "Surveyor" collected enough information to create a point cloud of 134,837,653 X-Y-Z-coordinates. All in all, the crew of the observation boat made it in five days to record all 2,855,204 square metres of the Klöntalersee.

BEYOND LIMITS

Not only rapid changing weather conditions and bone-chilling cold pushed man and machine to their limits, with the glaciated massif Glärnisch building the south embankment, the environment put the technology to the test. At 2,900 m, the massif literally threw its shadow ahead. Through the massif's steep slopes in close vicinity to the riverside, the experts feared they might lose their GPS-stream due to signal opacity on the south side of the Klöntalersee. In this case, the



determination of the boat's position would have been carried out by tachymeters placed on the northern and eastern shore of the lake. Because of the lake's long-drawn-out kidney shape, this would have led to serious problems to get accurate details of the boat's position.

By using the Leica Viva GS16 GNSS antenna on the "Surveyor," the data recorded with the multibeam sonar could be assigned inch-perfect to their coordinates. With its built-in SmartLink technology, the crew would still have been able to record high-precision data and receive the GNSS correction data even if the signal of the GSM network would have gone missing. Thanks to 550 channels, a state-of-the-art surveying engine and ultramodern RTK algorithms, both the data of the Aibot X6 UAV and the vessel could be precisely assigned to the test results.

Due to their general design, bank situations are hard to capture for multibeam equipped vessels. In addition to that, the risk of damaging the sensitive and expensive sensor rapidly rises in shallow water and in the proximity of the shore. In order to still obtain exact results for the volume calculations and simulations, the engineers relied on their experience with the Aibot X6 UAV and decided to capture the shores and embankments airborne via photogrammetry.

PRECISION FROM THE SKY

After the lake was measured at regular water level from the boat, the engineers began to plan the flights of the Aibot X6. To capture the shore regions overlapping with the measurements taken by the boat, it was crucial to plan to fly with the Aibot at lower water levels. After the level of the Klöntalersee had been lowered seasonally, the survey with the Aibotix hexacopter began.

For this purpose, the experts of the Ingenieur Team GEO planned the flight with the in-house built flight planning software Aibotix AiProFlight, set the waypoints for the following flights, and determined the parameters suitable for the survey, such as height, ground sampling distance (GSD), flight speed and overlapping of the data. To record the often angled and steep terrain of the bank area as precisely as possible, the experts decided to survey each area several times to increase the validity of their data. After the flight planning on the PC had been completed and the waypoints were loaded onto the internal storage of the Aibot X6, the ground control points (GCP) around the lake were measured by using the Viva GS16 so first flights could begin.

Once again, the surveying of the alpine reservoirs presented its very own challenges for man and machine. In addition to average temperatures of less than 0 degrees Celsius, rapid weather changes and low clouds, once again the southern bank of the Klöntalersee with its steeply sloping mountain walls was the biggest challenge. The Aibot X6 had to be started and landed on a separate boat because the steep walls and the dense vegetation of the shore made it impossible for the pilot to operate from the land. In addition to the sensitive and reliable technology, the skills and the steady hand of the pilot were particularly important.

Despite the adverse conditions, the team from Karlsruhe was able to collect highly precise data in 18 flights, so the dry shore strip with a total length of more than 12 km was covered within two days. With a picture taken every two seconds and the UAV moving with 4 m/s, the experts ensured the data was recorded with the highest accuracy by the camera attached to the flying multisensor platform.

“Due to the fast data availability of the Aibot X6, we were able to evaluate the first results on site,” said Benjamin Busse, IngenieurTeam GEO UAV pilot and geomatics expert.

COMBINING TECHNOLOGIES FOR ACCURACY

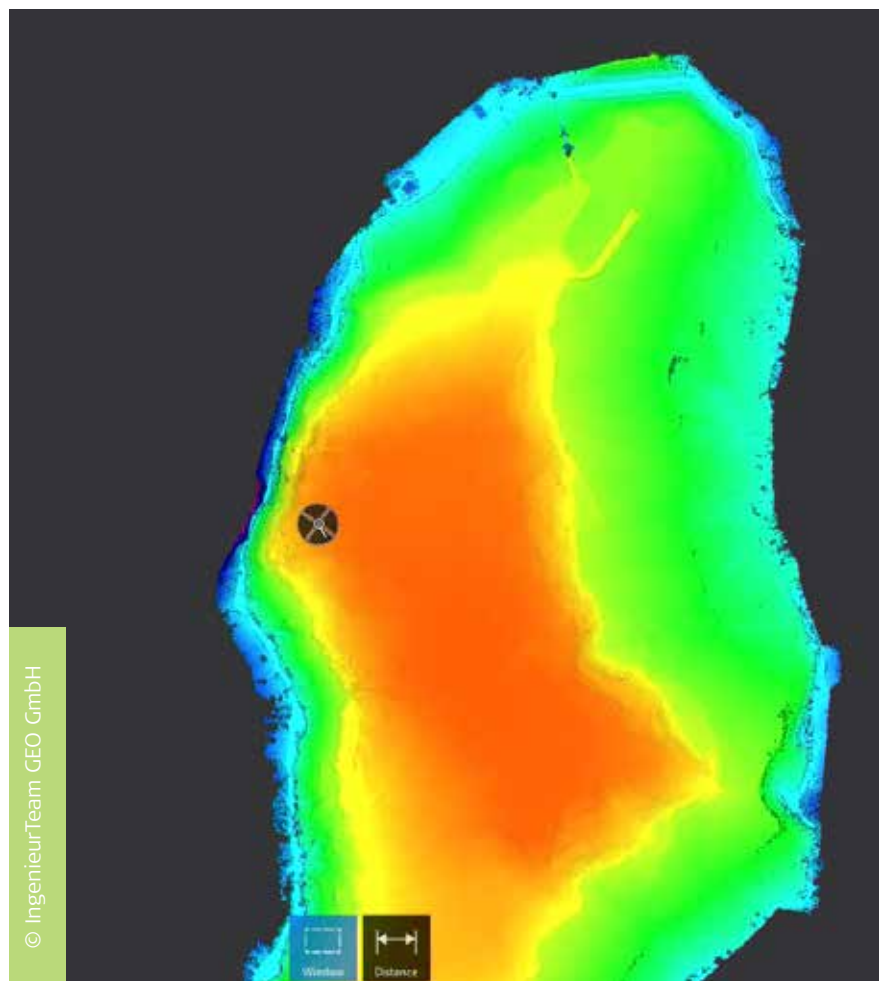
As with the recordings of the surveying boat, it was of immanent importance for the UAV-based results to accurately reference them. For this purpose, the experts of the Ingenieurteam GEO used the Aibot HP GNSS 2 RTK / GNSS module (L1 / L2) and the Viva GS16 GNSS antenna, which was the perfect match to work under these difficult conditions to achieve an accuracy of 1-3 cm in georeferencing the collected data.

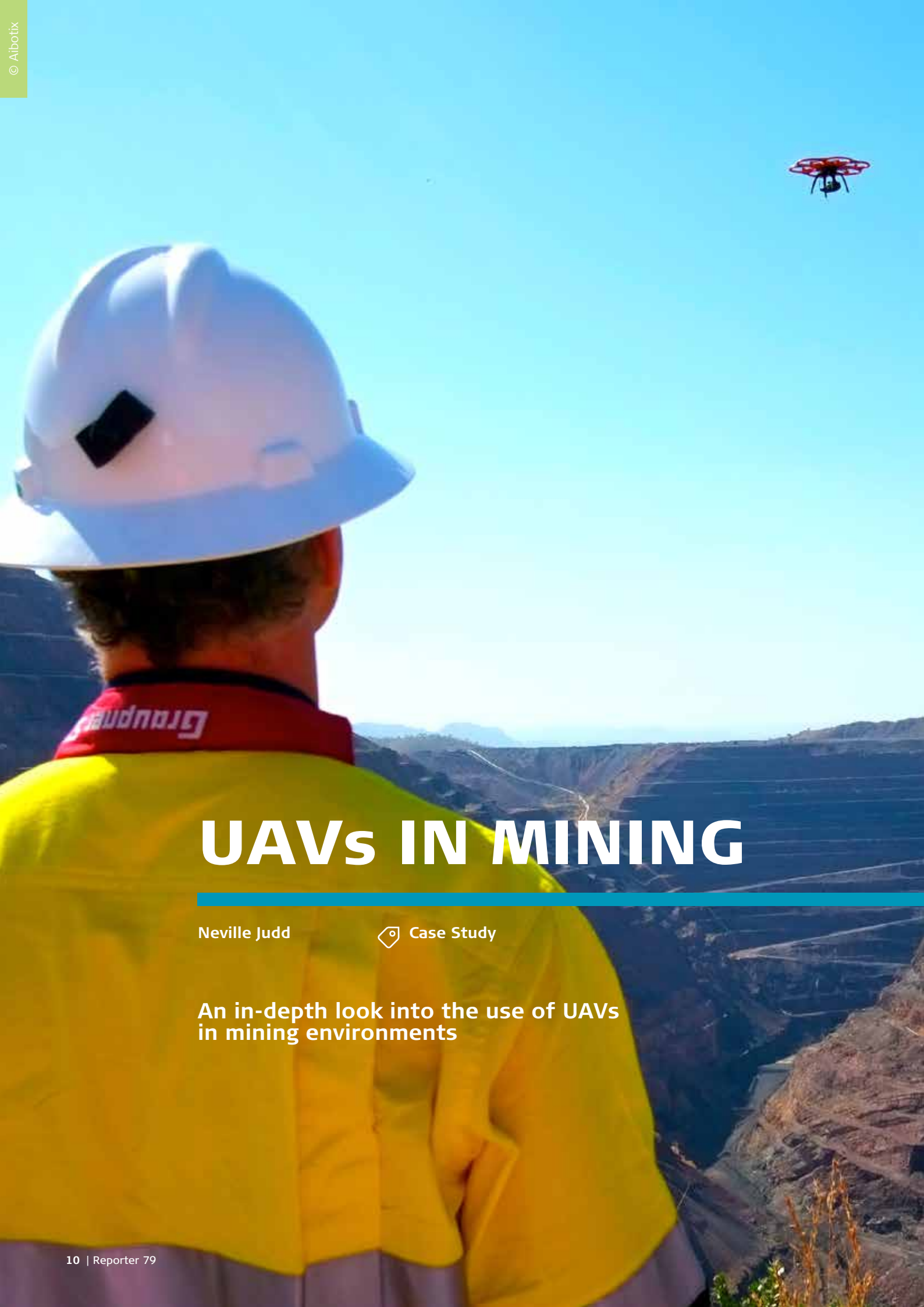
After all measurements had taken place, the surveying experts began to process the obtained data. The point clouds created by the multibeam sonar had to be fed into the PDS 2000 bearing software to manually edit and correct them from imprecision. In order to integrate the data of the river banks into the volume calculation, all 4,400 high-resolution images of the Aibot X6 multicopter had to be imported into Aibotix AiProFlight, where they were merged with the coordinates from the UAVs log file. After that, the georeferenced data was edited in the post processing software AgiSoft PhotoScan Pro to create a 3D model as well as a point

cloud. Subsequently, the two 3D models were combined in the Autodesk application AutoCAD® Civil 3D to generate an exact model of the lake's situation.

Using the data from the 3D model, the engineers generated a precise map with elevation lines for their client. By being able to generate such a precise result and to combine two completely different ways of surveying large and challenging areas, the engineers stood up to the game and used the most modern technology to get the job done. With the data generated by boat and UAV, the experts are able to fulfil their clients' wishes of having a detailed 3D-model and a metres long situation plan with contour lines printed out.

“The combination of the measurement results of our modern multibeam system and the Aibot X6 allows us to generate high-precision data very quickly,” said Busse.





UAVs IN MINING

Neville Judd

 Case Study

An in-depth look into the use of UAVs
in mining environments

Imagine a mine where everyday planning software automatically tasks a fleet of Unmanned Aerial Vehicles (UAVs) – completely autonomously – to collect high-resolution coordinate scans, imagery and other remote sensing of the entire mine. Data from highwalls, stockpiles, waste dumps, tailings dams, blasting, and plants is collected by the same software and converted into information for quicker, smarter decision making.



This scenario describes a future that will soon be reality. UAVs are already having a profound effect on mining. The regulatory process is catching up with the technology. According to the ADS report *UAV Drones Market-Global Forecast to 2022*, by 2022, the international UAV market is expected to be worth 19.73 billion Euros, growing at a rate of about 20 per cent annually.

“There have long been many places in a mine where foot traffic is not allowed or is ill-advised,” said Bryan Baker, Leica Geosystems Unmanned Aerial Systems Sales Manager. “These include near the crests and toes of highwalls, under operating machinery, on stockpiles and muck piles, and near blasts.”

“Under these circumstances, obtaining measurements with a surveying rod, total station or GNSS is problematic. UAV aerial photography and remote sensing allow us to capture all that information without putting someone in harm’s way. People, utilities, equipment, and public airspace, however, must be protected from UAVs, with the trade-off being strict safety regulations and serious pilot training.

“That trade-off and the amount of data that can be acquired through UAV technology make it more than justifiable and more than worthwhile.”

Hexagon is among the companies making progress in the application of UAVs in mining. Better blast optimisation, improved safety, faster surveying, and construction of the most comprehensive and continuous project datasets are just some of the advantages of this technology.

UAV DEVELOPMENT

“Aerial photogrammetry has been around for as long as the airplane,” said Baker. “For mining though, a manned aircraft was too expensive and too inconvenient for regular airborne photogrammetry. UAS are a natural fit for mining and the advent of the lithium polymer battery has transformed development of airborne photogrammetry.”

Electric motors now safely discharge at a very high rate to be able to carry small aircraft with a payload such as a camera. This technology allows us to capture data in near real time from areas that would otherwise be inaccessible or unsafe for staff. Whether it’s for blast fragmentation, stockpile volumes, or any other mine-related activity, data can be captured quickly and safely.

UAVS AND GEOSYSTEMS

Hexagon Geosystems business, Aibotix, is at the forefront of pushing photogrammetry’s boundaries with its core product, the Aibot X6. The Aibot X6 is an autonomously flying hexacopter, specifically designed for demanding tasks in surveying, mining and industrial inspection. Equipped with a high level of artificial intelligence, this UAV reaches almost any target and can independently create high resolution images and videos. A unique feature of the Aibot X6 offers the possibility to adapt varying kinds of sensors, such as hyper- and multispectral sensors, infrared and thermal sensors, and sensors for other industry-specific missions.

Surveying of the future is dynamic and flexible. Data captured by the Aibot X6 commercial UAV and the software solutions of Aibotix and Hexagon allow mines to generate orthophotos, 3D models and high-density point clouds with great accuracy.



The flight planning software Aibotix AiProFlight makes it simple to obtain all the parameters essential for proficient photogrammetry. The Aibot's ability to hover and take photos at any angle make it ideally suited to stockpile and muck pile monitoring and analysis, plus rock mass characterisation, and plant, equipment and highwall inspections.

For larger-scale aerial surveys, Aibotix recently added the long-range capabilities of the RF-70 fixed wing UAV. The RF-70 can fly up to one hour at higher speeds, allowing it to survey 1.61 kilometres (640 acres) per flight. This UAV is more than capable of surveying the entire pit, tailings impoundments, waste dumps, and leach pads.

With all the flight planning and data capture features of the Aibot, the newer RF-70 UAV is a complementary partner to provide mines with the tools they need to quickly and easily map their entire mine. The addition of terrestrial laser scanners completes the surveying picture, inside and out. The digital mine of the future will need all of these remote surveying sensors along with automated control and processing software to create complete digital project models.

MINESIGHT GEOLOGY AND PLANNING SOFTWARE

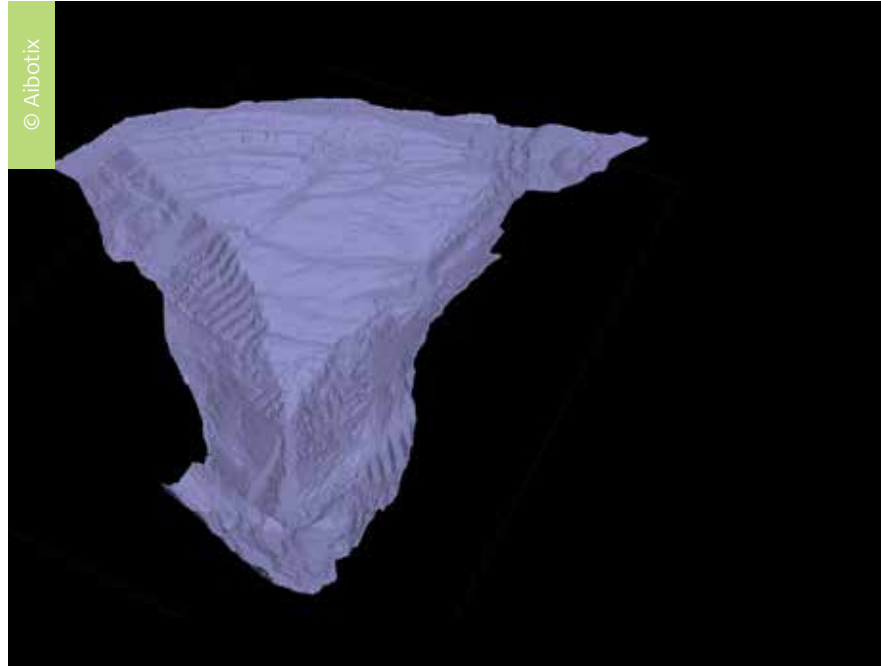
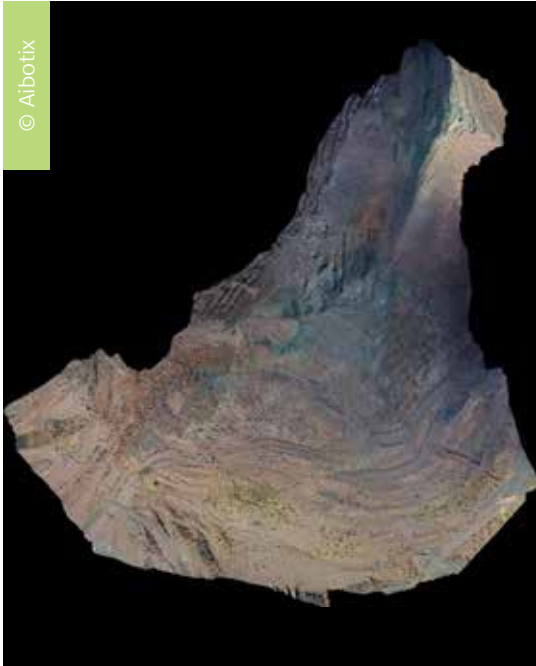
"Hexagon Mining's mine planning software, MineSight, is well equipped to handle point

clouds," said Hexagon Mining Applications Engineer Johnny Lyons-Baral. "Its point-cloud data type features a high level of detail rendering capability, akin to a gaming rendering. The software is capable of displaying billions of points at a time, averaging out points in the pixels with level detail rendering, saving computer memory while displaying high-resolution images."

"MineSight's Point Cloud Mesher turns large data sets into topographic surfaces, tunnels, drifts and stopes, and any other solids and surfaces available from point clouds. It allows mines to quickly go from field capture to usable data for optimisation. The tool removes errors and noise from the data to ensure clean surfaces are available for downstream processes. The colour point cloud can be displayed over the optimised surface to allow feature extraction and geologic interpretation."

BLASTING AND COMMINUTION

The crushing and grinding of ores account for a significant portion of energy costs at any mine. Comminution is estimated to represent 2 per cent of the world's electrical power consumption, according to the United States Department of Energy. Consequently, blast fragmentation has an important downstream effect with implications for total comminution energy, as well as extraction, recovery and



ultimately profit. Mills need efficient grinding for proper processing. Efficient crushing requires well-blasted material. Poor blast fragmentation of ore material can wipe millions of dollars from the value of a mine.

Aerial photogrammetry and point cloud technology have an important role to play in improving blast optimisation. Open face surveys can be used to detect areas of critical minimum burden that could cause dangerous flyrock. Analysis of the face geology can be used for rock mass characterisation, including initial block size distributions.

Videos taken by UAVs from a safe, eagle-eye perspective are fast becoming popular to evaluate the success of blasts. After blasting, UAV data can reveal blast material movement, delineations between ore and waste, and allow fragmentation analysis. All of this allows mines to quickly learn more about their geology and their blasting performance, driving the site toward better knowledge of its material and better blasting practices.

GEOLOGY AND GEOTECH

From a geological and a geotechnical perspective, there are numerous opportunities to extract mineralogical and lithological data, as well as structural and geomorphological data, shapes, etc. There are also numerous

possibilities for automation to be introduced to the UAV point cloud loop. More interpretation, more usable data for analysis for future designs, and reconciliation are among those possibilities.

“One post-blast scenario could be having the programme automatically delineate a polygon for ore location, waste location, or at least best-guess based on the imagery,” said Lyons-Baral. “Hyper-spectral imagery could also be undertaken where spectral signatures are established for different rock types that have been previously coded.”

A FUTURE LOOK

In the future, UAVs will be able to fly longer, farther, carry heavier sensors, and different types of sensors. A fleet of aircraft - multi-rotor, fixed-wing, or more likely a combination of the two - will be autonomously dispatched each day from mine planning software to collect necessary data before landing and downloading that data onto the cloud and into the office for extraction, analysis, rapid decision making and optimisation.


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A version of this story first appeared in World Coal.



CAPTURING REALITY ON THE GO

 Expert Insights

Alessandro Nuzzo, Product Line Manager for Mobile Mapping at Leica Geosystems, explains the technology of wearable reality capture solution



Alessandro Nuzzo
Product Line Manager
for Mobile Mapping at
Leica Geosystems



At Leica Geosystems, we are committed to provide the best surveying technology and shape smart change by creating products that are mobile, agile and efficient – just like the Pegasus:Backpack.

In this new Expert Insights Section, Alessandro Nuzzo, Product Line Manager for Mobile Mapping at Leica Geosystems, explains in detail the technology, workflow and applications for this wearable reality capture solution.

- **What is the Leica Pegasus:Backpack?**

Pegasus:Backpack is a disruptive wearable tool enabling users to capture reality faster, spending less time in the field while differentiating their business model with new applications in where and how they capture reality.

- **Can you explain the integrated technologies of the Pegasus:Backpack?**

The core technology centres on navigation. We distinguish indoor and outdoor missions. For outdoors, integrating a multiple band GNSS receiver leverages all available GNSS satellites from around the globe to achieve a high sigma confidence in terms of positioning accuracy. Furthermore, we have the Inertial Measurement Unit (IMU) consisting of three gyroscopes and three accelerometers that compensates the movements while walking and collecting data.

For indoor missions, we rely on the IMU and the LiDAR Simultaneous Localisation and Mapping (SLAM) algorithm. While scanning and creating a map, SLAM is able to detect the environment and calculate the trajectory based on LiDAR measurements. The Pegasus:Backpack provides a robust trajectory even in GNSS-denied areas.

In addition to the trajectory, we have two LiDARs collecting 600,000 points per second and five

automatic exposure controlled, high dynamic cameras with 4 MPix resolution each – enabling feature extraction over LiDAR or measurements over accurate photogrammetry. All the data are stored inside an integrated multi-core industrial PC with one terabyte solid-state drive storage in order to save long missions easily.

The system is powered with four hot-swap batteries extending the four-hour operational time to any desired length by simply swapping discharged batteries with charged ones on-the-fly. This technology is housed in a carbon fibre unibody chassis that is highly ergonomic for comfortable wearing.

- **How did you combine Geosystems technology with Hexagon business technology to create this wearable reality capture system?**

We started with a strong experience matured in Pegasus:Two, where we knew how to precisely manage GNSS and IMU data to calculate the trajectory and synchronise the LiDAR and imagery into a seamless data output. We set our target high and wanted the Pegasus:Backpack to become the first commercially wearable and indoor capable system available.

Within Hexagon, we strongly leveraged our Novatel know-how. Together, we tailored the GNSS/IMU calculations and developed our Hexagon SLAM solution. Expertise from different teams within Hexagon led us to make the right decisions.

- **What makes the Pegasus:Backpack special?**

It is clear – the product's disruptive characteristics. Starting from the futuristic product design to the use of carbon fibre to



reduce weight and increase the ergonomic. Continuing with the embedded technology, dual LiDAR, five high dynamic cameras, IMU and SLAM navigation technology, it is a unique data collection tool for the modern surveyor.

The combination of these distinguished characteristics makes the Pegasus:Backpack extremely versatile for outdoor and indoor applications enabling customers to spend less time on the field, differentiate their business model, and stay competitive in a consolidating market.

• **Can you explain the workflow (data acquisition, post processing, extract information, export to CAD) of the Pegasus:Backpack?**

The precondition is to have a master GNSS station within 15 kilometres from the data collection location or SMART net coverage. No surveyor skills are required for the data collection – it can be simply done by a trained operator.

The operator turns on the system and connects the delivered tablet over Wi-Fi or LAN to the internal PC where the data acquisition module runs – this is the dashboard for data acquisition. Before starting capture, the operator needs to initialise the system, first statically, and then by walking a couple of minutes. After the position is determined, he starts data collection and has full control by the tablet, where he can monitor in real time the images, LiDAR units and GNSS signal strength. Once the mission is completed, the operator does a static end alignment phase and closes the mission.

The post processing workflow is highly automated. By simply inserting an USB Key into the Pegasus:Backpack, all data can be downloaded and is ready for post processing. Operators can pre-select the deliverables and launch the post processing calculation – there is no need to supervise the process. A powerful

tool to interface with the SLAM algorithm is embedded directly within the post processing software. It enables the visualisation, and if needed, the correction of the SLAM navigation before processing and completing the dataset.

All industry standard file formats, like LAS, PTS, and E57, are supported and can be exported. Depending on the software solutions used for feature extraction, the Pegasus Software Suite natively produces 3D point clouds and images for ESRI ArcMap or Autodesk AutoCAD.

• **For what applications can the Pegasus:Backpack be used?**

The system's flexibility and ease of use is expanding the applications, going from the most common, for example, professional Building Information Modelling (BIM) documentation, surveying, asset collection, underground infrastructure maintenance, disaster recovery, and safety and security, to more digital reality-oriented applications, like industrial training, accidents simulation and urban planning.

• **What are some of the most interesting applications where you've seen the Pegasus:Backpack used?**

There are dozens of exciting applications. One of the coolest data collection was in Vars, France, where we provided 3D data for the speed world record attempt in downhill snow mountain biking.

At 3,000 m high, with strong wind, and temperatures around 0 degrees Celsius, a skier was wearing the Pegasus:Backpack and collected the necessary data to calculate a digital terrain model (DTM) that was fed into a Leica iCON controlled snow machine to prepare a perfect slope for the speed attempt.

Another very impressive application was the data collection of the Paris sewers- an extremely challenging environment for humans and the equipment. With the Pegasus:Backpack and the optional flashlight module, we collected a never-before-seen perspective – having the city surface with its buildings and streets and the sewers underground structure in one single 3D data set. The flashlight module delivered crystal clear images unveiling all the manual sprayed notes on the walls. This information was never georeferenced and not visible in any cadastral map. Through the images, it was possible to

recognise where maintenance was needed to assure a continued public service avoiding unexpected outages.

- **What are the customers doing with the data obtained from this wearable reality capture solution?**

The Pegasus:Backpack is used to provide multiple, fast and accurate data layers where traditional methods face limits in terms of feasibility, access and costs.

Various customers are using the data for urban area survey, where city centres are only accessible by walking and are closed to traffic or public transportation. An extraordinary application in India is the mapping of overcrowded urban districts. This project provided a detailed cadastral map of the thousands of unknown huts, giving to the habitants an address, name and dignity.

Electricity utility companies are collecting the high voltage power lines to map the infrastructure, analyse the cable sag between two electricity poles, and verify if vegetation is obstructing the right-of-way – assuring a high level of network service availability. Others are taking full advantage of the Pegasus:Backpack indoor capability and collecting entire buildings, verifying the as-built in terms of documentation and square metres per room.

Recently, Italian civil protection used the Pegasus:Backpack to quickly get an overview and properly plan the recovery of a devastated city in Italy after an earthquake. All these data use cases have in common the advantage of multiples layers of information provided by LiDAR, imagery, and SLAM or navigation.

- **The Leica Pegasus:Backpack was recently featured on the BBC's *Italy's Invisible Cities* series. Can you tell us more about how the Leica Pegasus:Two and the Leica Pegasus:Backpack played a major role in revealing the secrets of these fascinating Italian cities?**

It was a fantastic experience working with great professionals. The Pegasus:Backpack and Pegasus:Two were recognised for their ease of use, flexibility, speed and the quality of the data collection they provided. Similar to survey professionals, also in TV shows, production time is related to costs.



When we were in Venice capturing the canals on a boat with Pegasus:Two, within one day we collected more than 10 km of 3D point cloud and thousands of images in one single capture. We didn't have to close scanning areas, no curious tourists disturbed the collection - we simply sailed under bridges to be able to generate a new "canal view" perspective that would have been impossible with traditional capturing methods. The flexibility, in terms of vehicle and power source independence, made the difference.

In Naples, Florence and Pisa, the challenge was different. As many historical European cities, the city centre is densely populated, closed to traffic, and palaces are obstructing the GNSS signal. In Naples, we collected underground caves, and in Florence and Pisa, we captured indoors. A technology relying only on GNSS/IMU would not be able to collect data – with the Pegasus:Backpack, it was a home game. By using SLAM, we collected and georeferenced all our data step by step, delivering a comprehensive 3D dataset without the need of scan registrations. By just wearing the 12-kg light Pegasus:Backpack, we captured within 15 minutes the complete spiral staircase of the Pisa Tower with its 293 steps.

- **How is the R&D mobile mapping team preparing for new industry trends and integrating new technologies?**

Technology cannot be seen only as hardware or sensor integration. Of equal importance is the related software workflow and processing speed. It is there where we will focus and decide if additional information layers are needed to develop the right answer to meet market needs – a layer of information that predicts the accuracy and helps users deliver the highest accuracy, before even leaving the office.

MOBILE MAPPING AT HIGH SPEED

Case Study

Surveying a rail network with the Pegasus:Two in the United Kingdom

The Midland Mainline (MML) is an integral portion of the United Kingdom's rail network. With 639 kilometres of track, 16 tunnels and 35 stations, the MML has been serving the UK since 1870.

Periodic maintenance and upgrades are needed to keep the rail line functioning at optimal speed. As part of the MML Enhancement project, significant alterations were planned for the Market Harborough Station in Leicestershire, England to remove a major kink in the through alignment. The project required 8 km of the mainline surveying, consisting of high accuracy track alignment, structure gauging, drainage tracing and topographic cess detail.

Severn Partnership, a surveying firm of Chartered Geomatics Surveyors based in Shrewsbury, UK, was selected to provide the high accuracy surveying needed.

SURVEY GRADE RESULTS FROM MOBILE MAPPING

Severn Partnership has been involved in the MML upgrade projects since 2010. This programme of improvements to the line is the most extensive since it was completed in 1870, with Severn Partnership delivering more than 161 km of

permanent survey control and subsequent permanent way (P-Way) track survey. More than 70 bridge structures and three mainline train stations were added as part of the Electrification Programme. Severn Partnership installed all surveys relating back to the original snakegrid control.

Combined with its knowledge and expertise in the rail industry, Severn Partnership, needed a safe and cost effective method of capturing topographical line side details of the 8 km site at Market Harborough. The firm used its Leica Pegasus:Two survey grade, mobile mapping system to reduce track access requirements and to capture topographical detail.

Mobile mapping combines laser scanning technology with GNSS and motion sensors into a single unit that is easily mounted onto any vehicle. In a rail environment, Leica Geosystems considers mandatory the use of the second GNSS antenna. The Leica Pegasus:Two system requires GNSS coverage at all times, ensuring an accurate dynamic performance of the IMU by continuously calibrating it to zero drift.

Mounted on a motorised personnel carrier, it captured a 3D laser scan point cloud and imagery. This was done on a rail mounted



vehicle, at 16 km/hour for the length of the site in a single 3 hour shift. The resulting data could then be digitised at the office without the time and safety pressures inherent with working on the railway network.

To maintain high accuracy, the point cloud was linked to the site grid using the newly surveyed track alignment. The rails in the scan were automatically matched to the traditionally surveyed rail strings, resulting in sub-10 mm accuracy relative to the track alignment.

“Working with the Leica Pegasus:Two on the Midland Mainline Speed Enhancement project saved us significant time and cost,” said Rollo Rigby, Severn Partnership associate director.

SAFER WITH MOBILE MAPPING

The Pegasus:Two offered survey grade accuracy and high resolution images required for the project specification. Its versatility in being mounted on to any kind of vehicle enabled it to be mounted to a rail enabled vehicle as well as a road vehicle to capture all on and off track data. Using mobile mapping and the Pegasus:Two meant that the data was captured in one shift on one weekend as opposed to multiple weekends if more traditional methods were used.

Fewer rail teams were on the ground working in a potentially dangerous environment reducing risk to personnel. All detail was captured quickly and efficiently including cess detail, ballast profile, structures and vegetation, without the need for site visits. Site imagery was also shared with the project team in a ‘street view’ style potentially reducing the need for further site visits.

“In this project, with mobile mapping, we were able to reduce man hours on the track as well as improve the overall safety for the rail team,” concluded Rigby.



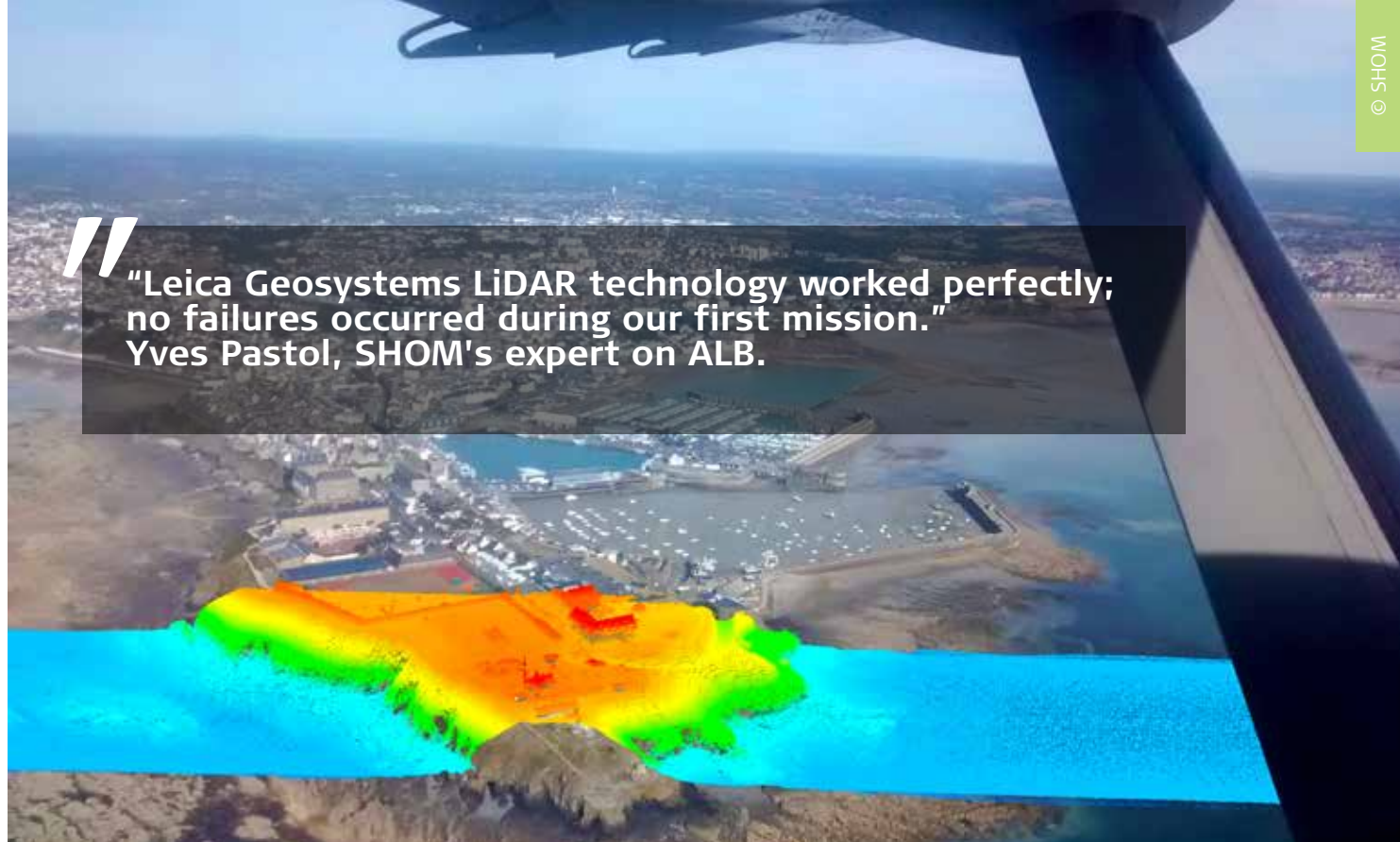
FROM CONCEPT TO FEASIBILITY IN AERIAL

Penny Boviatsou



Case Study

Use of airborne LIDAR bathymetry for coastal hydrographic surveying in France



“Leica Geosystems LiDAR technology worked perfectly; no failures occurred during our first mission.”
Yves Pastol, SHOM's expert on ALB.

Starting in 2005, the French Naval Hydrographic and Oceanographic Office (Service Hydrographique et Océanographique de la Marine [SHOM]) and the French National Geographic Institute (Institut Géographique National [IGN]) began conducting, as part of the national project Litto3D®, a series of coastal surveys of the metropolitan France and some overseas territories.

The coastal areas were at that time poorly described; airborne bathymetric LiDAR data were used to create a continuous altimetry dataset of the coastal zone. The purpose of this project was to produce better risk management prevention plans for floods, landslides and earthquakes, and to support economic development strategies, environmental protection policies and scientific studies that require the knowledge of the near shore topography and bathymetry.

From 2007 to 2015, SHOM built a strong expertise in the Airborne LiDAR Bathymetry (ALB) technical field by subcontracting data acquisition to survey companies. In February 2016, the French Ministry of Environment officially decided to finalise the maritime part of the Litto3D® program; up to half of the cost of a regional ALB survey could be directly funded.

This decision opened a new perspective; instead of subcontracting survey companies SHOM

could run and operate its own ALB capacity with the guarantee to be financially supported. It was decided to launch a call for proposals on a three-year ALB full service. The selected company would have to provide not only the bathymetric LiDAR system but also the aircraft and its pilots, the training of the laser operators, take care of the maintenances/calibrations, and deal with the administrative support (flight permits, insurance policy, etc.).

Leica Geosystems and CAE Aviation won this public tender.

PLANNING THE MAPPING MISSION

Leica Geosystems and CAE Aviation mobilised their efforts to offer a comprehensive theoretical and practical training to SHOM's team on the use of LiDAR and the associated software with this technology.

The first survey conducted in Normandy and North France used the Leica HawkEye III, an airborne multi-sensor deep water bathymetric and topographic LiDAR system, mounted on a Cessna Grand Caravan.

During the data acquisition in Cherbourg, the HawkEye III captured full waveform in a favourable survey environment; the wind conditions were relatively calm with flat seas and without fog in the survey area. In addition, the Leica MissionPro software with the 3D



virtual globe view helped in the preparation and planning for the flights, and the Leica FlightPro flight management and sensor control system assisted in the collection of the data.

The results of this first topo-bathymetric survey exceeded SHOM's expectations. The achieved work on morpho-sedimentary cells was impressive.

"Leica Geosystems LiDAR technology worked perfectly; no failures occurred during our first mission," said Yves Pastol, SHOM's expert on ALB. "Having in our team a Leica Geosystems technician the first weeks of the mission was very instructive. This way SHOM's crew was able to learn and survey at the same time."

THE CHALLENGE

Given these positive findings from the Normandy and North France survey, SHOM decided to plan a major operation along the Channel coastline: a coastal survey from Baie du Mont-Saint-Michel (western Normandy) to the Belgian border. This second topo-bathymetric survey will enable SHOM to generate a complete geographical

product by mid-2018. The expected coverage goes down to 5 metres isobaths and up to 400 m inland.

This second survey is a real challenge for SHOM; Mont-Saint-Michel is known for the highest tides in Europe. If the flights are correctly timed during low tides, the SHOM team can take advantage of them. The inclement weather might be another obstacle to overcome as well as the turbid coastal waters of the English Channel. The HawkEye III is deployed once again to provide high resolution and accurate deep bathy, shallow bathy and topography data. An important goal in this kind of survey is to have a smooth transition between topographic and bathymetric data.

"The HawkEye III can achieve earth-sea continuity with its various sensors," said Pastol. "This technology ensures us there will be no gaps in the Digital Terrain Model (DTM), which is essential for our end product."

On the software side, Leica Geosystems also provides the Leica LiDAR Survey Studio (Leica LSS) to pre-process the waveform and position



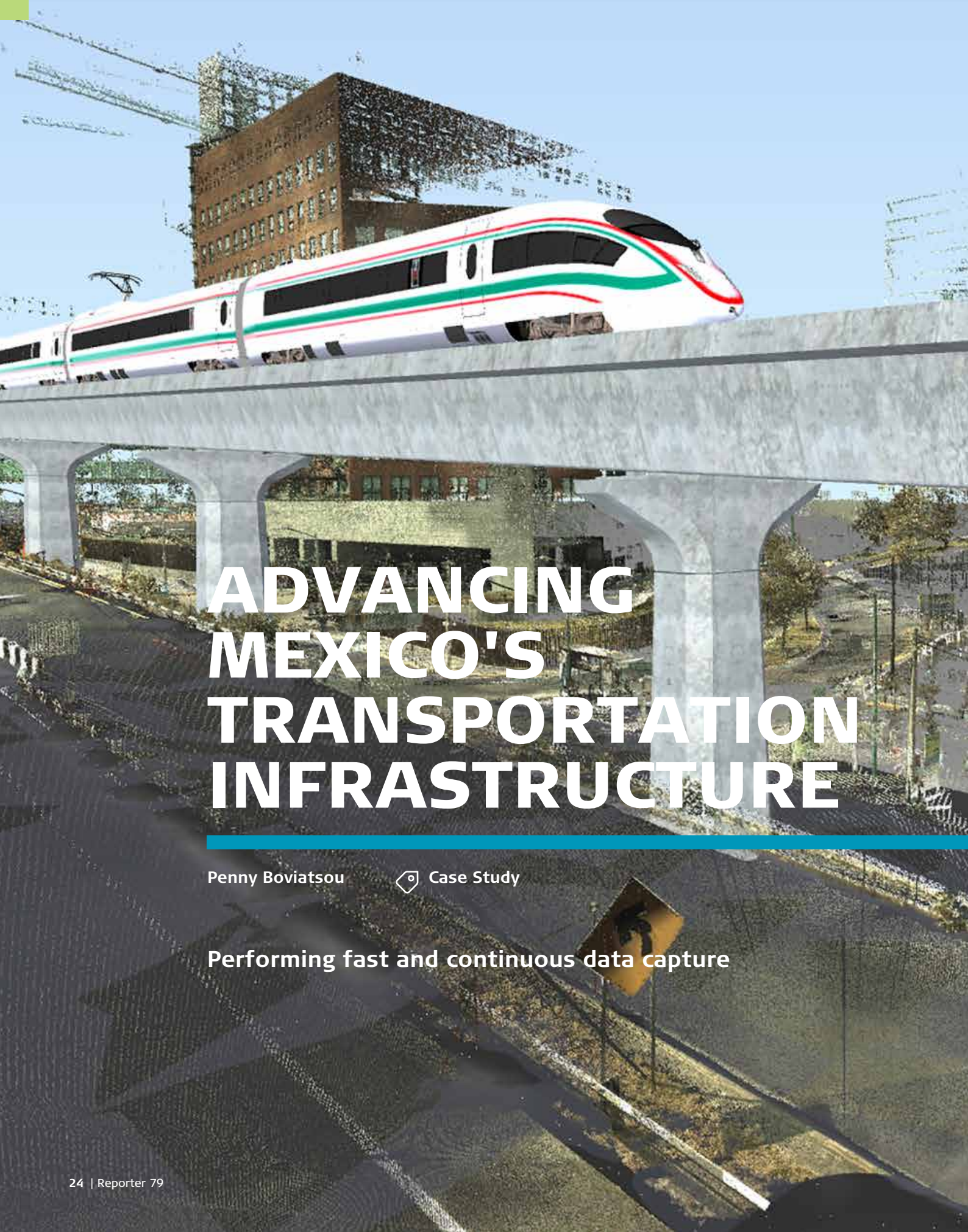
data to create classified point clouds. The SHOM team can review the deep bathymetry, the shallow and the topographic LiDAR data at the same time, including reviewing the images taken at the same location as the point cloud data.

“From a cost effective approach, comparing with shipborne surveys in the past, topo and bathy survey had to take place separately and we had to launch a complex merging data process. With Leica Geosystems technology this is not necessary anymore,” said Pastol.

AN INNOVATIVE SOLUTION

The LiDAR technology has been widely used in monitoring various natural hazards. Due to the high accuracy of the captured data, the technology is also used in the field of oceanic sciences, including a DTM and bathymetric mapping. The HawkEye III is a simple-to-use sensor optimised for the most demanding survey requirements.

“SHOM has the responsibility to conduct surveys in difficult areas and our partnership with Leica Geosystems gives us peace of mind by dealing with all the other aspects of the project, such as system installation, calibration, technical and aeronautical maintenance, among other tasks,” said Yves-Marie Tanguy, SHOM Litto3D project manager. “SHOM's needs are vast and complex, but we can testify that Leica Geosystems answers with great professionalism to all our requests.”



ADVANCING MEXICO'S TRANSPORTATION INFRASTRUCTURE

Penny Boviatsou



Case Study

Performing fast and continuous data capture

Imagine an airport featuring six runways and serving up to 120 million passengers per year, located approximately 25 kilometres from one of the largest metropolitan areas in the world. That airport, the Mexico City New International Airport (NAICM), is currently the largest Mexican infrastructure project and expected to open in 2020.

Millions of travellers are expected to fly into and out of NAICM, thousands of airport personnel will commute on a day-to-day basis, and hundreds of businesses will reside within or rely on the airport business district. All these airport users depend on transport infrastructure that provides an effective solution.

Mexico's Federal Secretariat of Communications and Transport (SCT) has developed a plan in which several international and Mexican companies are responsible for the design and construction of the NAICM. Besides the NAICM, a 57.7 km high-speed, modern, efficient and safe railroad is planned for connecting the city of Toluca and Mexico City.

Consortium IUYET, a leading Mexican civil engineering services company with 40 years of experience, is actively involved in the construction of the new international airport and railroad.

RESPONDING TO GLOBAL STANDARDS

The Interurban train will provide significant transport and economic benefits for the whole Mexico City region, and, along with NAICM, will be an important contributor to Mexico's economy. This new airport will not only facilitate tourism but also trade, and it will connect widely Mexico City to the rest of the world.

For this project, Consorcio IUYET uses a variety of Leica Geosystems solutions to capture, model and analyse the data, such as total stations, the SiTrack:One rail maintenance and refurbishment solution, GNSS receivers, digital levels and construction lasers combined with Leica Geosystems measurement software.

As part of the works performed by Consorcio IUYET for this project, 2,800 scans to cover 50 square km were captured and unified in a record time of two months, using the Leica



ScanStation P40. The point clouds from these scans were cleaned and registered using the Leica Cyclone 9.1 software for the most accurate generation of the Digital Terrain Model (DTM) of the zone. These data were used to develop the land and air design of the NAICM.

“The Leica ScanStation P40 enabled us to acquire 3D point clouds of the study area to generate a Digital Terrain Model and create planimetric maps,” said Guillermo Ortiz, CEO at Consorcio IUYET. “This allows us to gain reliable information and high precision data for the development of the Building Information Modelling (BIM).”

The railroad line will have four stations and two main terminals, including a station in Metepec, close to Toluca International Airport. The train will have a maximum speed of 160 km/h. The project will also involve the construction of a 3.9 km, 30 m deep tunnel to secure environmentally protected zones; this is the most challenging task. Consorcio IUYET is the first company in North America to acquire the Leica SiTrack:One, the mobile mapping platform made especially for railroad documentation,



“Thanks to the Leica Geosystems products, our project goals are clear, realistic, feasible and designed to complete the project on schedule with high quality standards,” said Guillermo Ortiz, CEO at Consorcio IUYET.

which will be used for the construction of the high speed passenger train Toluca-Mexico City.

“The SiTrack:One and its integrated P40 ScanStation will be used to obtain a highly accurate 3D point cloud of the railroad environment for applications such as rail geometry calculations, platform gauging and rail clearancing,” said Ortiz. “Rail’s ability to compete with other modes of transport, in particular with road, is crucial for its competitiveness. New technology such as the Leica SiTrack:One can offer much to help modernise railways and develop a smarter and safer rail system that will benefit travellers and commuters.”

USING THE MOST SUITABLE TECHNOLOGY

The airport journey experience has a high impact on travellers’ view of the quality of the airport. The route between the destination and airport will be the passengers first and last experience of Mexico.

The railroad project began construction in July 2014 and the new line is expected to open by 2018. It would be operated with a fleet of 15 trainsets giving an end-to-end journey time of 39 minutes. Using technology that allowed for easy access, the project is on track for a timely completion.

Consorcio IUYET combined several technologies in different stages of this project. The Aibotix X6 V2 unmanned aerial vehicle (UAV) was used

for the photogrammetry and construction inspection while the Leica Viva GS15 GNSS antenna helped create the Geodesic Reference Network, and the Leica DNA03 digital level ensured altimetry control.

The flexibility and simplicity in the collection of the measurements allowed Consorcio IUYET to focus efforts on evaluating and analysing data rather than working out how to collect the required information.

“Thanks to the Leica Geosystems products, our project goals are clear, realistic, feasible and designed to complete the project on schedule with high quality standards,” said Ortiz.

The firm also used the Leica Nova MS50 to integrate 3D point cloud measurements that enabled the collection and visualisation of topographic survey data together with detailed high-precision scans. Ensuring fast and efficient transfer of information from field to finish is vital for this demanding project.

“The precision and compatibility between the Leica Geosystems equipment allows the best use of the resources for our company,” said Ortiz. “The need for accurate measurement is critical for our project; it supports precision and saves money and time. The reliability that our customers recognise in our work is a reflection of the quality of the Leica Geosystems solutions.”



MEASUREMENT SUPPORTS INNOVATIONS

Mexico City has an opportunity to enhance the development of the airport region, to ensure the airport's support to the local and national economy is increased.

For a number of reasons, the terrestrial transport is considered to play a significant role in sustainable airport access. An effective and efficient transport network is one of the most important elements to ensure that the airport is cohesively integrated in Mexico City.

"The Mexico City New International Airport and Interurban Toluca-Mexico City train line will be a presentation for Mexican innovation," said Ortiz. "Known as the 'Airport of the future,' it will be one of the world's largest airports and will revolutionise airport design."




Session 9112: Construction Monitoring, Verification, and Fabrication with Aibotix UAV, HDS ScanStations, and SiTrack Mobile Rail System for Mexico City's First High-Speed Rail

Wednesday, 14 June, 4:30 p.m. P.T., Room 2403/2404



PRESERVING MANKIND'S PAST FROM MOTHER NATURE'S QUAKE

Dr. Shakhzod Takhirov

 Case Study

Laser scanning for historical documentation in Uzbekistan

Civil engineers are in a continuous search of non-destructive measurement techniques that can help to estimate structural condition. The high definition surveying (HDS) or laser scanning, from Leica Geosystems fulfils this need.

A joint research team comprised of members from UC Berkeley's Structures Laboratory (a research lab specialising in full-scale structural testing and numerical analysis), Miyamoto International (an earthquake and structural engineering firm in the USA), Smart Scanning Solutions, LLC (a 3D scanning and modelling service provider in Uzbekistan) and BNZ (Leica Geosystems' representative in Uzbekistan) has been deploying HDS reality management technology at heritage monuments along the historic Silk Road within Uzbekistan. Multiple monuments have been captured and analysed for earthquake susceptibility.

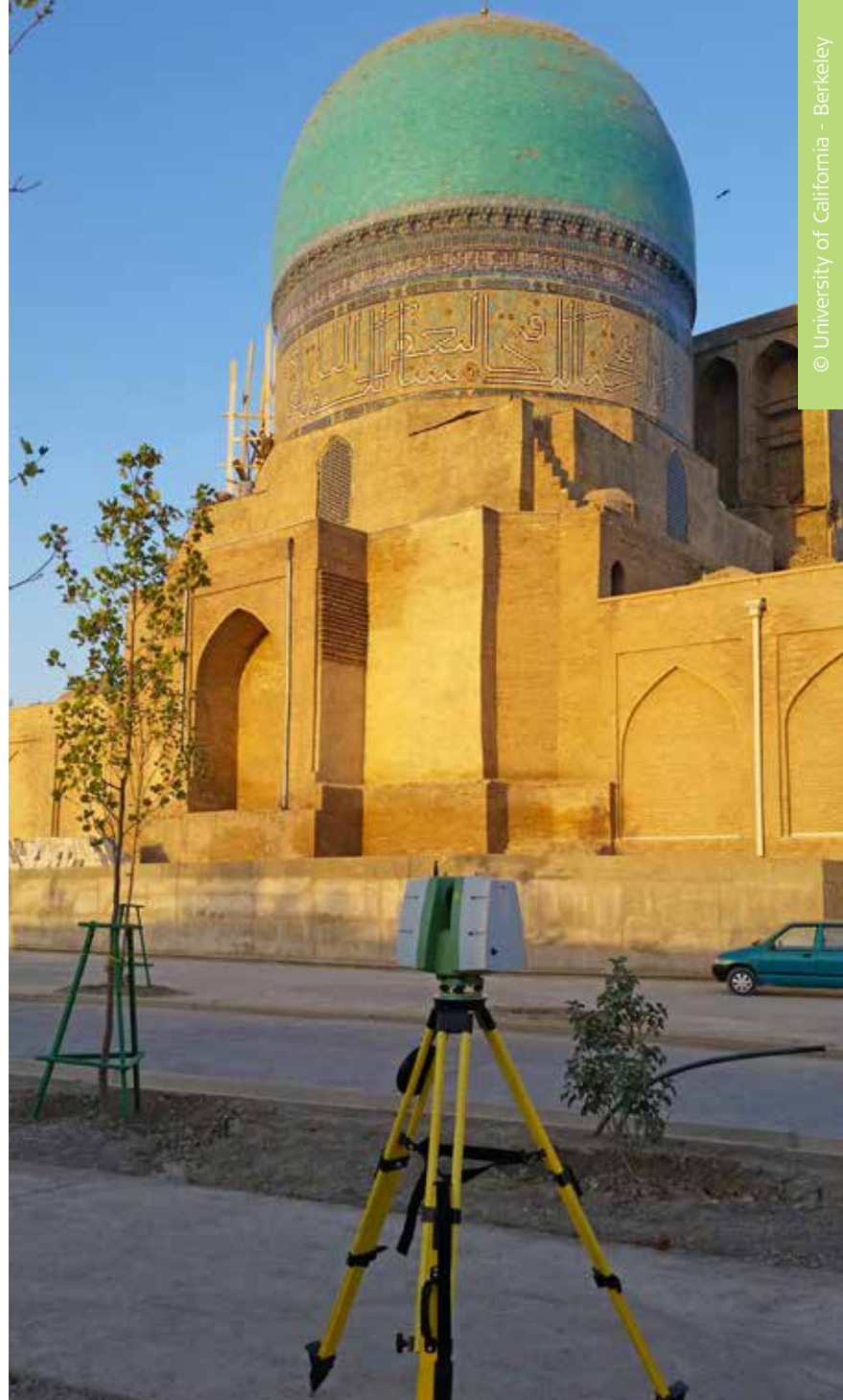
THE BEGINNING: ASSESSMENT OF NATURAL DECLINE

As a representative example of the many heritage monuments, the Registan Square ensemble in Samarkand, Uzbekistan was selected. The ensemble includes the Ulugh Beg Madrasah, 1417-1420, the Sher-Dor Madrasah, 1619-1636, the Tilya-Kori Madrasah and Mosque, 1646-1660, and the 18th century Chorsu domed market.

Earthquakes, extreme seasonal temperatures, normal depreciation of the buildings and the economic crises of the 18th and 19th centuries have left the ensemble in a ruined condition. Structural repairs and straightening of the minarets had been conducted in 1923 and 1932; however, major restoration works were undertaken in recent years.

The ensemble was scanned from more than 70 stations with a Leica ScanStation. In addition to the global dimensions of all monuments located within the ensemble, the scans captured all details of the monuments: tile shape and dimensions, their overall locations in the monuments, any imperfections and the overall geometric shapes of the portals and facades. To achieve this level of detail in point density, all scans were conducted with a density of 2 mm by 2 mm.

The scan data produced extremely valuable results to be used in the decision making of



further restoration strategies for the monument located in this earthquake-prone area of Central Asia. In generation of finite element models from the point cloud, Leica Cyclone software was used for surfaces with complex geometry.

"With the ScanStation's ability to achieve ultra-high scan speeds, we were able to quickly collect the data needed for a thorough investigation of the monuments," said Liliya Myagkova, Smart Scanning Solutions CEO. "And Cyclone's simple registration enabled the team to process the point clouds for fast analysis."

The point cloud of one of the leaning minarets provided answers to questions regarding the



amount of incline in the structure. Based on the analysis of the point cloud, an estimate of 4.6 per cent of inclination was obtained. The original taper of the minaret is estimated as 2.3 per cent.

NEW EXPEDITIONS AND MONITORING BY LASER SCANS

The laser scanning expeditions were expanded into new cities. An extensive list of historic structures included many cities of Uzbekistan: Bukhara, Shakhrysbaz and Tashkent. In addition to that, more historic structures in Samarkand were scanned.

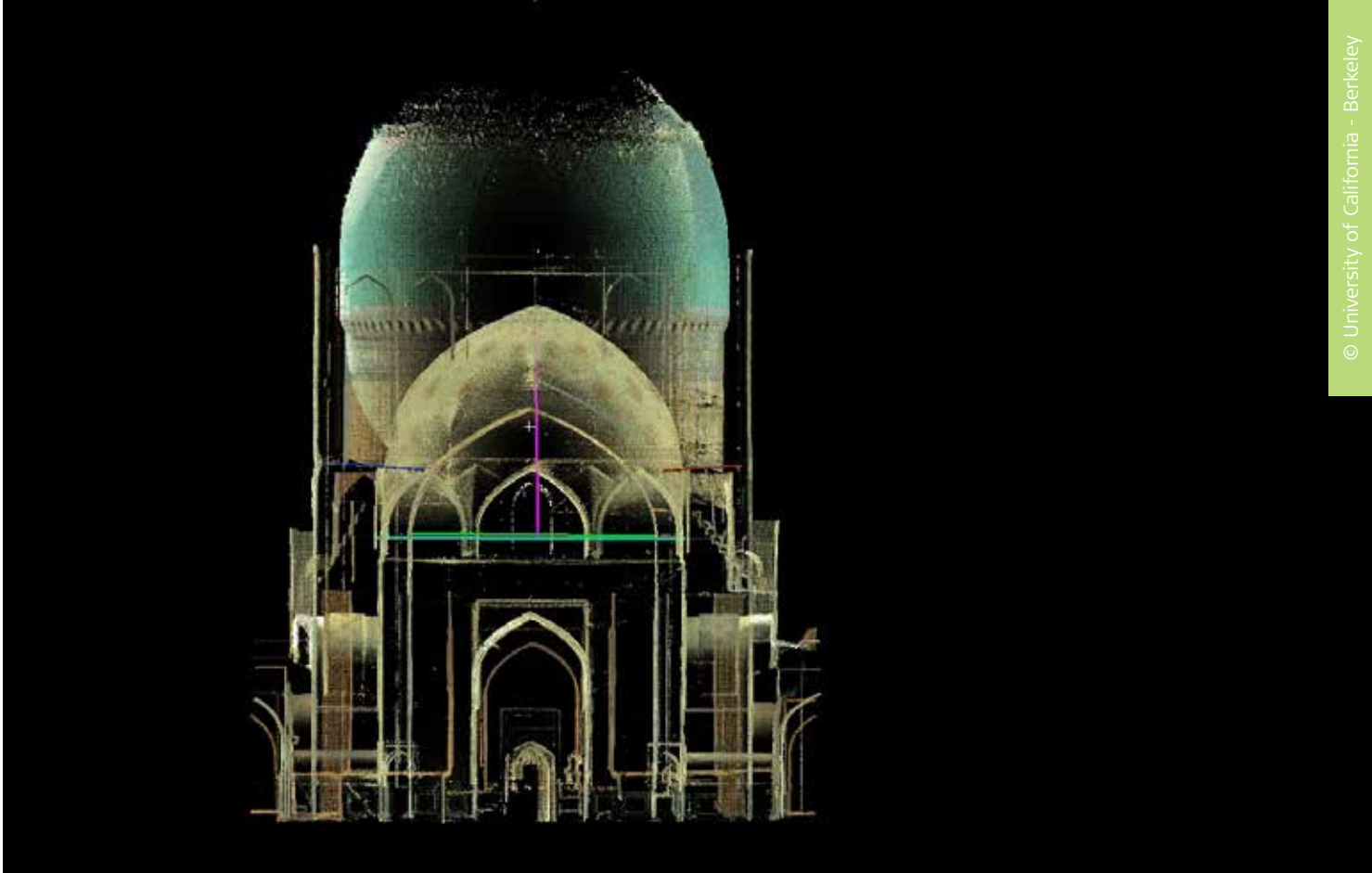
Shakhrysbaz is located in southern Uzbekistan approximately 80 km south of Samarkand, Uzbekistan. Once a major city of Central Asia, it is primarily known today as the birthplace of 14th century Turco-Mongol conqueror Timur. The scanned monument, the Kuk Gumbaz (Blue Dome) Mosque, is from the Timurid Dynasty era and it is on the UNESCO World Heritage List. The monument was built in 1437 and over the centuries has undergone several restorations and reinforcement efforts.

The historic monument was scanned from 13 stations with a Leica ScanStation C10. Data registration was performed in Cyclone and error did not exceed 3 mm for all scans used in the

final registration. The monument was scanned from outside, inside of the main hall, and inside of a stairway with a large crack between the portal and the main structure.

“With Uzbekistan’s extreme continental climate, the research team needed to ensure it could rely on the instruments. As the C10 can work in temperatures anywhere from -20 to +50 degrees Celsius, it was ideal for this project,” said Brian Quigley, BNZ director. “The full 360° x 270° field of view also ensured scanning the complex surfaces of the monuments would capture all features and make the process simpler for the researchers.”

The monument’s point cloud was investigated for anomalies. The main portal was investigated for its inclination from a vertical plane passing through the bottom of both piers. The portal’s inclination increases from south to north with the maximum differential displacement of 0.6 m at the top north corner. To ensure this degree of inclination of the portal is not progressing, a periodic monitoring by laser scanning was recommended to be carried out. It was also advised to proceed with the installation of laser targets to increase accuracy of monitoring. The permanently installed targets provide a consistent comparison between point clouds collected at different times.



The geometry of the finite element model was generated from the point cloud. All major imperfections and existing reinforcements were included into the geometry of the model. Numerical modelling and subsequent analysis was conducted in specialist software SAP2000.

Since there is a very large variability in the material properties of masonry walls, material tests were conducted on a brick recovered from the site. The material properties were used within the software for accurate modelling.

The minaret was scanned at different times to check if the inclination is progressing over time. The first scans were conducted by the ScanStation C10 and the second point cloud was collected by the P-series ScanStation. The first scans were registered to the second scans in Cyclone. The inclinations are estimated as a vector at each elevation with directivity and value. The latter result uses the main advantage of the high-definition laser scanning that captures multiple points of the surface that cannot be obtained by other means.

FUTURE RESEARCH FOR MORE PROTECTION

The test projects won interest from, and collaboration with, the Uzbekistan authorities dealing with heritage buildings. This provided

permissions for the additional heritage scanning along Uzbekistan's active seismic zones in Samarkand, Bukhara, Tashkent and Shakhrisyabz.

With HDS scanning combined with material testing, advanced calibrated models were produced, accounting for brick properties, current conditions, and previous structural reinforcements. Long-term monitoring is being strategised and conservation recommendations are being provided based on the research data, including the investigation of dampening devices at an active mosque with multiple structural concerns.

“Laser scanning helps us to capture structural anomalies of historical artefacts so we can help protect them for future generations,” said Amir Gilani, Miyamoto International, Manager of Earthquake Engineering Department. “Without this advanced technology, it would be challenging to get the as-found geometry of historic structures with accuracy of few millimetres that is essential for structural analysis.”

In recognition of the team's effort and value of the collected data, the point clouds were accepted into the CyArk 500 Challenge database, an international effort to catalogue and archive endangered cultural heritage.



BUILDING A PRECISE MONITORING NETWORK

Renata Barradas Gutierrez



Case Study

Leica Geosystems monitoring solutions provide precise positioning for critical infrastructure in the United Kingdom and beyond



The structures that accompany our everyday seem static and unalterable to our eyes. Weather conditions, aging, human activity, geological changes and other factors alter these structures and pose a challenge for engineers that strive to maintain the health of the constructions that our economies and daily lives depend on.

Structural behaviours are not always predictable by design and simulations. An unexpected bridge failure cannot just prevent you from arriving to work or getting back home. A lack of proper monitoring and maintenance can also result in the total isolation of cities and even in the loss of lives. Engineers, therefore, need to detect in an accurately and timely manner any structural movements under all natural physical conditions.

To gain knowledge of the integrity and changes of any structure, engineers today have Structural Health Monitoring (SHM) tools to obtain a clear picture of the current state, degradation and evolution of any structure to make fast informed decisions.

Led by UbiPOS UK as the prime contractor, consortium members including academics from the University of Nottingham's Geospatial Institute and industrial partners from Leica Geosystems, GVL, Amey, Transport Scotland and China Railway, are developing GeoSHM

(GNSS and observation for Structural Health Monitoring), a system to provide users with an integrated solution to monitor and assess in real time the operational conditions of different types of assets. Aware of the challenges to maintain the structural safety and operation of long span bridges, the European Space Agency (ESA), has supported the grant through the Integrated Application Promotion (IAP) Programme.

THE COMPLETE PICTURE

It is of critical importance to have the ability to monitor remotely and in real time any asset. GeoSHM uses real-time data gathered with Leica Geosystems GNSS receivers and software to analyse the operational conditions of bridges with the GeoSHM Deformation Analyst that is developed by the consortium.

Leica Geosystems GNSS monitoring systems provide the complete picture by producing 3D real-time displacements and tilt of the bridge. GeoSHM converts data into useful information to end users and delivers it through a web-based interface that provides precise deformation information that allows bridgemasters to understand the loading and response effect of the bridge under normal loading conditions.



Bridgemasters can measure the performance of structural design models against the current conditions to identify unusual deformations under extreme weather conditions and detect movement at millimetre level. When deformations surpass designated parameters, the GeoSHM Deformation Analyst issues an early and emergency warning. In this way, GeoSHM provides a service that offers 24/7 monitoring, and facilitates a targeted maintenance by identifying structural failures promptly and assessing the bridge after an event.

“We selected Leica Geosystems products for their high positioning precision and reliability. The GR10, the GM30 receivers and the Leica GNSS Spider software are stable, easy to use, and provided excellent results,” said Dr. Xiaolin Meng, GeoSHM project leader from Nottingham Geospatial Institute. “Integrating Leica Geosystems GNSS technology allowed us to simplify our process, save time, and remotely control and monitor the status of the project.”

THE TEST PLATFORM

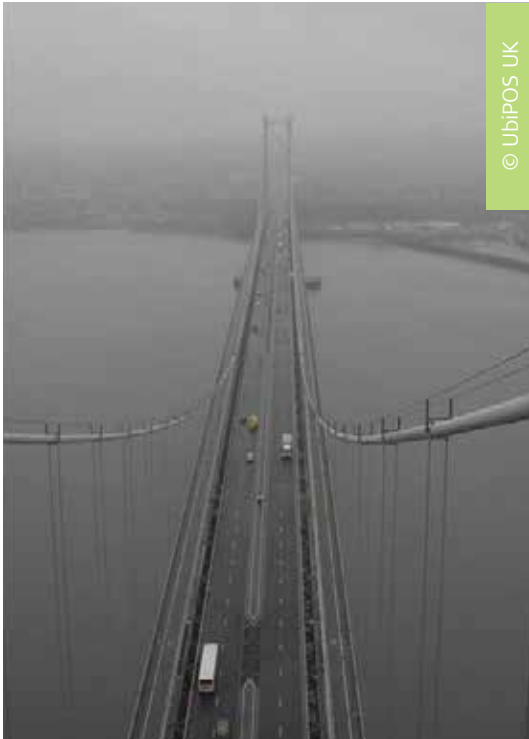
The Forth Road Bridge, a long span suspension bridge in east central Scotland, was the test bed for GeoSHM. The bridge was inaugurated in 1964, the longest steel suspension bridge in Europe at that time. When the bridge was designed in the 1950s, engineers could not

predict the increasing traffic this crucial corridor between south-east and north-east Scotland would need to support. Initially designed to sustain a traffic of 30,000 vehicles per day, the bridge can normally be exposed to support twice the traffic it was originally designed for.

The Forth Road Bridge, like many other span suspension bridges, must defy the most challenging conditions, such as unexpected deformation, unusual traffic loading, temperature changes, high winds and extreme tides. Bridgemasters and infrastructure managers, therefore, have an urgency to understand the behaviour to develop a maintenance programme that allows access to a rapid, targeted, and automated assessment of the bridge's health to assure cost efficient maintenance and management.

A SENSOR NETWORK YOU CAN TRUST

Currently the GeoSHM service collects the Forth Road Bridge data from four permanent Leica Geosystems GNSS receivers and two anemometers to measure the speed of the wind, but the programme will be further expanded by the consortium. The Leica GNSS Spider software provides the professional solution for controlling and operating the installed GNSS reference stations and networks. The GNSS receivers collect and stream out data through Leica Spider



via internet processing in real time, providing the positioning to analyse the bridge health status with the GeoSHM Deformation Analyst.

One Leica GR10 reference station was set on top of the bridge and three Leica GM30 monitoring receivers were set throughout the bridge to acquire the data from the GNSS satellites and sent via optic fibre network to a local hub. GNSS data is sent for processing through secure internet connection to the Central Processing Centre at the University of Nottingham where it is integrated with the data collected from the bridge sensors to generate changes in deformation and displacement information with millimetre accuracy and high resolution. At the Control Centre, the further processed GNSS data as deformation information is combined with InSAR, a radar technique used in remote sensing, to measure long-term structural trends and local environmental effects.

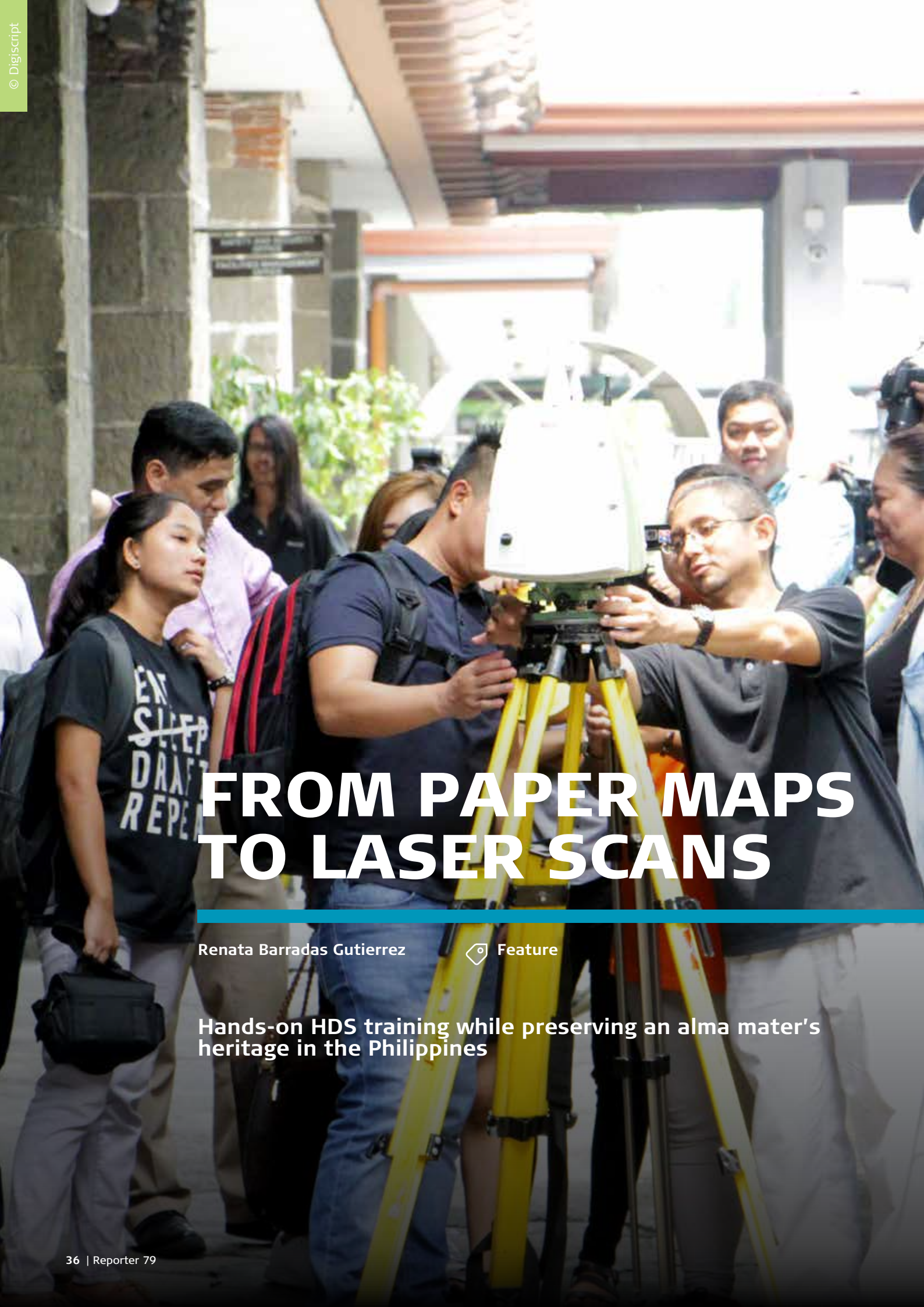
A PROVEN SOLUTION

Using Leica Geosystems monitoring technologies, together with other sensors, the GeoSHM project aims to establish a state-of-the-art system that can address the challenges in structural deformation monitoring of long bridges, and other critical infrastructure, with a model that combines reference monitoring




systems with the engagement of multiple stakeholders. As a next stage of development, GeoSHM will be expanded on a selection of bridges in China.

Using Leica Geosystems GNSS solutions that are empowered with the GeoSHM Deformation Analyst engine, GeoSHM has demonstrated that having a deep understanding and monitoring of this critical transport infrastructure can extend and safeguard the lifetime of aging bridges. Leica GNSS Monitoring Solutions provide vital information to reduce the maintenance costs with a targeted approach of inspections and timely identification of potential structural damage.



FROM PAPER MAPS TO LASER SCANS

Renata Barradas Gutierrez

 Feature

Hands-on HDS training while preserving an alma mater's heritage in the Philippines



Laser scanning, along with GNSS and remote sensing, has revolutionised the surveying profession in the last years. With the possibility to capture large amounts of data in a relatively short time, laser scanners are must-have instruments for collecting data that range from a simple topographic survey to a 3D model to preserve cultural heritage.

Future surveyors and Architecture, Engineering and Construction (AEC) professionals will need to be equipped with the right tools and be trained with the skills to solve challenges for a wide range of applications to keep up with competition and react to business opportunities.

Digiscript Philippines Inc., a company specialised in 3D measurement and digital building modelling technology solutions, conducted a hands-on training program for students of Don Bosco Technical College (DBTC) in the Mandaluyong Philippines on how to use laser scanning technology and imparted the benefits of this technology to help them develop new skills in their field.

HANDS-ON FOR HDS

As processes digitise and businesses digitalise, surveyors will have to adapt new trends to offer better, faster and more specialised services to their clients. Unfortunately, 3D laser scanning training is rarely available in civil engineering and land surveying programmes. Additionally, private

companies may offer training at a high cost inaccessible to most surveying students.

Aware that students should leave the pens and paper maps aside and be prepared to collect and share information digitally, Digiscript inspired young potential surveyors by introducing students to High Definition Surveying (HDS). The company's experts taught engineering and architect students the HDS applications for as-built, engineering and heritage preservation.

Students also learned the wide range of deliverables that can be produced with laser scanning such as 2D as-built drawings, Building Information Modelling (BIM), surface deformation analysis, area or cut/fill volume, dimensional control for fabrication Quality Assurance (QA), and clash checking for design versus as built, among others.

As part of the teaching agenda, Digiscript conducted an actual 3D laser survey of DBTC's old building and guided students through a hands-on training on how to install Leica Cyclone point cloud processing and modelling software, how to navigate and visualise 3D point clouds, and how to prepare as-built drawings. Students were able to learn how to use the scanner in a very short time thanks to the versatility and ease of workflow of the Leica ScanStation C10.

"It is very important for us students to stay updated with the latest technology," said Eric Solis, architecture student at DBTC.



“We are glad to know that there are more efficient ways of doing as-built drawings,” continued Paulo Riviera, engineering student at DBTC.

Universities and colleges have to adopt in their curricula the latest changes in surveying and documentation to offer the skills that professionals need to meet the industry’s demands for 3D laser scanning technology. Knowing the benefits that laser scanning offers, students will be able to identify and create business opportunities and keep up with the competition.

“Exposing technical college students to HDS technology will prove to be advantageous in the educational field for engineering students and also for future HDS projects in the community at large,” said Ronald Sampayan, director of Digiscript for the Philippines and Indonesia and engineer alumni of DBTC.

PRESERVING THE PAST TO TEACH THE FUTURE GENERATION

While teaching students the benefits of laser scanning technology, Digiscript scanned the old building of DBTC, a building that has witnessed 300 years of history, and has an educational institution for technical professionals for more than 60 years.

The data generated from the laser scanning helped Digiscript to create as-built drawings in 2D and 3D for the conservation and building plan of DBTC’s old building. The deliverables also included a fly through 3D animation of the college that will help marketing the school to increase its exposure.

“This is a historical event where the old building will be preserved forever,” concluded Fr. Demetrio Carmona, vice-rector of DBTC.





TAKING THE LEAD

Digiscript pioneered HDS in the Philippines in 2008. Since then, the firm has worked providing custom tailored 3D solutions for extensive projects and applications for various industries.

“Delivering value is what we guarantee,” expressed Conrad Alampay, president of Digiscript.

Whether it is ensuring a clash free Mechanical, Electrical and Plumbing (MEP) design, fabrication of support structures or pipes, understanding the general topography of a site, or capturing the intricate geometries seen in historic sites, Digiscript has been generating business in a developing emerging market with Leica Geosystems laser scanning technology.

“We empower our customers by providing results using Leica Geosystems solutions to help them measure, manage, design and visualise the current physical environment so that a comprehensive and unified understanding of their sites is obtained,” said Sampayan. “It is through this understanding that ideas are formed, visions become clear, and avenues for taking action are revealed in the ultimate goal of shaping a progressive tomorrow.”





FORCE MULTIPLIER: WHY GNSS NETWORKS ARE GAINING GROUND IN CONSTRUCTION

David Rowlett

 Case Study

Forward-thinking contractors are signing up for network subscriptions in record numbers



John Hugerich still remembers using a base station and setting up a local network for every stockpile calculation and flood elevation. The process was tedious and time-consuming, and the project manager of Hugerich Construction, based in New Jersey, USA, often wished for a faster and easier way to get the job done.

That was two years ago. Today, Hugerich relies almost exclusively on the HxGN SmartNet network for tasks requiring RTK corrections.

"It allows you to get your correction data and all of your state plane coordinates right there, so it makes life a lot easier," he says. "Just being able to run out to a jobsite and get a quick stockpile quantity or double check an existing elevation for estimates has been a really big help in bidding jobs and completing jobs on time and on budget."

Hugerich isn't alone. As contractors seek ways to become more efficient and productive, an increasing number of companies are replacing some of their base stations with network subscriptions—and reaping the benefits of this approach.

INCREASED ACCESSIBILITY, RELIABILITY AND EFFICIENCY

Surveyors have long used GNSS networks to save time and money as well as remove potential sources of error. Instead of hauling around two GPS receivers (a base and a rover), a lot of

batteries and cables, two radios, a tripod and a pole, and setting up their own local base for each project, network users simply carry a GPS or GNSS receiver (rover) with a modem or a mobile phone and use that equipment to quickly access a network of permanent reference stations. The combined data from those permanent stations is used to generate RTK corrections and provide accurate positioning at much greater distances than normally possible.

Using a network saves time since it precludes the setup of separate base stations, and it avoids the risk of having control fail due to a damaged or stolen base. It also eliminates potential errors due to the incorrect setup or replacement of the base station if it gets bumped or knocked down in the course of the project. For contractors, it provides the ability to go to a job they're preparing to bid, perhaps while their base is in use elsewhere, and quickly check elevations and quantities to protect profit margins.

In the past, having access to a reliable, precise network on a construction site was not a given. Contractors using GPS were almost always forced to set up their own local base stations to ensure accuracy. Over the last few years, however, substantial technology investments by the networks over the last several years, along with an increase in service capabilities, have made networks an attractive alternative for contractors seeking to take their productivity to the next level.



www.xyht.com

A version of this story first appeared in xzHt.



HxGN SmartNet, based on Leica Geosystems GNSS technology, is the GNSS correction service built on the largest reference station network in the world that brings the highest precision results. HxGN SmartNet continues to provide trusted GNSS data over more than 4,000 reference stations worldwide. The new naming of HxGN SmartNet reflects the ability of combining Leica Geosystems technology with other Hexagon businesses. Login procedures will not change, and users will be able to continue their service seamlessly.

For example, HxGN SmartNet in North America, which is regarded by many contractors and surveyors as the most reliable RTK correction network, has added a number of new support tools and hundreds of new reference stations in the last two years alone. It now has more than 1,300 sites, providing GNSS correction data coverage both GPS only and GPS and GLONASS coverage to 44 states and eight Canadian provinces, and it continues expanding rapidly.

The increased availability combined with the benefits of using a network is driving construction contractors to sign up for subscriptions in record numbers. HxGN SmartNet saw subscriptions by contractors double in the second half of 2016, and 2017 is already on track to eclipse those figures.

For most contractors, it's the simplicity and speed of the network that is the most appealing. "I can hand a receiver to one of my

operators and give him a quick tutorial on what he needs to do, and then go back to the office," says Hugerich. "Once he's on-site and gives me his coordinates, I can double check remotely to make sure everyone is on the same coordinates and that everything is running the way it should be. Ease of use is a really big thing."

Micah Sawyer of Chase Excavating in Maine, USA agrees, noting that using HxGN SmartNet has streamlined layout for his company. "It's fast and easy, and it makes us more productive on our jobs," he says.

PARTNERSHIP APPROACH HELPS ENSURE SUCCESS

Advances in how networks serve the construction market are also contributing to the rise in network subscriptions. For example, base stations are still required for most machine control finishing operations to ensure vertical



accuracy. HxGN SmartNet, however, recently rolled out a convenient site licensing option that allows contractors to purchase a single license for multiple rovers and machines on a project. With each site license, the service works closely with the contractor to densify the network so that the accuracies needed by machine control are achieved. The savings from not having to purchase a base station and repeaters provides

a significant advantage. The larger the project, the greater the gains in efficiency.

Overall, the benefits of network subscriptions combined with the quality of service are leading to increased confidence and widespread adoption by contractors. "The increased efficiency of using a network really makes this the next logical step in construction," Sawyer says.



Session 9014: The world of SmartNet, on-stage and behind the scenes

Thursday, 15 June, 3:30 p.m. PT, Room 2501



OVERCOMING THE BLUes OF CONSTRUCTION DOCUMENTATION

Kristi Vick

Case Study

Construction documentation for the building of multi-family housing in the USA



When building an eight-story, 285-unit luxury apartment complex in Florida, USA, developers had to pay careful attention to ensure construction progress was kept on schedule and on budget. To precisely track the progress of Miami’s BLU at North Bay Village project, the developer, ZOM, turned to the construction documentation expertise of Multivista.

Founded in 1977, ZOM literally built its reputation from the ground up as a leading developer in Florida. While its first real estate investment activities were broad, ZOM eventually specialised in multi-family developments in and around Orlando. Today, the company is one of the most highly-regarded multi-family developers in the United States.

Jointly and directly responsible for developing more than 16,500 apartments, ZOM is meticulous in terms of deliverables and quality assurance on every project. While architects are mandated to provide regular reports and photos detailing construction progress, ZOM wanted a more efficient and comprehensive method of tracking its projects as they were built. According to Brett Gelsomino, Development Project Manager at ZOM, “Before Multivista, the process of tracking the progression of our construction was much more manual. Aside from the regular architect reports, a ZOM employee or the contractor would snap pictures randomly or as needed. Although these were useful, we had to dig through phones or cameras to find shots, time stamp images,

upload, and organise. It just took more time away from other important tasks.”

Once introduced to photo documentation services, ZOM was hooked. Providing these services from start to finish, Multivista documents, visually tracks, organises, and communicates the progression of construction projects through an easy-to-use and highly efficient online platform. “When a Multivista photographer comes on-site to take pictures, we are getting hundreds of shots. That was incredibly difficult for us to do on our visits of yesteryear. We were really only taking specific shots, so it wasn’t nearly as thorough as compared to the amount of information and pictures we now have access to in the Multivista platform,” explains Gelsomino.

IMPROVING QUALITY CONTROL AND ACCESS TO INFORMATION

Already familiar with the importance of professional photo documentation, ZOM re-enlisted Multivista again for the construction of BLU at North Bay Village. For this apartment development, ZOM chose the following shoot types:

- Interior and exterior progressions
- Mechanical, electrical and plumbing (MEP) Exact-Built®
- Window Installations Exact-Built®

“The main advantage for us in using Multivista has really been about maintaining the highest level of quality control and verification,” said

Gelsomino. "Construction at BLU has been going very well, but if ever we do run into anything, it's useful having the pictures to see how things were assembled or what's going on behind the walls without having major delays or expenses associated with tearing things apart."

ZOM used MEP photographs to identify and coordinate plumbing and mechanical details pro-actively. Gelsomino also remotely accessed exterior and interior progression photos, saving him countless visits to the job site. Instead of having to physically go on site every time a reference to a detail was needed, Gelsomino simply signed into the Multivista platform where all the information was readily accessible at the click of a mouse.

"Multivista has definitely made my job easier, especially when it comes to photographic reporting. I get such a variety of images and angles that I can share with stakeholders, whether it's interior or exterior photos, micro or macro level details; it's all there in the platform - dated, organised, and easy to find."

The advantage of remaining informed between site visits extended to ZOM's capital partners as well. "Multivista has been really helpful in keeping our capital partners informed about the progress of construction from far away," explained Gelsomino. "We always keep them plugged into the development, but a picture is worth a thousand words; and in this case, a hundred pictures are worth far more words."

KEEPING EVERYONE ON THE SAME PAGE

Working with the construction documentation team has been seamless for ZOM. Multivista worked with the general contractor to schedule shoots and the photos are uploaded to the project site after each site visit. An unlimited number of users assigned to the project logged into the Multivista platform to pull up the pictures indexed directly to the CAD drawings, highlighted details, browsed thumbnails, added comments, and created favourite folders.

"My favourite feature in the Multivista platform is being able to select a few pictures and generate a report with date and time stamps, location markers, and all associated information," explained Gelsomino. "Either it can show the evolution of one detail over time, or it can show specifics in an area at a certain time, and then I can print it or email it to anyone

involved in the project." Architects, general contractors, third-party inspectors, and other stakeholders were given access to the BLU project site and found the system beneficial. For ZOM, the streamlined flow of information between all parties is another key benefit of construction documentation services.

"Again, Multivista saves us time in terms of sharing information, but it also saves us money with being able to avoid conflicts and refute change orders. Generally speaking, the verification of change orders has become much more streamlined. Minor disputes that do arise are much more black and white, and it is easier to get everyone on the same page if we can prove conditions with photos," added Gelsomino.

FUTURE BENEFITS AND LONG TERM PROJECTS

In the 17 months that Multivista captured the BLU site, a total of 19,625 images were taken and attached to the project plans. In addition, Gelsomino and the ZOM team used the Multivista App to snap their own pictures on site and directly upload and index them to the architectural drawings; access their project floor plans and photos from the field; and view their hi-resolution, live streaming webcams from anywhere at any time. This direct access from the field is yet another time-saving asset.

In a concluding statement, Gelsomino explains why ZOM has continued to invest in Multivista on an additional 11 multi-family developments since BLU. "For ZOM, there is so much value in the Multivista services and platform that we will likely continue to use it for all of our ground-up developments. Simply put, I would rather have it and not need it than need it and not have it. It's a great tool and resource to document and archive all stages of construction progress, and the documentation remains on file long after project completion."

GOING BELOW TO PROTECT THE ABOVE

Special to Reporter from Technics

 Case Study

Underground survey for archaeological artefacts using
Ground Penetrating Radar in the United Kingdom



Standing since medieval times, the famous Lincoln Cathedral in the United Kingdom provides some of the most remarkable architectural elements in the British Isles. Records show Saxon houses from the 12th to 17th centuries within the church's courtyard. Along with these elements comes many buried archaeological relics dating back to the construction in 1072.

As the cathedral prepares to undergo renovations to develop a new refectory and visitor facilities, planners needed to ensure no historical artefacts could be harmed during the process. They turned to Technics, a geospatial consultancy specialising in building and utility surveying across the U.K.

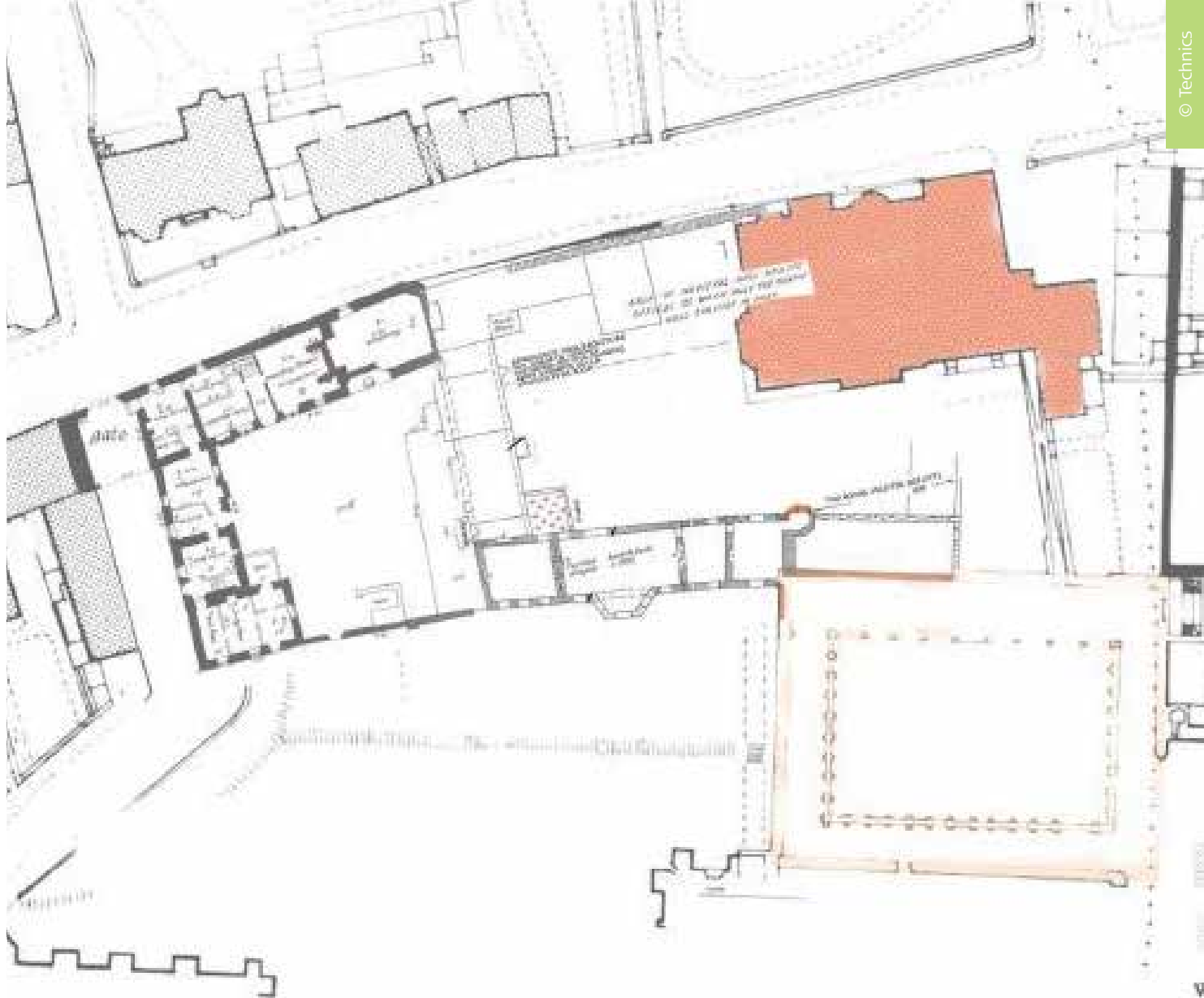
LOOKING BELOW

Technics carried out a Ground Penetrating Radar (GPR) survey at the historic cathedral to provide detailed subsurface data to detect both archaeological and utility features.

The GPR data has been used to support the development plans, and, most importantly, minimise the risk of damage to any buried archaeological evidence as well as plot the position of known and unknown utilities.

Technics used a suite of GPR systems by IDS GeoRadar. This included the RIS MF Hi-Mod, a specialised GPR system capable of investigating large areas to produce a 3D view, and the new Stream C, the company array solution for real-time 3D mapping of underground utilities and features. Technics captured multiple 3D data sets in high resolution for post-processing the detectable utilities and archaeological features.

"We were very excited to employ the suite of IDS GeoRadar equipment we have on site including the new Stream C. Processing the results in GRED HD enabled our team to view the data sets in three different views – tomography, cross sections and in 3D," said John Macintyre, Technics managing director. "The result was



highly effective in highlighting a mass of deeply buried Roman walls and clear evidence of the medieval Deanery in the area of the proposed visitor facilities."

PROTECTING HISTORY

Having carried out the detailed survey, Technics was able to compare the GPR data and evidence from boreholes, which included traces of Roman tiles, ceramics, plaster and tesserae. Analysis of the GPR data revealed the positions of a series of probable structures, including parts of Roman, post-Roman and medieval buildings.

These results will now enable the planned works with prior knowledge to minimise damage to the historical elements. Cathedral officials can now also instigate appropriate recording programmes for archaeological features that cannot be avoided during development.


"The GPR survey to the north of the Cathedral revealed the traces of the Medieval buildings

where we expected them, but much more vital and interesting, it showed a mass of deeply buried Roman walls beneath them in the area where the new shop, museum and restaurant were designed to be built," said professor Dominic Powlesland, Lincoln Cathedral archaeologist consultant. "Finding this out at an early stage has been crucial in allowing modifications to the plans within a scheduled area, which would otherwise have been ruinously expensive once the project got underway."



DIGITALISING CONSTRUCTION

Renata Barradas Gutierrez

 Feature

New cloud solution and web interface helping to digitalise the construction industry

Time pressure, unexpected costs, and changes in design and delays are inevitable in nearly all construction projects. In most cases, erroneous or inefficient sharing of information and data is the underlying cause for these issues.

These barriers are torn down by connecting and sharing data across all elements of the construction chain in real time, increasing productivity and efficiency. This digitalisation of sites advances the construction industry and is fundamental to what is often referred to as intelligent construction.

Construction companies agree digitalisation is a trend that will drive the industry and lead it to make tremendous gains in both productivity and quality. According to the Association of German Chambers of Commerce and Industry, 93 per cent of construction players agree that digitalisation will influence every one of their processes.

To address the industry's needs to share 3D data in real time, Leica Geosystems developed ConX, a cloud solution and web interface to seamlessly integrate, manage and analyse surveying and machine control workflows for construction projects.

CONSTRUCTION DATA IN REAL TIME, EVERYWHERE

According to Roland Berger, a global strategy consulting firm, the four keys to the digital transformation are:

- Digital data
- Digital access
- Automation
- Connectivity

In this sense, Leica ConX is designed to increase collaboration and simplify the data handling of machine control operations by integrating and automating workflows, enabling remote control of connected machines, and creating





real-time data exchange from the office to the field and back. Personnel and machines on the jobsite need to share the same data and stay in sync with changes so work can be completed on time, on budget, and to specification. ConX allows users to share and visualise positioning, reference model and constructed data. Field and machine control solutions connected to ConX can remotely receive and share information, and access the web interface for visualising the data anywhere with internet access.

“Leica ConX is an investment to simplify and expedite the flow of critical information between the site and the office helping to maximise the productivity of the technology and resources while reducing the burden of data collection, aggregation and reporting,” said Doug Eggert, product manager at Leica Geosystems.

MOST OPEN, USER FRIENDLY SOLUTION

This cloud-based collaboration tool enables users to efficiently manage all connected construction projects, including third party platforms, and share job-related data with all stakeholders. With ConX, non-experienced users will be able to visualise and validate localised reference models, survey data and constructed data.

“When investing in Leica Geosystems machine control and positioning technology, operators can choose to connect their products to the ConX platform, giving them the tool to aggregate, manage and store 3D data at the project level. Once connected, each product can be supported remotely and can seamlessly exchange data to and from any other connected applications or devices and applications connected to the customer account. In this way,

ConX makes information accessible to everyone working on a construction project in the role of designing, constructing, managing or validating the completion of work.

We are working hard to keep things simple and avoid introducing new and cumbersome workflows to our end user. Instead we automate existing workflows and incorporate the wealth of information generated on a modern jobsite into intuitive analysis tools making it easy to influence and monitor the production of the job site,” said Eggert.

TRENDING TOWARD DIGITALISATION

Even though there is a trend toward digitalisation in the construction industry, few construction companies are taking complete advantage of tools that digitise their processes. In an analysis by Harvard Business Review that compared how digitally advanced 22 sectors are, construction ranked second to last.

Players in the construction industry that strategise how they will integrate digitalisation have a better chance to create new businesses, stay competitive and improve productivity. Companies that ignore this trend have the risk to fall behind by losing business due to the lack of productivity.


“We are seeing an increase in project tenders requiring the use of 3D machines and field solutions for not only production and optimisation but also the subsequent data capture that is used to validate and report the work that was completed. Managing all of this data is an ever increasing problem for our customers so we aim to provide the best solution to solve it,” concluded Eggert.



SW-001

GETTING SMARTER ABOUT LASER SCANNING

Monica Miller Rodgers

 Product Focus

New laser scanning software offerings simplify point cloud processing

Point Cloud Processing.

It's a phrase that can strike fear into the heart of any laser scanning professional. The massive amounts of data. The long hours of painstakingly stitching together detailed point clouds. The even longer road to a quality checked, validated and certified 3D project, compounded by complexity in registration workflow, makes it difficult to bring data from the field into the office to a final deliverable. Is it any wonder then why just the mere mention of the phrase can be so debilitating?

Laser scanning professionals and those just getting started with the technology no longer need to fear, though, as the complex process of registration and point cloud processing just got a whole lot smarter.

NEW OFFERINGS BRING RELIEF

Leica Geosystems has recently released two new offerings to relieve the historical pains associated with point cloud processing.

"We see a surge in demand for 3D digital reality data across many industries and a growing pressure to deliver final and professional results quickly. To meet this growing demand, we embarked on a fundamental technology project to overcome the various data processing bottlenecks witnessed in the industry," said Faheem Khan, vice-president, Business Development for Leica Geosystems. "From import time, registration automation, quality management to deliverable production, we have fundamentally improved every step of the data processing pipeline to deliver a new user experience, speed and automation where we can."

The new Leica Cyclone REGISTER 360 registration software combines ease-of-use and automation with high accuracy and reliability. With a point cloud technology unparalleled in the industry, import times are more than 10 times faster than before, point clouds are centralised and archived, and an unlimited amount of data can be streamed over the cloud or deployed via portable USB sticks.

There are three main areas to Cyclone REGISTER 360:

1. A prep staging area to set up the import process in a simple method, ensuring the best initial registration possible. The user

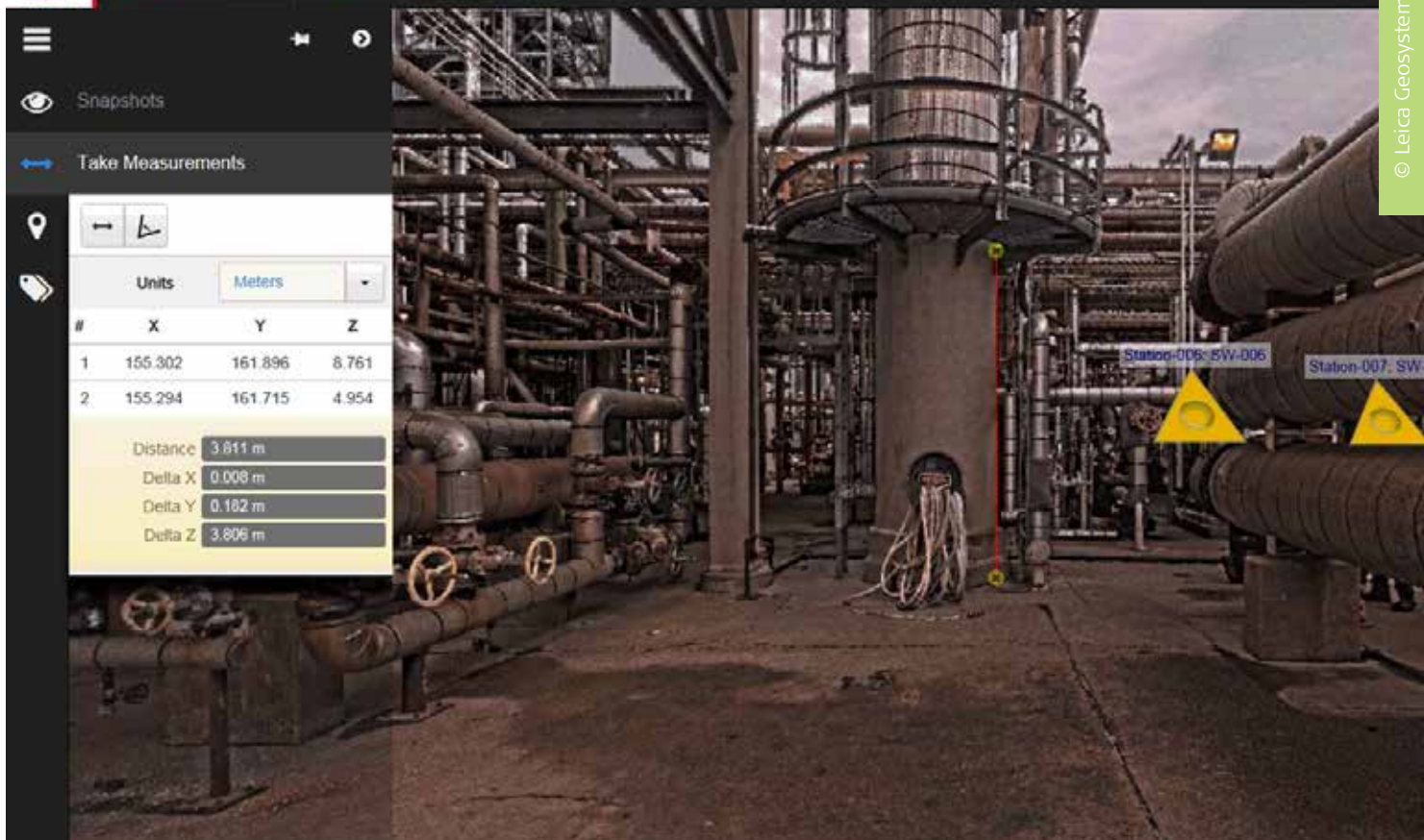
simply has to drag and drop the data and Cyclone does the rest: running multiple automated processes in the background to extract targets, create normals, index the data, clean outliers, perform pattern matching and image alignment, as well as an auto cloud-to-cloud and a fully networked registration. The user simply pushes a single button and the result is a final deliverable ready for review.

2. New visual Quality Assurance/Quality Control (QA/QC) tools to quickly check and validate the registration. These processes are often neglected because of the inherent complexity and lack of automation. With Cyclone REGISTER 360, the process of QA/QC is built into the heart of the product.
3. Finalising reporting area to create a high value report of the data processing process. Providing tools to batch deliver datasets into the various formats and outputs that are required – again all with the single push of a button. The goal is to make the end-to-end process highly productive and automated and to free up the operator for other productive tasks from these ultra-long transactions.

"With a focus on building quality control into the heart of product, we encourage professionals and non-professionals alike to follow surveying and industry best practices to generate accurate results through a strong adherence, simple yet robust workflow," said Khan.

The second release finally brings laser scanning into the cloud. The new Leica TruView Cloud Services is an easy, reliable and secure platform for quickly sharing digital reality data within a project community, globally, in a cost effective and efficient manner. The platform connects users, locations and capabilities while allowing the administrator to quickly decide who is able access what data anywhere in the world.

TruView Cloud Services offers Snapshot and GeoTag features with an available software development kit. These powerful tools enable project communication, workflows, and asset data and application integration. Users can ingest data from GIS/AM/FM/Information Management solutions and can connect asset data with digital reality content through the process of automatic GeoTag analysis inside Cyclone.



Cyclone Cloud Services will first offer the TruView Cloud Services module, which allows for powerful visualisation and sharing of digital reality data online. TruView Cloud Services is the first of many service modules to come that enhances the overall Cyclone Cloud Services experience.

“TruView Cloud Service enable scanning professionals to collaborate with organisations worldwide and pay only for the services and consumption they need,” said Khan. “With a simple upload operation from the field or the office, TruViews are created from any sensor.

TruView Cloud Services are enabled and managed by the Cyclone Cloud operations team – freeing up scanning professionals from the complex Information Technology demands to maintain highly available cloud servers and services.”

SMARTER FOR ALL

Both Cyclone REGISTER 360 and TruView Cloud Services are compatible with the entire line of Leica Geosystems laser scanners. From the professional use of the P-Series ScanStations to the more consumer use of the new BLK360 imaging laser scanner, these new offerings simplify registration, visualisation and collaboration. Users can take advantage of the extended range, robust survey-grade output the

ScanStation delivers and densify the project with a “swarm” of BLK360 scans – all registered and combined automatically with the various tools and processes offered through Cyclone REGISTER 360.

Through these new offerings, data is available into multiple industry, vertical software solutions with a simple open operation – no imports and no exports. Powered by Leica JetStream, the simplified point cloud access and ultra-high-speed rendering platform, 3D data can be imported from any major sensor into any major software.

“One hallmark of our offering is in providing a multi-sensor, multi-vendor connected ecosystem,” said Khan. “All of our software products share a common technology, so an expensive and time consuming data export operation is not required.”

The new Cyclone REGISTER 360 and TruView Cloud Services take out the scariness of point cloud registration and processing. Whether a plant manager needs a better understanding of the shelf life of his pipes, a crime scene forensics investigator needs to accurately analyse the evidence and share the data, or an architect needs to quickly and simply capture a façade, these new offerings simplify the process for smarter laser scanning.

HEXAGON GEOSYSTEMS FEATURE CUSTOMERS

AROUND THE WORLD. EVERY DAY. ANY APPLICATION.

Whether it is teaching students to use GNSS technology in Northern Ireland or scanning piers in the USA with the Leica Pegasus:Two, our users are working diligently to further not only the industry but global society.

At Hexagon Geosystems, we are honoured to be a part of this, supporting them with precise and accurate instruments, sophisticated software, and trusted services. We deliver value every day to those shaping the future of our world, and we thank them for all that they do continuously, tirelessly, decisively. Here, we feature a few of our users in the field doing what they do best - shaping smart change for a better world.

Share with us how you are solving complex daily challenges using Geosystems solutions. Send us your photos at reporter@leica-geosystems.com to be featured in our Reporter magazine.



Tunnel scan for historic sites in Phu Yen, Vietnam

Tunnel scan for historic sites project in Phu Yen, Vietnam using Leica MS50 MultiStation by Hieu



Staking out a photovoltaic park in Lyon, France

Staking out a photovoltaic park in Lyon, France using Leica TCRP1205 and RH1200 by Rui Peixoto



Soil sampling in Northern Ireland

Northern Irish Geography students taking soil sampling surveys using Leica GS15 and CS15 by Conor Graham



Piers scanning in Astoria, Oregon

Oregon Department of Transportation using the Leica Pegasus:Two mounted to a boat to scan the piers in Astoria, Oregon by Lloyd Bledsoe



Topographical survey, India

Project Pet, topographical survey from Hassan to Mangalore, India with Leica TPS by Indra Bist II



Survey in University of Guadalajara, Mexico

Survey in University of Guadalajara, Mexico with Leica TS02 by Cristobal Romero

THE BLK360 IMAGING LASER SCANNER IN YOUR WORDS



Leica Geosystems in collaboration with Autodesk have come together to shape the future of reality capture. Shaping reality capture represents combining the state-of-the-art technology with a first-class design to democratise 3D laser scanning for everyone in the architecture, engineering and construction market. The Leica BLK360, together with Autodesk's ReCap 360 Pro, allows everyone to incorporate high resolution 360° imagery and 3D laser scan data in their daily work.

Since its announcement, the BLK360 has received the 2017 Geospatial World Innovation Award, the 2017 PRISM Award for Photonics Innovation, the CES Innovation Award and the IF Award for its groundbreaking technology.

This revolutionary miniaturised 3D imaging laser scanner has also received the ovation from people around the world in social media. "Game changer", "disruptive", "speechless", "tiny" and "simplified workflow" were some of the words used to describe the BLK360.



James Draycott

A scanner that can fit in the palm of my hand. When can I have one @bwbTandl? #leica #blk360



Phil Shuttleworth

Calling Surveying + Laser scanning geeks, check this tiny new gadget out #blk360 #thefuture #leicageosystems #autodesk



Charlie Cropp

Geosystems & Autodesk: Shaping the Future of Reality capture youtu.be/MLUQen5A4dY #precise #powerful #tiny #blk360 well done team #Leica



Mark Concannon

I'm hearing Genius, Speechless, Worth Waiting for... The new @LeicaGeosystems #BLK360 simple #realitycapture is here



Will

Something that's truly disruptive? Watching the #blk360 launch online. Congrats @autodesk @LeicaGeosystems



Daniel Gadowski

Leica BLK360 laser scanner... so small!!!! #BLK360

For more information visit: <http://blk360.autodesk.com/>



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