REPORTER

September 2019, English Version

BEYOND REALITY. DIGITAL REALITY'S NEXT FRONTIER

How digital realities are transforming the way we interact with data and how we experience and understand the world around us

Featured stories:

- Supporting artificial intelligence solution to parking problem
- Leveraging visual documentation to avoid rework
- Driving productivity with smart drilling at Hinkley Point C
- Revolutionising Smart Factories with reality capture

HEXAGON
GEOSYSTEMS

CONTENT

The front cover of this issue of *Reporter* shows the layout of the most important heritage site of the Maldives – the Malé Hukuru Miskiy. Read how Water Solutions Pvt Ltd. captured and documented this heritage complex in 3D. p. 70.

President's Message

Limitless. Infinite. Unleashed.

I've used these words and those like them to describe many times before the possibilities of digital realities – the convergence of physical and digital. While these words remain accurate in their descriptions, we are now reaching a point where we're moving beyond reality. We are at the beginning of an exploration into how reality capture fits within entire business ecosystems – making them more connected and increasingly autonomous.

At the dawn of this new era, the world is becoming digitised, making it machine readable and subject to the power of algorithms. For this edition of *Reporter*, we take a distinct look at how these digital realities are transforming the way we interact with data and how we experience and understand the world around us. We expect to see countless more companies and ideas released into these ecosystems, making the once impossible possible.

Bridge surveys have historically been conducted by closing roadways and taking costly hours to stake the points needed. When Amey Roads NI was contracted to capture 140 bridges in Northern Ireland as part of the infrastructure project Building a Better Future, the special purpose project company knew it needed to find a safer and more cost and time effective solution. It found it with the laser scanning technology of the Leica BLK360. The detailed scans were passed immediately to designers, enabling them to make instant decisions on remedial work needed, connecting field and office personnel and cutting out several hours in the workflow. Also, without the need to close roadways to make the scans, more than half a million euros was saved.

Finding parking in a large city – the struggle is real. Recognising this problem, the machine-learning startup TerraLoupe came up with the idea to connect artificial intelligence with orthorectified aerial imagery to create an accurate inventory of available parking spaces throughout Germany. Turning to the HxGN Content Program for 15-centimetre-resolution orthoimagery of Berlin, the company was able to successfully test its internally-developed object-identification algorithms. Parking maps of locations, entrances and exits of parking lots, and the number of cars of different categories that can fit into each space have now been made for the entire country.

To make the planet digital, we can't just rely on the traditional experts. This evolution requires an all-hands-on-deck approach. At HxGN LIVE, we launched two new members of the popular Leica BLK family. Further democratising technology, the Leica BLK2GO handheld imaging laser scanner enables simple reality capture in the palm of your hand. The Leica BLK247, an autonomous surveillance solution, provides continuous 3D reality capture of busy public spaces. Digitising the world around us, making it machine readable with fused sensor technology, we truly are entering an era of limitless, infinite, unleashed possibilities.

We are on a journey to expand capabilities past expectations, tackling the most daunting challenges of today and tomorrow. As I always say, though, there are opportunities in challenges. Seeking these chances, we are transcending the next innovation, the next technology. Together, we can move further than ever thought possible before – beyond reality.

Enjoy your read.

Juergen Dold
President, Hexagon's Geosystems division

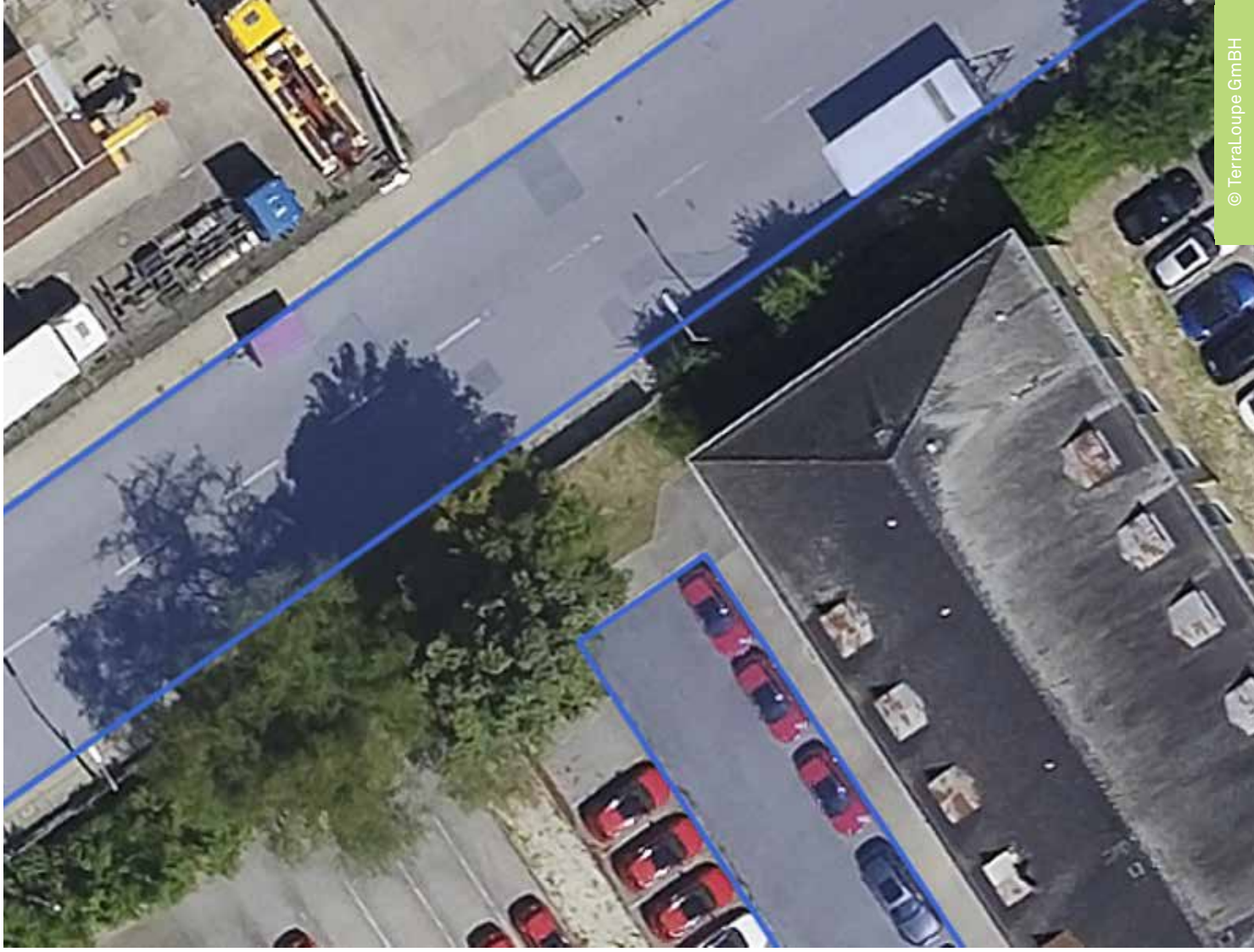
SUPPORTING ARTIFICIAL INTELLIGENCE SOLUTION TO PARKING PROBLEM

Linda Duffy

Geospatial Content

Case Study

Combining artificial intelligence and orthorectified aerial imagery to create parking lots in Germany



With a finite number of parking spaces and an increasing number of cars, frustration and inconvenience related to parking is growing. Recognising this as a problem, Manuela Rasthofer, CEO of TerraLoupe GmbH, launched a project to combine artificial intelligence and orthorectified aerial imagery to create an accurate inventory of available parking lots and spaces throughout Germany.

MAPPING AVAILABLE PARKING

Parking a car can be a stressful and time-consuming activity, and in the future, autonomously navigated vehicles will be searching for spaces without a driver to help. The need for high-definition digital maps that accurately measure and identify all types of objects, including parking spaces, is quickly becoming a reality.

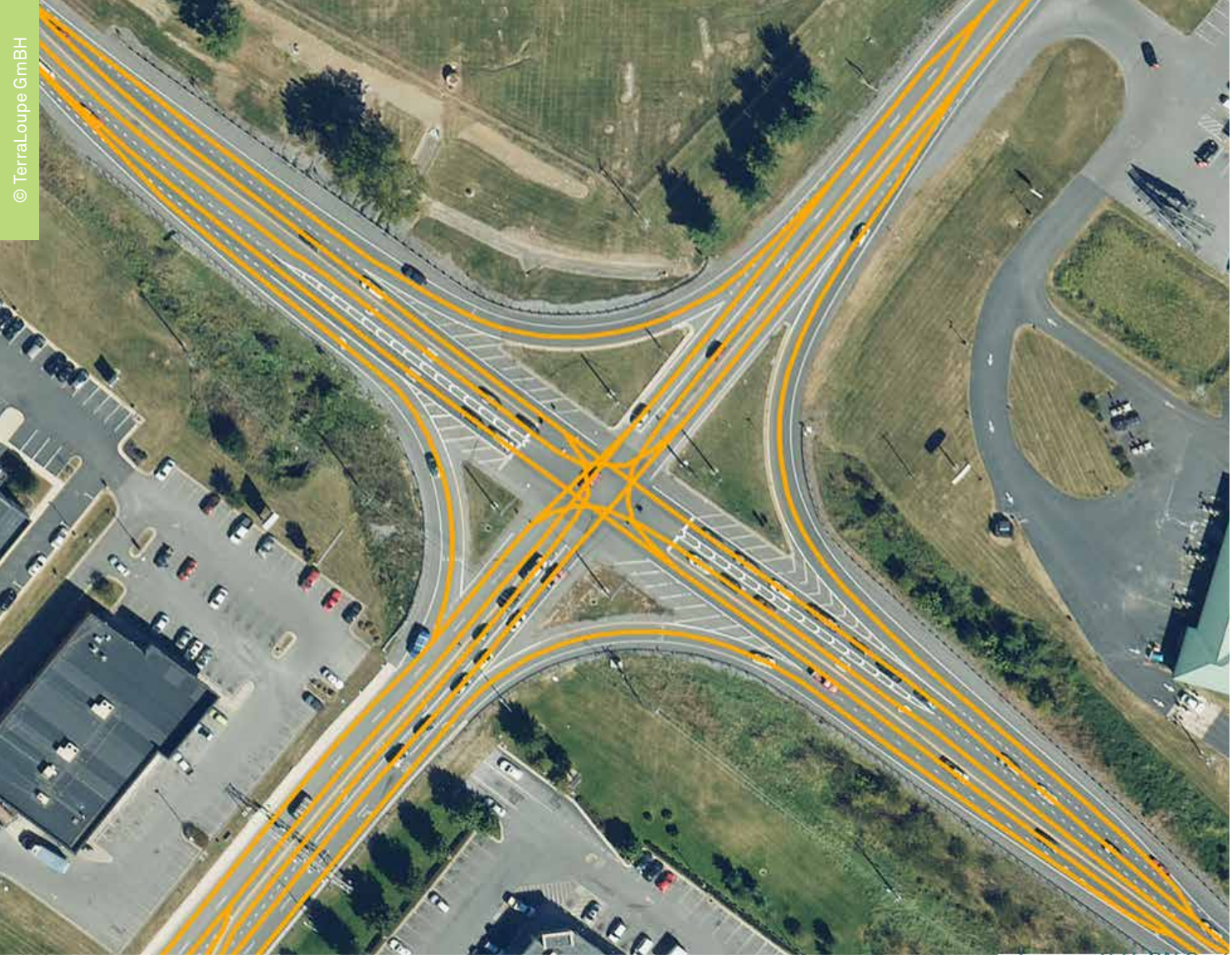
TerraLoupe GmbH is a technology startup based in Munich, Germany, that focuses on combining geodata and computer analytics in innovative ways. Starting with high-resolution orthoimagery, TerraLoupe applies machine learning algorithms to detect and measure objects in the physical world, such as buildings, roads, and trees, to create data-rich 3D models.

"To address the growing parking problem, we wanted to see if it was feasible to detect and assess parking lots using aerial imagery and artificial intelligence," says Rasthofer. "By automating the extraction of features and digital content, we thought we could greatly reduce the time it took to create maps, without sacrificing the accuracy."

A cost-effective method of creating digital maps is particularly interesting to Tier One automotive suppliers and original equipment manufacturers (OEMs) to support the autonomous navigation industry; however, many other industries can make use of the information as well.

HXGN CONTENT PROGRAM DELIVERS

In 2014, the HxGN Content Program began collecting speculative off-the-shelf orthorectified imagery of the US, parts of Europe, and populated areas of Canada to create a database available to customers. The goal was to acquire cloud-free 30-centimetre resolution, 4-band imagery over less populated areas, and 15-cm resolution over



metro areas with a population greater than 50,000.

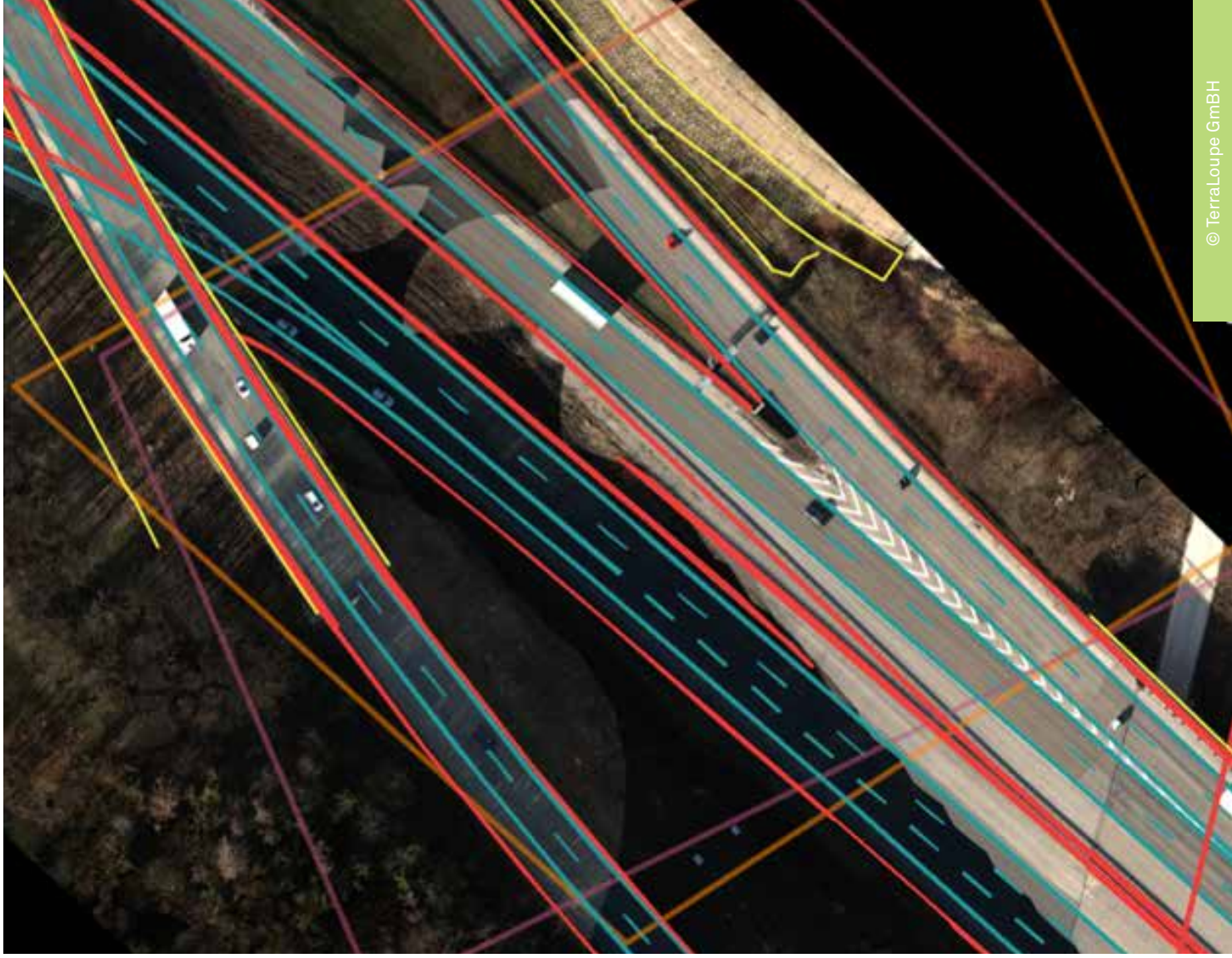
Through the HxGN Content Program, TerraLoupe obtained 15-cm resolution orthoimagery of Berlin to test its internally developed object-identification algorithms. The initial work on Berlin took eight weeks to train the algorithms to accurately identify and categorise parking spaces, followed by just three days to analyse and produce maps for all of Germany.

“Access to imagery through the HxGN Content Program allows us to download the geographic locations we need, and then train our algorithms on the new data,” explained Rasthofer. “There are always slight differences in architecture, infrastructure, and road systems that are unique to each country. We check the confidence interval for each object and recheck low percentages. As we correct errors, the algorithms continue to learn and improve until we achieve a very high accuracy level.”

The aerial orthoimages available through the HxGN Content Program go through a rigorous QA/QC process to ensure delivery of survey-grade images. “The HxGN Content Program best suits the needs of our customers in the areas of autonomous driving, parking assistance, and loss reports for insurance/reinsurance companies,” says Rasthofer. “We also successfully deliver intelligence related to infrastructure, utilities, railways, and others for a variety of purposes.”

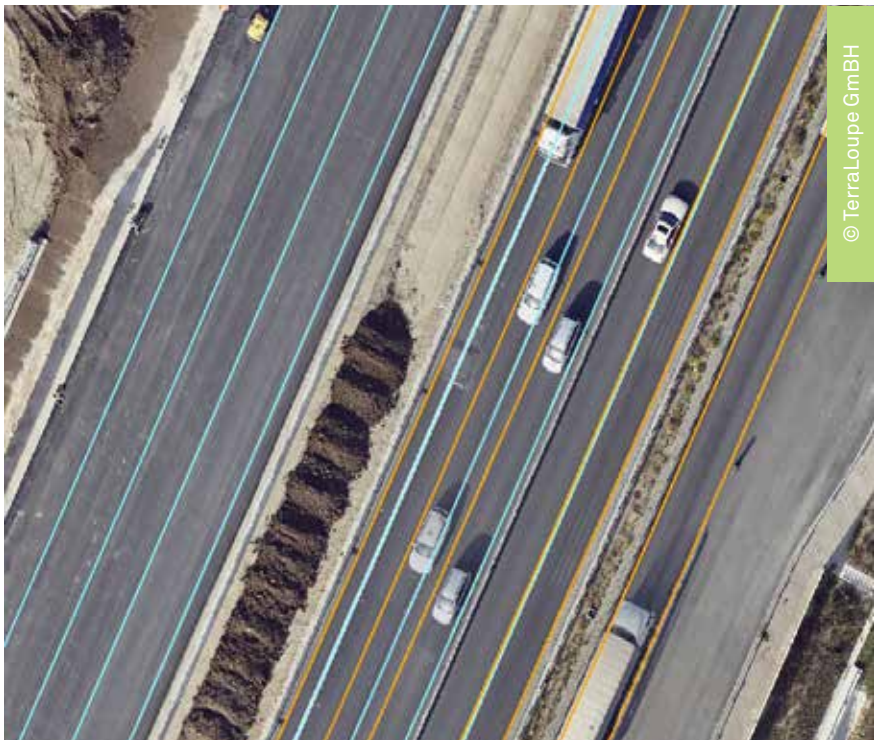
MACHINE LEARNING EXPEDITES ACCURATE MAPPING

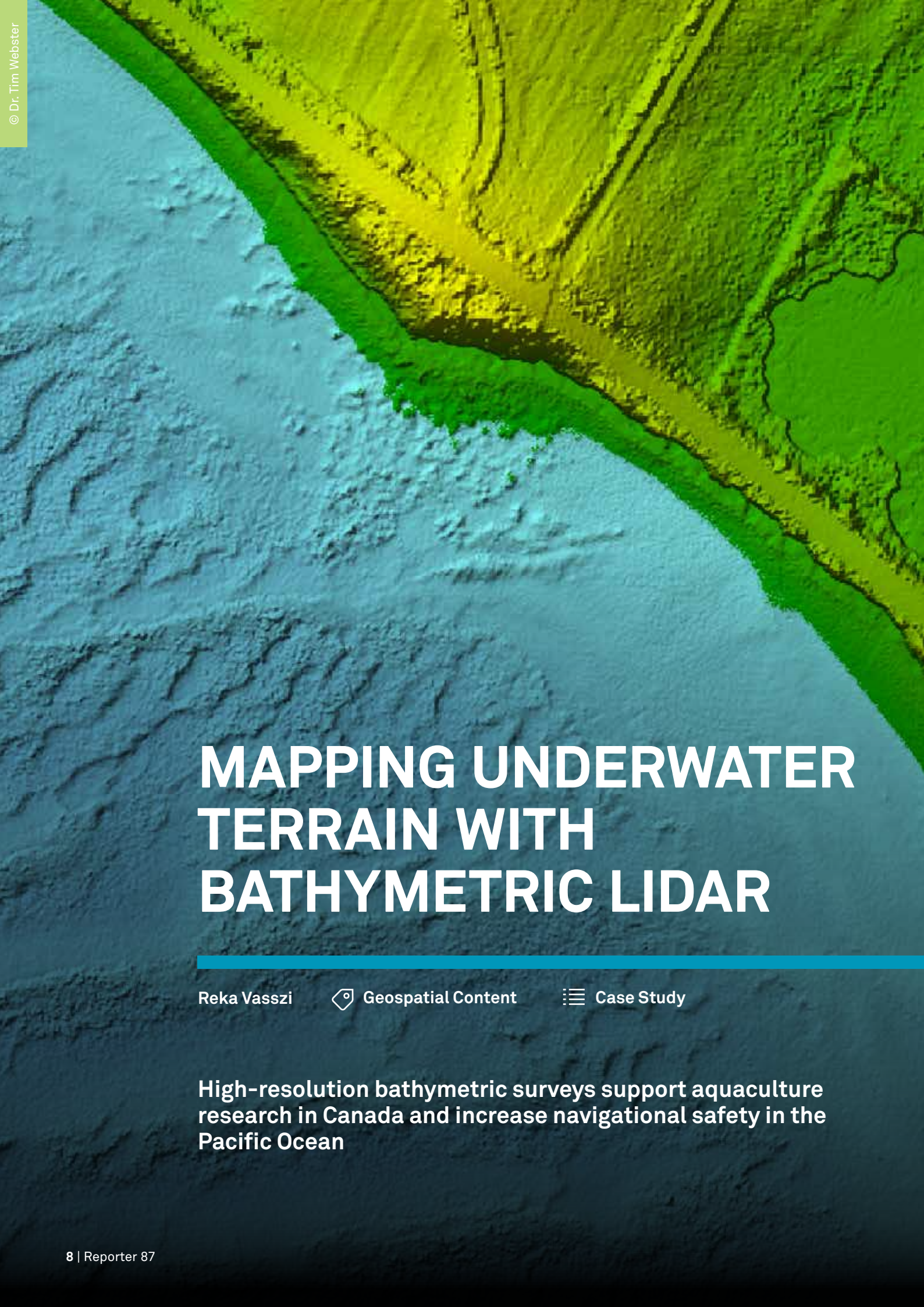
TerraLoupe’s project shows that high-resolution aerial orthoimages combined with machine learning can effectively be used to extract digital content. The parking analysis provides useful information, such as the locations, entrances and exits of parking lots and the number of cars of different categories (compact, medium-sized, large) that can fit in each lot. Urban planners, companies, taxi drivers, and patrons in congested retail areas could all benefit from this improved parking intelligence.



“The availability of high-resolution, high-accuracy imagery determined where we started the project; however, we intend to perform this analysis on all of Europe as data becomes available through Hexagon, and we’d like to expand our services into the U.S.,” says Rasthofer. “Overall our goal is to efficiently extract all types of objects and create a complete digital environment.”

Obtaining aerial imagery is faster and more efficient than terrestrial methods, allowing more frequent updates, which is crucial for many applications. Hexagon’s global operations generate widespread availability of imagery and good business partnerships with data providers to continue to meet the growing demand for digital maps.





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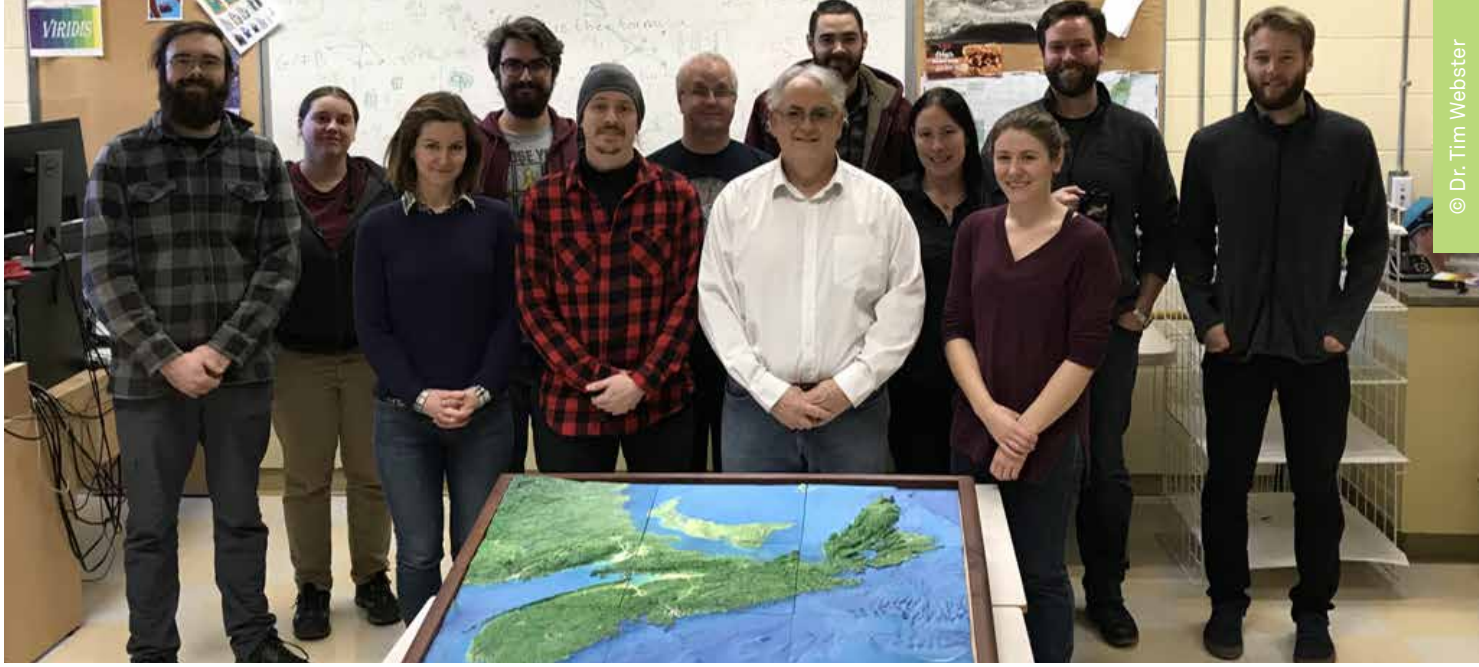
MAPPING UNDERWATER TERRAIN WITH BATHYMETRIC LIDAR

Reka Vasszi

Geospatial Content

Case Study

High-resolution bathymetric surveys support aquaculture research in Canada and increase navigational safety in the Pacific Ocean



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Measuring water depth for nautical purposes dates back to ancient civilisations. As technology has evolved through centuries, besides ship-based echosounding, remote monitoring and mapping of water bodies became more available via LiDAR bathymetric surveys conducted by airborne systems.

Bathymetric surveys allow professionals to measure water depth, map the underwater terrain, classify submerged vegetation and habitat as well as study marine ecology, water quality, contaminant spills and hydrodynamics.

With the 4X bathymetric product line, Leica Geosystems introduced an innovative high-resolution technology for shallow water and coastal mapping and increased point density by a factor of four compared to previous airborne systems versions. The Leica Chiroptera 4X, bathymetric and topographic LiDAR system, captures 140,000 points per second and covers shallow water regions down to a 25 metre depth. This efficient coastal survey LiDAR sensor, designed to offer more accurate data for environmental monitoring, research and surveying even in turbid water demonstrated its efficiency mapping Cape John peninsula in Canada and the Tonga islands in the Pacific.

IMPROVING SHALLOW WATER DETECTION

Dr. Tim Webster, research scientist at the Applied Geomatics Research Group (AGRG) from Nova Scotia Community College, was among the first to use the new Chiroptera 4X to survey the coastal zone of Cape John peninsula in Canada.

Mapping shallow water and coastal areas using traditional aerial photography or boat-based echo sounder methods can be costly, time consuming and challenging due to water clarity and unforeseen weather conditions. To overcome these challenges and increase productivity and data accuracy, Webster decided to use the Chiroptera 4X bathymetric and topographic LiDAR in his geomatics research.

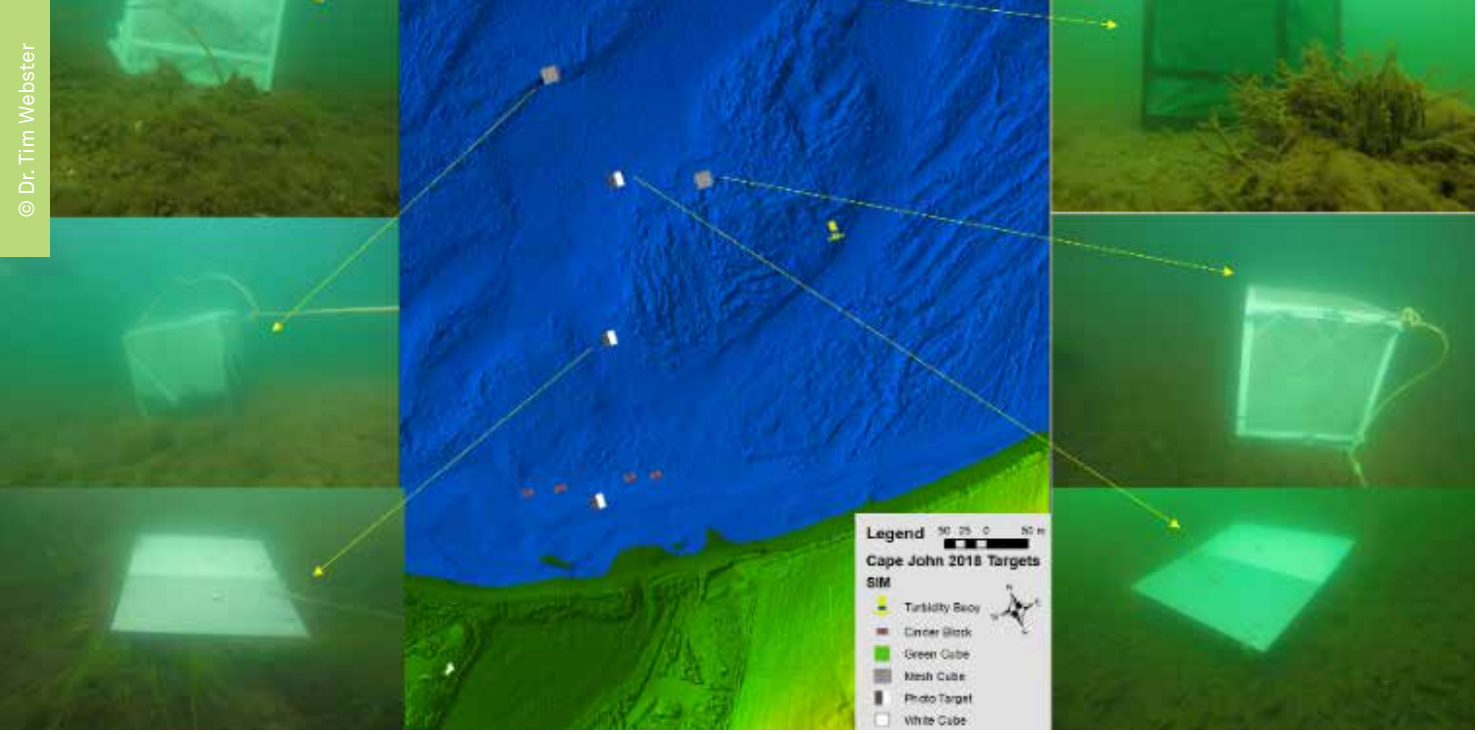
The purpose of the geomatics research was twofold. First, the team mapped the benthic habitat and the existing aquaculture in the bay, including the mapping of the shellfish infrastructure and the buoys to estimate how much biomass is being grown.

The second goal of the research was to develop a hydrodynamic model to help the lease of new oyster farms and propose the appropriate locations around the bay without damaging the sensitive Zostera marina or so-called eelgrass. The eelgrass beds are important for sediment deposition and nursery grounds for many species of fish and shellfish, thus it is used as an ecosystem health indicator by Fisheries and Oceans Canada (DFO).

Webster has carried out similar research in the region of Maritime Canada in 2014 on how to optimise data collection and post-processing of shallow water topographic-bathymetric LiDAR survey using the Leica Chiroptera II. This time, the professor and his team had the chance to deploy the new Chiroptera 4X and compare the captured data with results from 2014. To quantify the improvement of the point cloud density and target identification of the new Chiroptera 4X, the team compared the captured data of three surveying instruments:

- Chiroptera II
- Chiroptera 4X
- Multibeam echo sounder.

This geomatics experiment involved the target



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surveying of four 1 cubic metre cubes at different water depths to determine the level of detail and data provided by the three different sensors.

Flying the Chiroptera 4X over the bay, the research team collected information on the surveying targets and compared the captured data of the terrain and seabed from 2014 with the data from this experiment carried out in 2018. Using the four cubes and other flat targets captured with the three different survey methods, researchers compared:

- Point cloud density
- Orthophoto mosaics
- Digital Elevation Model
- LiDAR amplitude.

The analysis of the captured data was completed using the discrete points derived from the waveform data in Leica LiDAR Survey Studio post-processing software for point cloud generation and cleaning of raw LiDAR data.

"This particular experiment was to quantify the accuracy and level of detail of the Chiroptera 4X and we are very pleased with the results," reported Webster. "The results show a significant increase in point density comparing to other equipment, improved target detail, detection limits, and potential for more direct benthic point classification."

Taking advantage of the Chiroptera 4X's near-infrared laser for topographic data collection combined with a green laser for bathymetric data collection, the research team precisely captured underwater features and generated virtual reality elevation models to study the benthic habitat. Additionally, researchers proposed sustainable locations for oyster farming without damaging the eelgrass habitat.

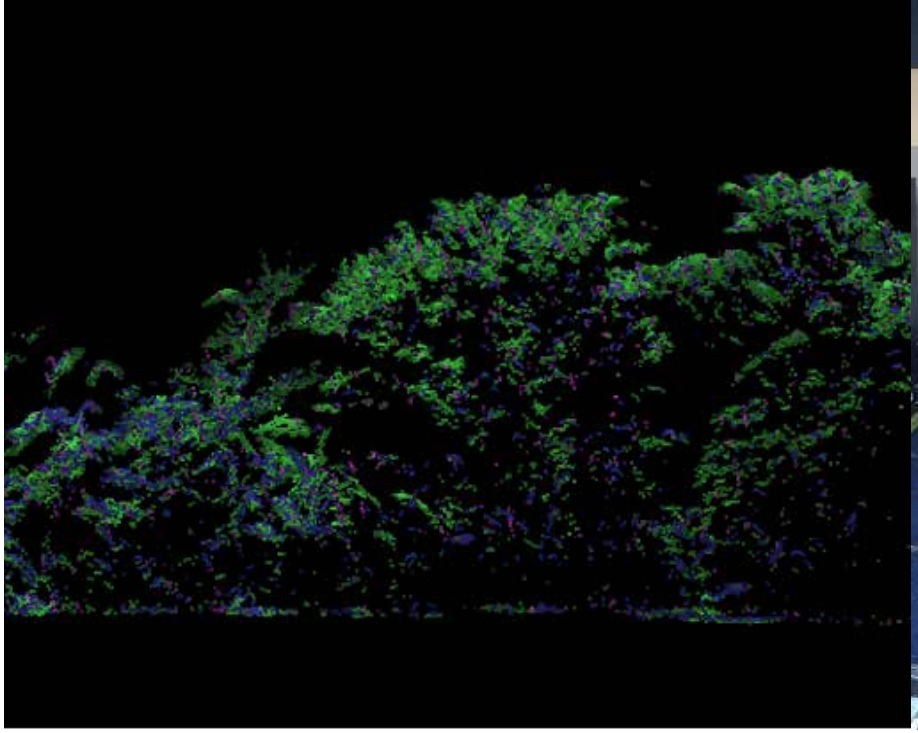
"This advancement of Chiroptera 4X is a significant breakthrough in terms of point density and it improved the resolution of our coastal zone mapping," said Webster. "In any application where target detection is important, I would see the increased benefits of the Chiroptera 4X in industries like hydrography and archaeology."

SAFE AND RELIABLE PASSAGE THROUGH PACIFIC WATERS

The Pacific is an extremely culturally diverse region, as exemplified by the more than 1,000 languages spoken and, yet, what connects them is the water. The ocean and coastal seas have long been integral to the Pacific way of life. The economy, transportation and culture of those sharing the Pacific waters is based on the naval and marine infrastructure and ecosystem this ocean provides. Even though marine navigation plays a key role in the archipelago, the South Pacific is inadequately charted.

Shallow water depth range data is critical for safe marine navigation and for construction of harbours, pipelines and any other infrastructure in the coastal area or shallow offshore zones. Without precise information on water depth and the exact location of underwater features and submarine canyons, economic and sustainable development is negatively impacted.

iXBlue together with project partners Geomatics Data Solutions (now Woolpert, Inc.) and EOMAP Australia were requested to map the Tongan archipelago and surrounding areas to provide the 3D water depth information and improve the



© Carol Lockhart

nautical chart of the region.

The project was part of the Pacific Regional Navigation Initiative (PRNI), an overarching programme geared towards the safe and reliable passage through the Pacific Ocean while protecting the environment and allowing Pacific island economies to develop. The project was sponsored by the New Zealand Ministry of Foreign Affairs and Trade (MFAT) in partnership with the Land Information New Zealand (LINZ).

The Kingdom of Tonga, a Polynesian archipelago comprising 169 islands, stretches across approximately 800 kilometres in the South Pacific Ocean. In Tonga, agriculture, fishing and forestry provide the majority of employment, therefore, detailed data on both land and shallow-water features can support the sustainable development of the island group.

Considering the relatively large area in need of high-resolution survey and charting, LINZ required a smart solution to bring the most out of the tight budget. iXBlue, together with EOMAP Australia and Geomatics Data Solutions, applied a multi-sensor approach to collect topographic and bathymetric data, including:

- Satellite-Derived Bathymetry (SDB)
- Airborne Laser Bathymetry (ALB)
- Multibeam Echosounder (MBES)
- Tide gauge install and datum computations.

SDB surveys are very effective tools in mapping large areas to the visible water depth, however, to capture high-resolution data on land and underwater the Chiroptera 4X ALB was used.

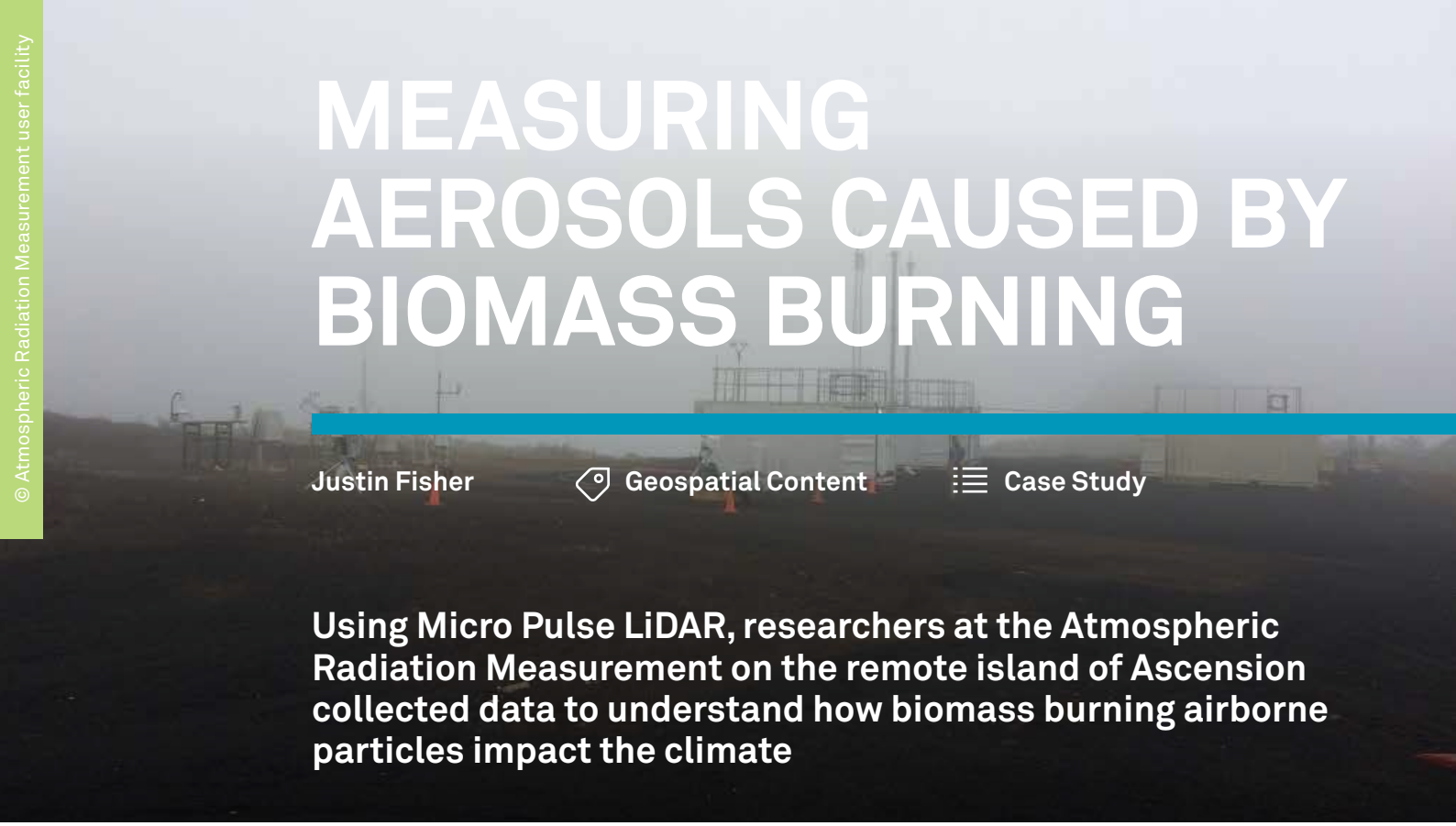
The Chiroptera 4X was installed in a Cessna 441 to acquire data for Tonga and Niue, including Beveridge Reef, covering approximately a 633-square-kilometre area. Geomatics Data Solutions experts collected both high-resolution bathymetric and topographic data on- and offshore and compared the results of the Chiroptera 4X to SDB.

“Having the extra density of the Chiroptera 4X, compared to the Chiroptera II, allows us to run spatial algorithms while reducing the risk that we are accidentally removing seabed objects from the dataset. In other words, it improves our target recognition probability,” said Carol Lockhart of Geomatics Data Solutions.

Beside the bathymetric data of the seafloor, one of the unexpected benefits Geomatics Data Solutions gained from using Chiroptera 4X was the improved penetration of the denser bathymetric laser data on land, providing full coverage even on dense vegetation where the topo laser did not penetrate.

“Local stakeholders will receive full imagery and the topo-bathy dataset, so they can also benefit from the high-resolution data provided with the new Chiroptera 4X, and can use the data for other purposes in addition to improving the nautical charts,” explained Lockhart.

The combined approach of different surveying equipment provided the complete knowledge of all navigational-significant features and additional topographic information of the islands. Thanks to the 4X technology of the newly-released Chiroptera, experts surveyed at four times the sounding density than it was previously possible.



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MEASURING AEROSOLS CAUSED BY BIOMASS BURNING

Justin Fisher | Geospatial Content | Case Study

Using Micro Pulse LiDAR, researchers at the Atmospheric Radiation Measurement on the remote island of Ascension collected data to understand how biomass burning airborne particles impact the climate

From June to October, the burning of agricultural fields in southern Africa creates smoke that blows west across the south-eastern Atlantic Ocean and reaches Brazil, more than 4,500 miles (7,242 kilometres) away. Using Micro Pulse LiDAR (MPL) and other instruments, researchers at the Atmospheric Radiation Measurement (ARM) user facility on the remote island of Ascension, operated by the U.S. Department of Energy, collected data for 16 months to help understand how these airborne particles impact the climate.

BETTER DATA NEEDED IN CLIMATE MODELS

Biomass burning (BB) produces aerosols that enter the atmosphere. A significant amount of this particulate matter consists of black carbon and other carbonaceous aerosols that absorb light, warming the atmosphere; however, if the underlying surface is a dark ocean, the particles reflect light, cooling the atmosphere. Scientists need accurate measurements of each type of aerosol in the layers of the atmosphere to study the movement and long-term consequences of the smoke.

Currently, the vertical extent of the BB aerosol layers transported far from the sources is poorly represented in global climate models. To help improve the models, ARM deployed one of its mobile atmospheric observatories for the Layered Atlantic Smoke Interactions with Clouds (LASIC) campaign from June 2016 to October 2017 on Ascension Island, about 1,000 mi. (1,609 km) off the west coast of Africa. From this unique location, researchers recorded measurements from numerous instruments to compile a comprehensive dataset representing two BB seasons.

MICRO PULSE LIDAR USED IN LASIC RESEARCH

ARM launched the LASIC campaign specifically to gather data on how smoke properties (i.e., ability to absorb shortwave radiation) change after long-range atmospheric transport, as well as the smoke's effect on clouds. While aerosol surface measurements were available from multiple instruments, to study the vertical structure and the monthly and seasonal variations of the BB aerosol layers transported to this remote island, it was important to include profiling instrumentation.

"One of the critical MPL capabilities for LASIC is its dual-polarisation capability, which allows discrimination of smoke, dust and sea salt aerosol layers above Ascension Island," said Paytsar Muradyan, Argonne National Laboratory researcher. "Also, the ARM mobile facilities are frequently deployed in remote locations around the world, and MPL is capable of providing unattended continuous observations of clouds and aerosols."

Raw MPL measurements consisting of profiles of backscattered signal from atmospheric

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particles were collected throughout the LASIC field campaign. The ARM Data Center (ADC) ingested hourly raw data along with the MPL corrections, and Climate and Forecast (CF) standardised NetCDF files were archived at the ADC to help validate results.

The analysis of the monthly variations of the retrieved extinction profiles provides a first look into the 'evolution' of the pre-BB and BB season aerosol vertical structure and elevated smoke layer depths over Ascension Island. High amounts of aerosols that can affect the Earth's energy balance and cloud properties are common in the marine boundary layer during the southern African burning season (June-October).

The MPL data shows the smoke layer is present mostly above boundary layer clouds between 1.5 to 3 km at the beginning of the burning season in July and extends up to 4 km in September. Occurrences of the BB smoke layers coincide with the peak black carbon concentrations (>1,000 nanogram/cubic metre) observed at the surface, suggesting that these aerosols are strongly absorbing, as back trajectories indicate that they originate from the same continental BB regions.

"The data collected during LASIC improve our current understanding of aerosol vertical distribution and their radiative impact," says Paquita Zuidema, principal investigator of the LASIC campaign. "This will ultimately lead to improved accuracy of long-term climate forecasts and help us develop sustainable solutions to energy and environmental challenges."

ELEVATING ATMOSPHERIC MONITORING

MPL instruments help scientists, meteorologists and air quality professionals monitor aerosols to better understand the structure of our atmosphere. MPL's long-range capabilities and high-quality signal increase the efficiency and accuracy of the data capture process for improved atmospheric monitoring. Originally designed by Sigma Space for NASA, now part of Hexagon, MPL uses eye-safe lasers, precision photon counting, and built-in data analysis to deliver the best signal-to-noise ratio, providing the most reliable information in this category.

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BUILDING A BETTER FUTURE WITH MEASURING TECHNOLOGY

Renata Barradas Gutiérrez Building Case Study

Opening opportunities through vocational training, delivering drinking water and building better schools in Tanzania using Leica Geosystems' construction tools

© Rural Development Organisation (RDO)

Houses, buildings, schools, bridges, roads and any infrastructure you can think of stand not only in the material and structure that support them but in the work and know-how of the people who built them. Qualified and skilled labour has never been more vital for not only the construction industry but for the economic well-being of societies and countries. Craft trade schools, vocational schools and trainee programs can provide the valuable hands-on and work experience needed for construction projects and building construction companies.

The Rural Development Organisation (RDO), founded in 2012 and established in Tanzania, is aware of the life-changing potential of learning a new trade. RDO, in partnership with Eine Welt Gruppe Schlins - Röns, works to improve the long-term living conditions of the people in the regions of Mdabulo and Kilolo, in the highlands of Tanzania, through diverse programs based on the principles of sustainability and knowledge transfer. RDO is opening opportunities to young men and women through vocational training and building projects – undertakings where Leica Geosystems equipment has proved quite useful.

THE TRANSFORMATIVE POWER OF LASERS AND LEVELS

For young people in the region, mainly living from subsistence farming, RDO training centre is a hub of opportunities to expand their prospects by receiving training on diverse craft trades and sustainable agricultural practices. RDO's beneficiaries usually come from an agricultural holding and completed compulsory schooling but couldn't continue their studies. The training provided by RDO in specialised areas includes practical and theoretical courses and is completed by a state examination.

"Craft trades have no tradition here, which is why craft training places are rare, and the infrastructure for such training is generally very poorly developed. In addition, there are only a small number of secondary schools, which are only affordable for a fraction of the population," explained Johannes Rauch, project manager at Eine Welt Gruppe Schlins - Röns.

To support the mission of RDO, Leica Geosystems donated a Leica NA730 automatic level, a Leica Rugby 800 Series rotating laser and a distance metre to the organisation.


© Rural Development Organisation (RDO)

Since then, the equipment has been key to support RDO projects.

“We use Leica Geosystems equipment very frequently and very often. This has made our work much easier. In the training for building craftsmen, these devices increase the value and the modernity of the training very much,” stated Rauch.

At RDO’s course centre in Mdabulo and through hands-on community projects, students learn the basics of construction and acquire skills using the automatic level, rotating laser and distance metre. Students learn to use the Rugby Series laser for different applications including, land levelling, grade checking, tie in slopes, vertically align formwork, and set out walls. Likewise, using the NA730 automatic level, learners understand how to measure distances, set as-sign datum lines, define height differences and read heights.

“The training takes place through regular lessons at the building craftsmen's school. The use of laser and level equipment is now firmly anchored in the curriculum. Every year, about 40 students are trained in the use of lasers, levels and distance metres,” said Rauch.

DELIVERING DRINKING WATER, BUILDING BETTER SCHOOLS

Leica Geosystems equipment is also used in the construction of the region’s infrastructure, including schools, buildings and water supply works. As of today, three water supply concrete tanks have been erected and four school buildings at two school locations are currently being built.

“Leica Geosystems equipment is particularly useful in the construction of our project buildings, such as school buildings, student hostels, craft workshops, administration buildings, agricultural stables, teaching kitchens, teacher's accommodation, water tank construction, pump houses and field surveying for water pipes,” said Rauch.

A key programme of RDO is the construction and management of drinking water facilities in the villages. Geared with Leica Geosystems equipment, RDO and Vorarlberg experts together with the villagers, dug water pipes from

the spring catchments into the villages, wells and founded water cooperatives.

Planning, digging and building a water supply infrastructure in a hilly terrain with deep valleys and heights is not an easy task. To do it right, the NA730 automatic level is used over long distances of up to 3.5 to 4 kilometres to measure foundations and precisely plan pipe-laying terraces in connection with gravity pipelines.

“Previously, the foundations were done with a slat and spirit level or with a cord spirit level. Deviations up to 15 centimetres at distances up to 15 metres were the rule,” said Rauch. “The use of the levelling device greatly simplified planning and made it safer. Also, we have succeeded in significantly improving the accuracy.”

EMPOWERING PEOPLE WITH LASERS AND LEVELS

Empowering people and ideas to do their greatest good – this is the ultimate purpose behind Hexagon’s technology solutions. In this sense, RDO is leveraging construction tools in Tanzanian communities to deliver access to clean water, provide the structures so children attend school, and prepare a generation of young individuals with a trade and skills to face current and future challenges. Access to measuring and positioning technology has the transformative power not only to build the world around us but provides skilled labour the means to earn a livelihood.

© Rural Development Organisation (RDO)

BUILDING A ‘LIVING CLASSROOM’ IN EASTERN NEPAL

Cornelia Dietz

Building

Case Study

Building an 8000-metre ‘Vertical University’ in the eastern region of Nepal with laser distance metres

KTK-Belt, Inc., is a non-profit organisation whose mission is to catalyse new models of biodiversity conservation and environmental learning in eastern Nepal. It works with teachers, farmers, youth and women to create a 'Vertical University'. The idea of this sustainable project is to create a 'living classroom' in the form of a 7,620-metre vertical forest corridor stretching from Koshi Tappu (67 m), Nepal's largest aquatic bird sanctuary, to Mt. Kanchenjunga (8,586 m), the world's third tallest peak.

The 'Vertical University' is a vessel to teach and conserve the 6,600 flowering plant species, 800 bird species and 180 mammals that are found in eastern Nepal. In a mountainous country like Nepal, where there is exceptional biological, climatic and cultural diversity from the tropical plains to the alpine Himalayas, conventional education paradigms where students sit in a stationary classroom, divorced from their surroundings, make little sense.

With a shared belief to foster a sustainable planet, Leica Geosystems supported this new biodiversity conservation and environmental learning project by donating a Leica DISTO™ D810 touch pro pack. This complete professional system for convenient aiming, precise measurements and documenting the results with pictures, includes a Leica DISTO™ D810 touch, the Leica FTA360 tripod adapter and the Leica TRI70 tripod packed in a rugged case.

CREATING FLEXIBLE MULTI-PURPOSE COMMUNITY SPACES

KTK-Belt fellows used the DISTO™ D810 touch during the construction of their first learning grounds, an outdoor learning and community space for children and villagers in Yangshila. Local labourers used DISTO™ in the construction, documentation and modification of the centre to host exhibits and other activities.

"During construction, we worked with local labour workers who have little or no formal schooling. The Leica DISTO™ tool allowed us to ensure the structures were according to the drawings that were submitted by the design and engineering team. The device was easy to understand and could be operated by our local workers. The built-in camera worked great outside also in these weather conditions," said Priyanka Bista, co-founder and co-director of KTK-Belt studio.

The structure built using DISTO™ has 45 square metres, roughly the size of a typical village home. The modern structure made of stacked recycled shipping containers, reclaimed wood from a dismantled local barn, and native bamboo, stone and mud has folding doors on both levels, opening the surrounding landscape to accelerate sustainable livelihood opportunities in the community. The top container is cooled from the shade of eight solar panels that provide the full energy requirements of the building. Climber vines, vertical gardens, and the green roof are used to show different ways to integrate vegetation and passively cool the building, providing ecosystem services.

"We are so happy to see that already some campus is built, and they could build up a flexible multi-purpose community space with the help of the Leica DISTO™," said Markus Hammerer, program director of Leica DISTO™ handheld products at Leica Geosystems.

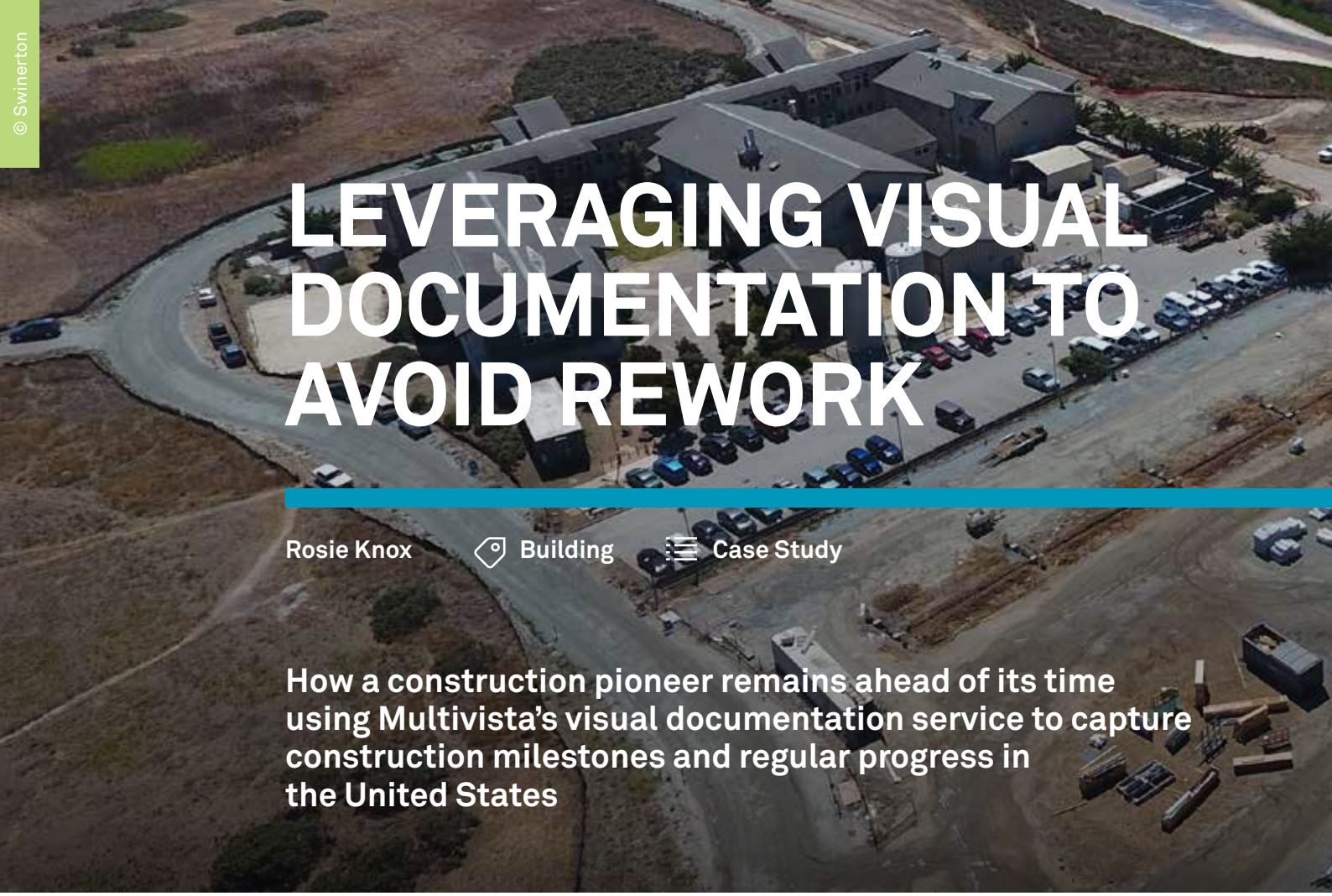
TEACHING TOOLS FOR BUILDERS

To recruit, train and build the capacity of youth fellows to lead in various areas of the project, KTK-Belt created the BELT fellows program. So far, the first five youth fellows have been trained in construction, design, hospitality, outdoor education, and conservation and GIS.

"Ever since I was a child, I've been interested in construction. Unlike my sisters, I was always attracted to building tools. I am also driving myself these days to learn how to use a measuring tape, scale, calculator and even a laser distance metre in order to draw proper architectural drawings. Seeing us in the construction site, women in the village have become encouraged to work for themselves as well," said Pabitra Magar, KTK-Belt construction fellow.

With intuitive features and functions, such as the 4x zoom point finder, BELT fellows measured distances with the DISTO™ D810 touch even if they could not see the red laser dot on the target because it was too far away or the sun was too bright. Fellows just orientated with the cross displays to aim at the right target.

Ensuring a scalable and sustainable future with technology that is used to do its greatest good – this is at the heart of Hexagon's approach. KTK-Belt is using technology to leverage the potential of biodiversity, indigenous knowledge, and people-plant interactions.



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LEVERAGING VISUAL DOCUMENTATION TO AVOID REWORK

Rosie Knox

Building

Case Study

How a construction pioneer remains ahead of its time using Multivista's visual documentation service to capture construction milestones and regular progress in the United States

When building a state-of-the-art environmental science campus on the seaside bluff of a national marine sanctuary in the United States, 1888-founded general contractor Swinerton leveraged Multivista's visual documentation service to capture construction milestones and regular progress throughout this complex state-funded build.

Swinerton's project manager, Jeff Stephenson, originally planned to leverage Multivista to meet the project's progress photography requirement but found significant additional benefits throughout the 24-month project.

AVOIDING REWORK AND DESTRUCTIVE VERIFICATION DELAYS

As the multi-use facility included both laboratories and offices for school personnel, in addition to progress photos, Multivista's MEP Exact-Built® service was procured to capture the critical in-wall systems in each room before coverup.

"Each lab and office in the building required wall-hung cabinets, so proper backing was crucial for the stability of the casework install," Stephenson explains. "During the casework install, the owner's representative was away on vacation and, upon their return, they wanted to make sure that a number of important rooms had the backing installed per plans."

Due to the vital nature of each laboratory, the owner needed visual confirmation that the backing was installed. Stephenson turned to the project's progress photos to provide the owner the assurances they needed.

"Instead of slowing the construction process down and tearing out freshly-painted drywall, I used Multivista's progress photos to show the time lapse of the rooms in question - from wall framing install to final paint," Stephenson continues. "The photos clearly showed the backing installed at the proper locations.

"I estimate approximately 15,000 USD [13,300 euros] in rework savings by avoiding the destructive verification that would have been needed to confirm the backing installation - not to mention mitigating the schedule impact of that rework."

Swinerton leveraged the visual records to avoid rework on the same project soon after.

"Our project was on the coastline of the Pacific Ocean, which exposed all building elements to a corrosive, salt-water atmosphere, and our inspector noted some rusting on some exposed

steel on the jobsite. We removed the noted rust, and the painter moved forward painting the steel," says Stephenson.

When the inspector returned to the project site and questioned the rust removal, Stephenson showed the inspector Multivista's date-stamped and location-indexed images captured the day after the rust was removed.

"As a result of the photos, we did not need to stop the painter's progress," Stephenson explains. "I estimate rework savings of approximately 12,000 USD by avoiding the need to strip and repaint the steel to prove the rust was removed."

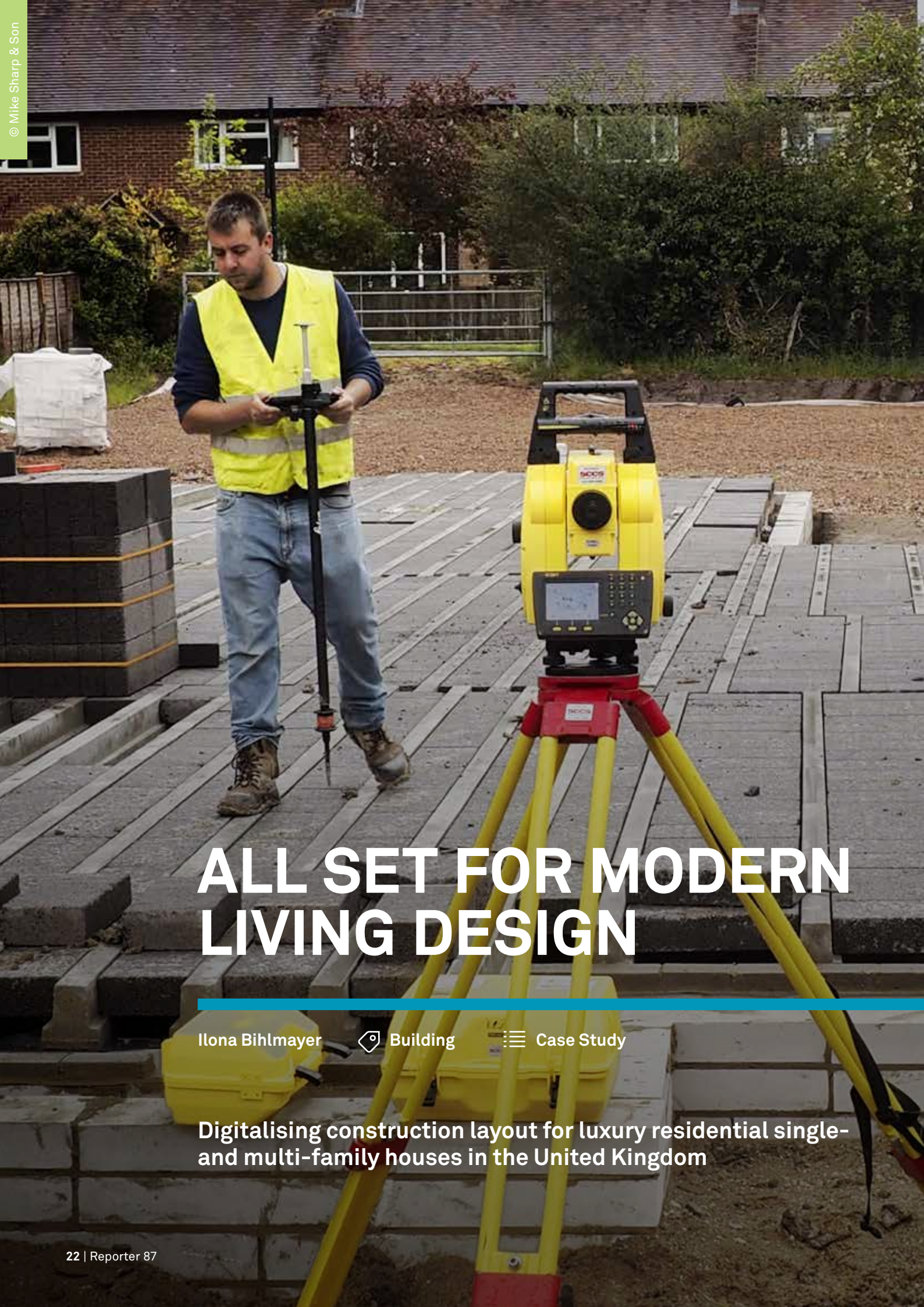
LASER FOCUS ON THE BUILD

With remote project stakeholders involved, providing regular project updates was critical. Multivista's team of construction documentation specialists captured approximately 12,000 progress and milestone images, which allowed Swinerton to share real-time construction progress without tying up critical resources.

"Having Multivista also saved our PEs at least a couple hours a week, taking pictures and uploading them throughout the duration of the project. I estimate a savings of about 10,000 USD in salary time over the life of the project," explains Stephenson.

"So just on these three items, our savings total almost 40,000 USD and that doesn't take into account the amount of time we saved being able to navigate the site virtually by pinpointing exact locations based on your project mapping."

© Swinerton



© Mike Sharp & Son

ALL SET FOR MODERN LIVING DESIGN

Ilona Bihlmayer

Building

Case Study

Digitalising construction layout for luxury residential single- and multi-family houses in the United Kingdom

Managing and planning living spaces is becoming more and more complex due to decreasing space for new buildings together with increasing customer demands on design and comfort. Across the residential building industry, including single- and multi-family housing construction, there is a growing importance for construction companies to be ready to deal with multiple building regulations regarding environmental protection and living space optimisation.

Especially in the luxury single-housing construction industry, these regulations have to be combined with special designs and smart ways of construction to fulfil the requirements of demanding customers. To satisfy the needs of today's residential building construction industry, a transition from time and labour-intense traditional analogue layout methods, such as tapes, stringlines, batter boards and chalklines to modern digital layout techniques is inevitable.

WITNESSING THE DEVELOPMENT IN BUILDING CONSTRUCTION

Mike Sharp & Son is a general contractor company for luxury residential single- and multi-family houses in the United Kingdom. Established in Wallingford and founded in 1980, the company looks back to close to 40 years of development in the building construction industry. Increasing government building regulations and design requests on the customer side require digital layout techniques to achieve the highest productivity and accuracy.

Mike Sharp, CEO at Mike Sharp & Son explains, "The demands of our customers have increased a lot in the last couple of years. The rising complexity in the designs of our houses made us think about alternatives in our layout techniques to fulfil customer's requirements." Sharp explains the layout accuracy for the inner walls is extremely important, "For a kitchen manufacturer, for example, a deviation of just a few millimetres between two walls means additional rework. Additional work, which causes time, money and, in the worst case, unsatisfied customers."

Matthew Sharp, working in the family company, is responsible for the layout measurements of all trades involved in the building projects – from defining reference points to start the actual design, laying out the outer and inner lines of the house, to defining the fall of sewer lines. Without a survey background, Matthew Sharp got trained on construction layout tasks on various construction sites. An easy-to-use but highly accurate construction layout solution, designed specifically for the building construction industry, helps him to do layout tasks efficiently.

DIGITISING CONSTRUCTION LAYOUT

Mike Sharp & Son purchased a Leica iCON robotic total station with Leica Geosystems' construction-tailored field iCON field software to do layout tasks automatically. Before the company did layout measurements conventionally by using tapes, stringlines and spirit levels. These procedures were time consuming and stretched the team's limits with the increasing complexity of designs.

"When we realised that we lose lots of time in the layout process, we started to look for modern alternatives that help us facilitate the whole layout process. One of the reasons why we choose the Leica iCON solution is the ease-of-use of both, instrument and software. The intuitive software interface makes it simple to operate, even for employees without a professional layout background," states Mike Sharp.

Since working with the iCON robotic total station, Mike Sharp & Son achieves much higher accuracy in its projects in a shorter time. The company has found especially helpful to look at the visualisation of the whole design file in .dxf format. This way employees can show every trade working at the construction site the entire project and everyone knows right on the spot the status of the project and where teams come into play. Mike Sharp explains, "Moving away from 2D design on paper plans to 3D design data directly and intuitively shown in the iCON field construction software ensures the latest design files are available without outdated or missing elements."

Another reason for Mike Sharp & Son to go with an iCON robotic total station from Leica Geosystems was the great consulting, support and outstanding training before, during and also after the purchasing process they received from SCCS Survey. SCCS Survey is a Leica Geosystems, part of Hexagon, authorised distributor and service partner in the U.K.

© Hinkley Point C

DRIVING PRODUCTIVITY WITH SMART DRILLING AT HINKLEY POINT C

Mike James

Heavy Construction

Case Study

Increasing productivity at Hinkley Point C construction site in the United Kingdom with machine control for geotechnical drilling

A belief in doing things better continues to drive innovation at Hinkley Point C (HPC), the first of a new generation of European Pressurised Reactor (EPR) nuclear power stations being constructed in the United Kingdom. This vision isn't simply a throw-away statement but echoes from every corner of one of the largest construction sites in Europe and is ingrained in the makeup of its people.

To obtain core samples and establish a safe foundation prior to construction of this mega project, geotechnical drilling was needed. Geared with Leica Geosystems solutions, HPC adopted cutting-edge geotechnical drilling – the first of its kind in the U.K. This methodological operation phase was led by Julian North, former senior geotechnical engineer at Kier BAM Joint Venture.

INTRODUCING MACHINE CONTROL TO GEOTECHNICAL DRILLING

Geotechnical drilling is performed before construction begins to prepare and analyse the site, determining soil stability and the geology of the site. Complex heavy construction works, like geotechnical drilling, can greatly benefit from machine control, which displays and positions tools according to reference, allowing operators to position the bucket or blade between the target grade.

Having overseen the geotechnical drilling operations at HPC, from the early groundworks investigation and instrumentation drilling through to the main ground installation, North understands the benefits of digitalising operations with machine control, "We looked at potential risks and how we can make traditional approaches of geotechnical drilling better for everyone – machine control fit this belief."

What North found was that positional control is vital to geotechnical drilling and having quick access to certain information in the field is crucial. "One big advantage is that we do not need to do a topographical survey. We can go in using an excavation model into an area where we may not have been able to excavate before," explained North. "Machine control saves vast amounts of engineering time and ensures far better optimisation of equipment."

North also highlighted the importance of benefits beyond machine optimisation, "Health and safety have a huge payback. Capitalising on remote-control systems limits exposure to noise, dust and hazards of large equipment."

STITCH DRILLING TO INCREASE PRODUCTIVITY

Stitch drilling is the process of drilling a series of holes near one another (typically 200 to 250 millimetres), creating a line of weakness. Making it easier for an excavator to exploit any discontinuity and tear out the intact rock. This technique results in faster and cleaner excavation, minimising disturbance of the remaining rock mass.


© Hinkley Point C

Equipped with Leica iCON iRD3 solution in two drilling rigs, operators completed more than 40,000 linear metres of stitch drilling. North explained the benefits of this method, “As the rock naturally weakens, you can use smaller excavators, useful for deeper parts of the excavation where space for a larger plant is limited.”

As stitch drilling normally comprises the drilling of large numbers of shallow holes, any decrease in the time taken to set up the drill mast on individual holes had a significant implication in reducing the overall time taken to complete a specified area. The use of Leica Geosystems machine control enabled the setup of the drill mast at the correct orientation and position, bringing not only significant savings but also reducing labour and engineering resources.

North witnessed how well the machine operators adopted Leica Geosystems technology. “As soon as they used it for a couple of days, it was ‘I can’t go back. I can’t do this any other way’,” added North. “The machine operators found the screen ideal for them to set the drill mast up. The engineers also loved it because they didn’t have to be out in a muddy site all the time, we could just drill in a line and didn’t have to worry about losing the finite positions.”

DIGGING DEEPER: EXCAVATION

The use of machine control allowed operators to do fewer drilling rigs more efficiently with less downtime without waiting for positions to be excavated or marked out. This efficiency released the drilling rigs to complete other drilling activities faster and with less supervision.

The complex components of deep excavation were made up of more than 100 different construction platforms, numerous galleries, shafts and sumps. Vertical rock faces ranged in height from less than 1 m to 38 m, so boundaries had to be designed to allow for the difference in elevation.

“All faces are treated with site-produced steel fibre reinforced sprayed concrete within 48 hours of excavation to provide protection from weathering,” explained North. “Ground nails [metal bars] are then installed to provide global slope stability for surcharge loads that will be imposed by cranes.”

GEOTECHNICAL DRILLING AND BEYOND

At HPC, digital construction, encompassing 3D modelling of construction sites and visualising end-to-end construction project workflows is instrumental. “Every operation at Hinkley Point C is examined, to make it better in terms of safety, quality and productivity,” explained North.

For this construction stage, positioning the drilling rigs to drill mast at the correct orientation and position using machine control brought significant time and resource savings while reducing exposure to dust, noise and equipment hazards.

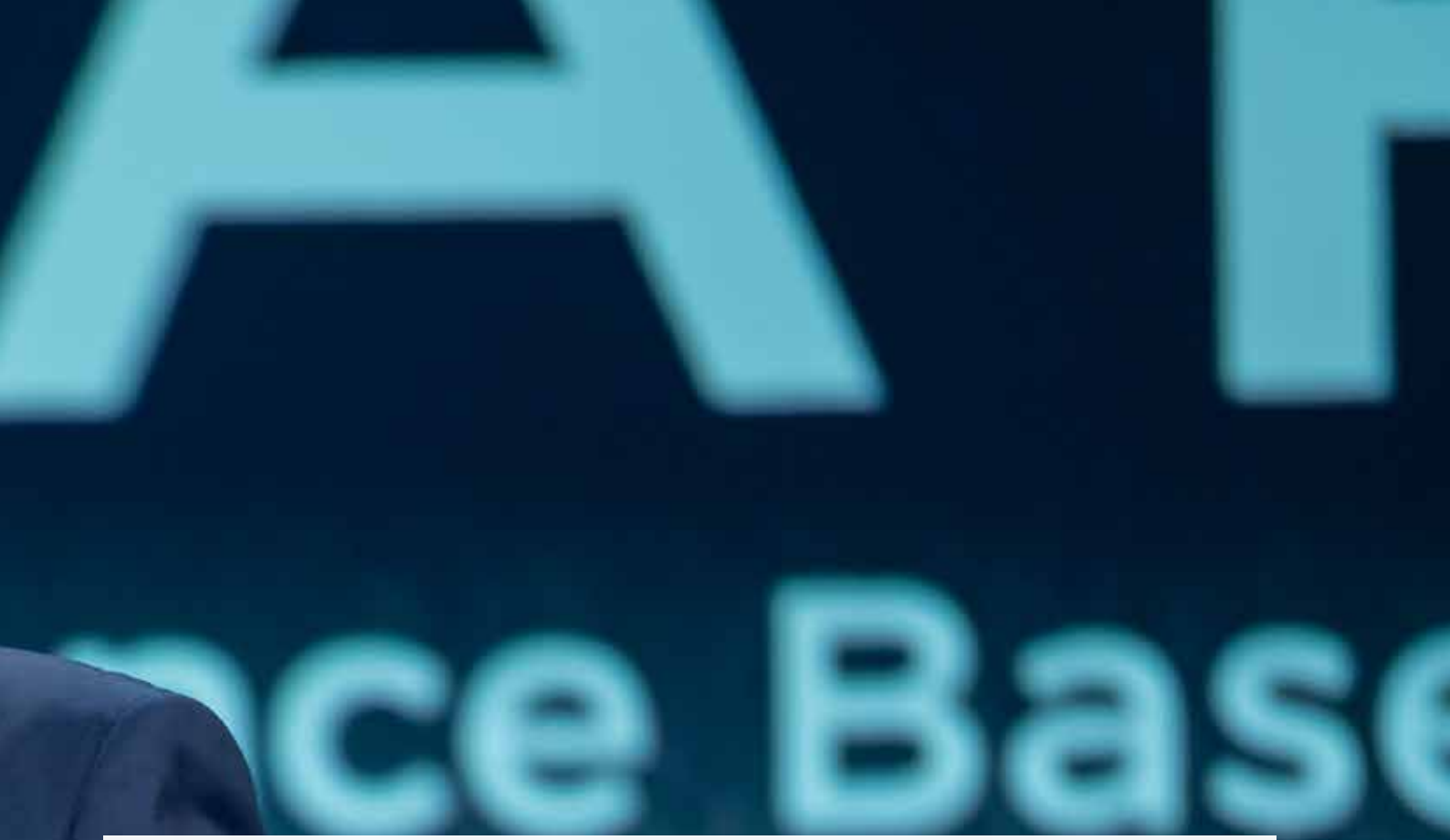
According to North, machine control drives productivity by transforming practices through the whole project cycle, such as taking away ground nails, like railway cuttings, in slopes. “You have a virtual site layout held in the machine control system. There are also huge benefits with the control of instrumentation holes for site investigation. There is a huge opportunity where machine control can be used.”

BEYOND REALITY. DIGITAL REALITY'S NEXT FRONTIER

Monica Miller Rodgers

Event

Hexagon's Geosystems Division President Juergen Dold presented ideas and case studies where the entire planet can be digitised at HxGN LIVE in Las Vegas, USA



Hexagon's Geosystems Division President Juergen Dold presented *Beyond Reality. Digital Reality's Next Frontier* at Hexagon's digital solutions conference, HxGN LIVE, 12 June at the Venetian Ballroom in Las Vegas, Nevada, USA.

In this main event for the Geosystems Track, Dold explored the limitless opportunities available for digitalisation. Presenting ideas and case studies where the entire planet can be digitised, he unveiled a never-before-seen world of possibility where all things are machine readable and subject to the power of algorithms.

DREAMS DO COME TRUE

Using the famous quote by Walt Disney, Dold kicked off his keynote with a discussion on inspiration. Where does it come from? How can inspiration be turned into reality? What is possible?

If you can dream it, you can do it.

-Walt Disney

Examples included Leonardo DaVinci's dream of flight and NASA's dream to reach the moon.

"At Geosystems, I'm very fortunate I'm working together with quite a number of dreamers that not only challenge the status quo but also make dreams true," said Dold.

BEYOND MAPPING

With transformation taking place in the airborne mapping business, 5D digital realities are not only possible but becoming accessible to everyone. Dold exemplified this by providing a historical timeline, detailing the century it took to convert from film to digital cameras, from analogue plates to pixels.

"This transformation unleashes the power and potential to think in different dimensions and completely new scales," said Dold. "Data sets have taken over, fostering not only new levels of automation but also new business models, providing the opportunity to expand the ecosystems."

As an example of this expanding ecosystem, Dold showcased the HxGN Content Program. Providing quality airborne imagery data on a subscription service, the Program demonstrates society's move to a sharing economy through Content as a Service (CaaS). Dold provided three reasons for this transformation:

- Accurate, high-resolution and updated data tailored to specific needs
- Online streaming to improve access
- Affordability of the service through the sharing business model

Moving forward, the airborne imagery in the Program is being provided to startup companies to further develop and test Artificial Intelligence (AI) algorithms. This drives added value to the mapping process, enabling applications such as autonomous vehicles and available parking throughout cities by way of high-definition 3D digital models.

“We don’t know how far AI will take us, but we’re convinced that higher resolution data with ever more powerful algorithms accelerate the accurateness and results these algorithms will bring us,” said Dold. “For those who are in mapping, they completely understand how much automation we can get in these mapping processes.”

Dold expanded on these processes with a focus on sensor fusion by unveiling datasets of Las Vegas, Seattle and Lucerne, Switzerland.

With most realistic flythrough, the cities were captured with the Leica CityMapper, fusing LiDAR and imaging technology to provide detailed cityscapes down to the exact imaging of the trees. Underneath the city streets, pipes were also revealed in the datasets with Ground Penetrating Radar (GPR) technology.

BEYOND MINING

Moving from a bird’s eye view of cities, Dold dived into the depths of mines to speak on technologies increasing the safety of sites around the world. By digitising mines, they become more reliable, effective and efficient. With a 50-year history in the mining industry, Geosystems has developed digital solutions to advance the business and keep miners safer.

Launching one of those solutions onstage, Dold unveiled the HxGN MineProtect Operator Alertness System Light Vehicle (OAS-LV) and explained how 65 per cent of all open-pit mining incidents are related to fatigue, the inspiration for this new safety-enhancing technology. Sensing the openness of a driver’s eyes in the

cab of a vehicle, the OAS-LV sounds a real-time alert, both inside the cab and back at the control centre, if signs of fatigue are detected. By digitising the driver's face and using analytics, the data is fed into an Internet of Things (IoT) environment with location-based information to reduce fatigue-related accidents by 85 per cent.

"[The OAS-LV] is the perfect example of when we speak about making the world machine readable and creating critical information with analytics ... saving lives and costs," said Dold. "Every mine should be efficient, and that's what we foster with our digital solutions. In addition, we go beyond efficient mining by improving safety dramatically."

BEYOND CONSTRUCTION

Returning to middle earth, when discussing the construction industry, Dold focused on the ecosystem of buildings. Seeing the opportunity in the challenge, he explained how digitalisation can take this underserved industry to the next level with digital solutions for the entire lifecycle of a building.

"Construction is not a one-man job," he explained. "It's not about digitalising your employees; it's about digitalising the entire process that brings perfection and efficiency for your project."

Dold went on to share several new technologies that are supporting the whole process, the entire lifecycle from planning to renovation. He started with the Leica DSX and IDS GeoRadar Opera Duo utility detection solutions in the planning phase. Using GPR technology, the DSX and Opera Duo make the invisible visible. With an array of software selections to use in combination, safety and efficiency are increased when construction and utility professionals can precisely locate assets below the ground and plan operations to avoid striking them.

Next in the construction phase, the Leica iCON iCT30 construction layout tool was showcased by Dold for its seamless connection of design to real-world building. The unique technology predicts the path of the construction professional, preventing errors and increasing time savings.

In the commissioning phase, Multivista imagery has now been integrated with the Leica BLK3D handheld imager. The construction progress documentation workflow of these merged technologies increases awareness of the construction crew and the contractors needing to better understand and verify the developments on site.

For renovation, the C-Thrue concrete scanner enables construction professionals to see through walls for cables, rebar and other potential strike risks. Increasing safety and efficiency, the C-Thrue converts the insides of walls into digital models using Augmented Reality (AR) to display results.

Finally, for the operation phase, launching on stage, Dold shared one of two of the newest members of the popular Leica BLK family. With a focus on expanding the ecosystem in the building market, the new Leica BLK247 is an autonomous surveillance solution to make buildings machine readable and subject to analytics. Providing continuous edge computing enabled 3D reality capture capabilities, the BLK247 provides 3D situational awareness for in and around buildings. With applications in also public safety and smart manufacturing, this new digital solution creates awareness whether objects are left behind, moved from one location to another and many more 3D change-related events in the observed space.

"It's a beginning of a journey .... And we are very excited to extend this reach and new ecosystems we may have not touched before," said Dold. "These are exciting times."

BEYOND SURVEYING

The year 2019 marks the 200th anniversary of Geosystems serving the surveying field. From the 1819 beginnings of the company Kern to the 1921 founding of Wild Heerbrugg to the 1990 formation of Leica Geosystems to the 2005 acquisition by Hexagon, the organisation has a long history of revolutionising and innovating the world of survey.

"Today our portfolio is a rich, full suite of infinitely connected survey solutions that puts data to work," said Dold.

He then went on to explain how Leica Infinity software connects all the Geosystems survey solutions from field to office. Users are able to expand their business capabilities from traditional, accurate survey practices to advanced, reality capture techniques based on merging sensors across total stations, laser scanners and imaging instruments.

Reviewing a history of fusing technologies, such as

LiDAR and imaging, laser scanning and distance measurement, wearable and Simultaneous Localisation and Mapping (SLAM) technology, Dold unveiled the second newest member of the BLK family. The Leica BLK2GO handheld imaging laser scanner rose from the stage with the BLK series signature green light band as if by magic.

“With this BLK2GO we fulfil a dream to place reality capture in the palm of your hand,” said Dold. “Is this not a piece of art? A piece of art our engineering and design team performed to give this high-tech solution a beautiful appearance truly unmatched in our industry ... so much technology into such a small device.”

The Leica BLK2GO handheld imaging laser scanner brings four key elements together in one instrument:

- Sensor fusion
- Mobility
- Simultaneous Localisation and Mapping
- Simplicity-driven design

Combining technologies, such as visual inertial navigation with LiDAR-based navigation, the BLK2GO orients itself as it is moved throughout the most challenging environments to create a 3D map. This instrument further democratises reality capture to enable more professionals to digitalise their own worlds and, in turn, making them machine readable for limitless possibilities.

BEYOND REALITY

Returning to Disney’s famous quote, Dold closed his keynote with a charge to the audience to become inspired, move beyond the realm of what is thought possible, and achieve the impossible. When the world becomes machine readable and subject to the power of algorithms, the potential of thousands of new companies and millions of new ideas will be unleashed.

“We have found ... ways to break through limits, to go beyond today’s reality, to create a new reality,” concluded Dold. “Dream your dreams, how you can foster digitalisation in your businesses. Never forget, if you can dream it, you can do it.”

MONITORING DUBLIN COMMUTERS' SAFETY

Renata Barradas Gutiérrez

Survey

Case Study

Keeping light railway travellers safe with a monitoring system in Dublin, Ireland

© LDG Datum

Cities worldwide need to build, maintain and expand infrastructure, especially public transportation systems, to move people, be they business professionals, shoppers or students, to keep a country and its economy going.

But, have you ever thought what goes behind moving people safely across a city? Although most likely building or repairing infrastructure first comes to mind, there are other crucial activities, just like monitoring, that although unnoticed, help engineers and designers to understand the impact of structural movements of infrastructure and materials. To reduce risk to infrastructure, early and precise monitoring is necessary.

The infrastructure supporting each of us, be it roads, bridges, dams, buildings or railways, is subjected to hazards, environmental factors and load pressure. Stress and risk to infrastructure can come from direct use but also from other factors, such as nearby construction sites and excavations. Such is the case of a north section of Luas light rail system in Dublin, Ireland, where the construction of a group of commercial buildings - built to cope with the increasing demand for student accommodation - were monitored to ensure the integrity of the transportation system.

With 67 stations and 42.5 kilometres of track, Dublin's Luas light rail system safely carried 41.8 million passengers in 2018. To minimise current and future concerns related to safety and structural integrity of Luas, Datum Monitoring Ireland (part of the Lloyds Datum Group), a specialised company in remote monitoring of earthworks, structures and transport infrastructure, analysed the data of the dual Luas light railway system continuously through a specialised monitoring system.

ALERT 24/7

LDG Datum was requested by Walls Construction to supply an effective, accurate and reliable warning system that would operate 24/7 and notify stakeholders in near real time if a threshold exceeded specifications. The monitoring system needed to meet design requirements, local council regulations and Transport Infrastructure Ireland's (TII) code of practice without interrupting the railway operations at any time. The team at LDG Datum also had to ensure no physical object was on the tramway. Traditional methods involved survey engineers taking physical manual readings on track, which creates its own inherent dangers.

Monitoring solutions involve geodetic, geotechnical and environmental sensors and monitoring software. LDG Datum's monitoring solution for this project consisted of two Leica Nova MS60 MultiStations, one LS15 digital level and Leica GeoMoS monitoring software. This solution allowed non-intrusive movement monitoring; therefore, the area could stay open for the entire duration of the project with no disruptions for the public or rail services.

"Datum's on-site core activity was to provide continuous scanning of the dual Luas light

railway tracks using Leica Geosystems' robotic MultiStation – the MS60. These instruments scanned the dual tramway continuously and hosted data directly onto a secure webpage for the relevant parties to review," said Mark Hodgen, director at LDG Datum.

The team also used vibration monitoring with incorporated Sound Level Microphones to capture ground-borne vibration arising from site works and used inductive displacement sensors to monitor the crack movements of existing cracks on neighbouring structures. Continuous dust monitoring stations, furthermore, were used to capture the levels of PM10 particles, or particle pollution, in the local area.

CAPTURING ACCURATE DATA IS JUST THE START

The main monitoring tasks captured all heave or settlement [vertical elevation of ground] of the light way tram line through the laser scanning with the MS60. To keep the rail track area free from hurdles, no prisms on or near-by the track were mounted. Hundreds of mark points along the closest part of the rail were, therefore, measured with laser scanning. The captured scans consist of thousands of measurement points with X,Y,Z coordinates, allowing to detect outliers [blunders] and ensure that the wanted position [area] is measured in a reliable way, even under normal load of the rail track traffic and the adjacent pedestrian area.

Three initial scans set a baseline to obtain a reference scan. All subsequent scans were compared to their reference scan and calculate the median deformation between the reference and the subsequent scan. This value is used to compare against a defined threshold. TII's code of practice solicits to trigger alarms, should displacement occur. The system provided automated alerts notifying stakeholders when values surpassed the designated threshold.

The scanned data captured by the two MultiStations was collected through GeoMoS and hosted on LDG Datum's secure website so its client and TII could have full visibility of the current and historic recorded values. This tailor-made process, from the acquiring of the data to the deformation analysis, was fully automated.

"Data was checked and compared to historical data allowing a safe protocol to be followed. Our bespoke physical on-street precise levelling captured by the LS15, was undertaken weekly, to provide the contractor with assurance and a back-up that the automated monitoring

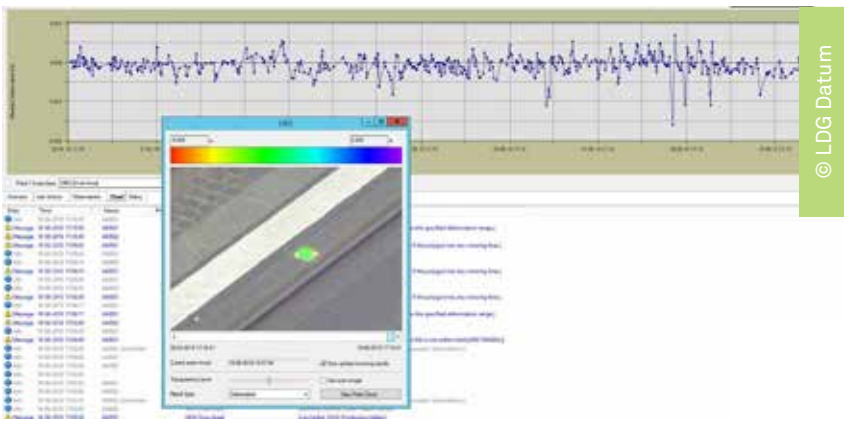
was working as planned. Vibration and noise monitoring were also carried out on surrounding buildings during the demolition, piling and construction phase," said Hodgen. "LDG Datum offered Walls Construction a complete remote monitoring systems package, so they can access and review data."

REDUCING RISKS

All instrument data collected and processed through GeoMoS maintained stakeholders informed on Luas light rail stability during the construction work near the railway while preventing any interruptions to the service. With proven success in this project, LDG Datum is replicating this automated monitoring system on all its tramway projects along the Luas line.

"Our primary focus for this project, considering the level of geotechnical and construction works, was ensuring that public infrastructure and surrounding buildings remain undisturbed. LDG Datum has a high level of credibility in the monitoring sector. Therefore, we engaged with Mark and his team who designed a suitable system that complied with the O'Connor Sutton Cronin (Consulting Engineers) specification and Transport Infrastructure Ireland's Code of engineering practice for working on, near or adjacent the Luas light rail system," said Cathal Healy, divisional director for Walls Construction. "LDG Datum delivered a highly accurate, reliable and commercially viable service, and we were delighted to have had them on this project."

Contractors, just like Walls Construction, may reduce their exposure to risks, before during and after construction by continuously monitoring the project as it progresses through its lifecycle. Geosystems' monitoring systems detect and help rectify potential problems in any structure before a situation becomes critical or, worse, out of control.



MOVING A CAMEL THROUGH THE EYE OF A NEEDLE WITH GNSS

Beate Wesenigk

Survey

Case Study

Undocking cruise ships' power stations with the help of GNSS in Germany

The NEPTUN shipyard is part of the MEYER Group based in Papenburg, northern Germany, and enormous floating objects are constructed in it – Floating Engine Room Units (FERUs), the 'power stations' for giant cruise ships. Specialised in FERUs, this shipyard in northern Germany faces a big challenge – FERUs are not constructed in dry docks, but in various production halls above the water line. To bridge the 2-metre height difference, a floating lowering system was developed. To manoeuvre FERUs safely out of the production halls and off the lowering systems, NEPTUN shipyard started using Leica Geosystems GNSS technology.

BLIND TRUST AS A PREREQUISITE

The lowering system is a shippable floating dock. It consists of a reinforced concrete pontoon with additional superstructures on top. The float itself is 150 m long, 55 m wide and 7.5 m high. Inside the pontoon, there are water tanks. During docking, FERUs are fixated with the help of steel-cable winches. The lowering system has a dedicated control room located in the front tower on the starboard side. From there, all systems are monitored and controlled.

When it is ready to be transported off-site, a FERU is first lifted inside the production hall with the help of a hydraulic system. It is then slid across a silicone-coated path on land up to the quay wall where the lowering system is waiting in the water. When the ship is positioned on the lowering system, tug boats pull the gigantic FERU – that weighs more than 40,000 tons at this point – right above the 16-m deep docking pit. The lowering system must then be correctly positioned down to a couple of centimetres and secured in a way the only options for movement are up and down.

Subsequently, the tanks are flooded, thus sinking the entire lowering system. Ultimately, only 2 m of the 18-m superstructure protrudes above the water. As soon as there is enough water on the deck, the tug boat captains receive their go-ahead. The FERU is then moored at the bow and the stern.

This undocking process itself can be likened to the metaphor of a camel going through the eye of a needle describing a very narrow opening – the distance between the undocked ship and the superstructures is only 120 cm at its most. The tug boat captains and the pilot atop the

© MEYER Group

FERU have no means of orienting themselves towards the port- or starboard side. The captain at the stern only sees metres upon metres of grey metal wall towering in front of him. Both captains need to blindly trust the pilot. This means the exact position of the FERU atop the lowering system must be known. Otherwise, avoiding collisions with the superstructures is impossible and these would inevitably damage the FERU as well as the lowering system.

USING GNSS TECHNOLOGY FOR CONSTRUCTION SITES

A GNSS-supported measurement process with Leica Geosystems technologies is now used in all the steps. Multi-frequency GNSS antennae were installed on the starboard-side bow and stern of the superstructures on the lowering system. The accompanying dual GNSS receiver Leica iCG80 is fitted in the control room. This installation, originally developed by Leica Geosystems to be used on heavy construction machinery in civil engineering, cannot only determine the exact position but also make predictions about potential movements. Subsequently, the relative position of the antennae in relation to the lowering system was determined with a one-time tachymetric measurement using a Leica Nova TS60 total station. In one of the shipyard's halls, a Leica Viva GS10 GNSS high-precision receiver was installed in a relatively sheltered spot, serving as a precise-measured fixed point.

FERU 1396, the first undocked power station, will be the centrepiece for one of the newest cruise ships for the largest cruise line in the world. Two iCG80 GNSS receivers were first installed at the previously measured locations on the lowering system and the receiver in the control room was activated. Using this installation, it was possible to move the FERU from the production hall onto an exact position on the lowering system. To undock the FERU from the lowering system, both antennae were installed on it.

The control software for the lowering system used in the control room links GNSS data, terrestrial and maritime maps, providing real-time data as well as forecasting data for the projected movements of the lowering system and the FERU to all participants in the undocking process. To react immediately to changes and give out appropriate instructions

the pilots and tug boat captains use Leica CS35 field tablets. In addition to the real-time data and movement projections on their CS35 field tablet, the pilots and tug boat captains also see exactly how much they have to steer to starboard and port to leave the lowering system without damage.

Navigating FERU 1396 out of the eye of the needle took only 10 minutes – a time that would have been impossible for a safe undocking, especially at a day with winds of force six because, due to its dimensions, the FERU poses such a big target for the wind.

FASTER + MORE FLEXIBLE = MORE PROFITS

The MEYER Group has been successfully using measurement solutions from Leica Geosystems for many years. During the conception phase, GNSS solutions from various suppliers were evaluated. The main criteria were:

- Positioning accuracy of 2 to 3 cm, even on moving ground
- Immunity to environmental factors, such as temperature fluctuations and saltwater
- Wireless and radio-less data transfer.

The survey team headed by Ralph Zimmermann decided for the Leica Geosystems solution. The iCG80 GNSS receivers were developed to withstand harsh conditions on construction sites, work error-free from -20 C to + 40 C and are splash water resistant.

Lars Wegener and Kevin Schemmel, part of the survey team at NEPTUN shipyard, reported, “Relocation of 1396 went well.” Zimmermann expanded, “With the help of this technology, we have literally made big things happen. You could clearly see that we practise the motto of the MEYER Group, ‘Stronger together’, because, in addition to the workers of both shipyards, many specialists were involved; experts for nautical map technology, classical coastal navigation and tugging methods.”

This system benefits the MEYER Group in various ways for ongoing tasks as well as for future projects. The entire process of moving and undocking FERUs has become much safer because of the provided real-time positions, movement projections and calculations for tug control help to avoid collisions. Furthermore, it is possible to move and undock objects that extend beyond the bow and stern of the lowering system. The speed, precision and reliability of the system unaltered by weather conditions is a perfect fit for MEYER Group who plans to build three cruise ships in Papenburg starting in 2019 and, in the future, two per year in Turku, Finland.

HEXAGON'S GEOSYSTEMS DIVISION FEATURES CUSTOMERS

AROUND THE WORLD. EVERY DAY. ANY APPLICATION.

Whether it is surveying a hydroelectric plant in the Andean Mountains or working on an airport runway in Greenland, our users are working diligently to further not only the industry but global society.

At Hexagon's Geosystems division, 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 - ensuring a scalable, sustainable future.

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 *Reporter*.

Heritage conservation project in Costa Rica

Dayhiana Dalvise creating the as-built plan of a 100-year-old heritage building in Cartago using the Leica BLK360 imaging laser scanner.

Runway maintenance with machine control in Greenland

Per Eriksen witnessed the maintenance of the runway at Qaarsut airport in Greenland with a grader equipped with Leica iCON iGG3 dual GNSS machine control solution.

Surveying a hydroelectric plant in the Andes

Bruno Vásquez Ceballos, surveyor and geomatics engineer at Underground Hydroelectric Plant Cóndores Enel, uses Leica Viva GPS15 smart antenna in Chile.

Training future mining engineers in Burundi

Maxim Bukin, chief mine surveyor at Tanganyika Gold S.A. trains local engineers to use the Leica TS06, TS02, Leica Viva GS14 and Leica Infinity surveying software in Burundi, Africa.

Ground survey of water race in New Zealand

Scott Cookson and his assistant undertook a full-aerial and ground survey of a 7-km-long piped section along the Beaumont Water Race with three Leica Viva GS14 GNSS smart antennae in Otago high country, New Zealand.

Boundary survey in Canada

Veronica Meister doing a boundary survey with her dog, Bonnie, using Leica TCR805 prismless robotic total station in Williams Lake, British Columbia, Canada.

Expanding tunnel infrastructure in Indonesia

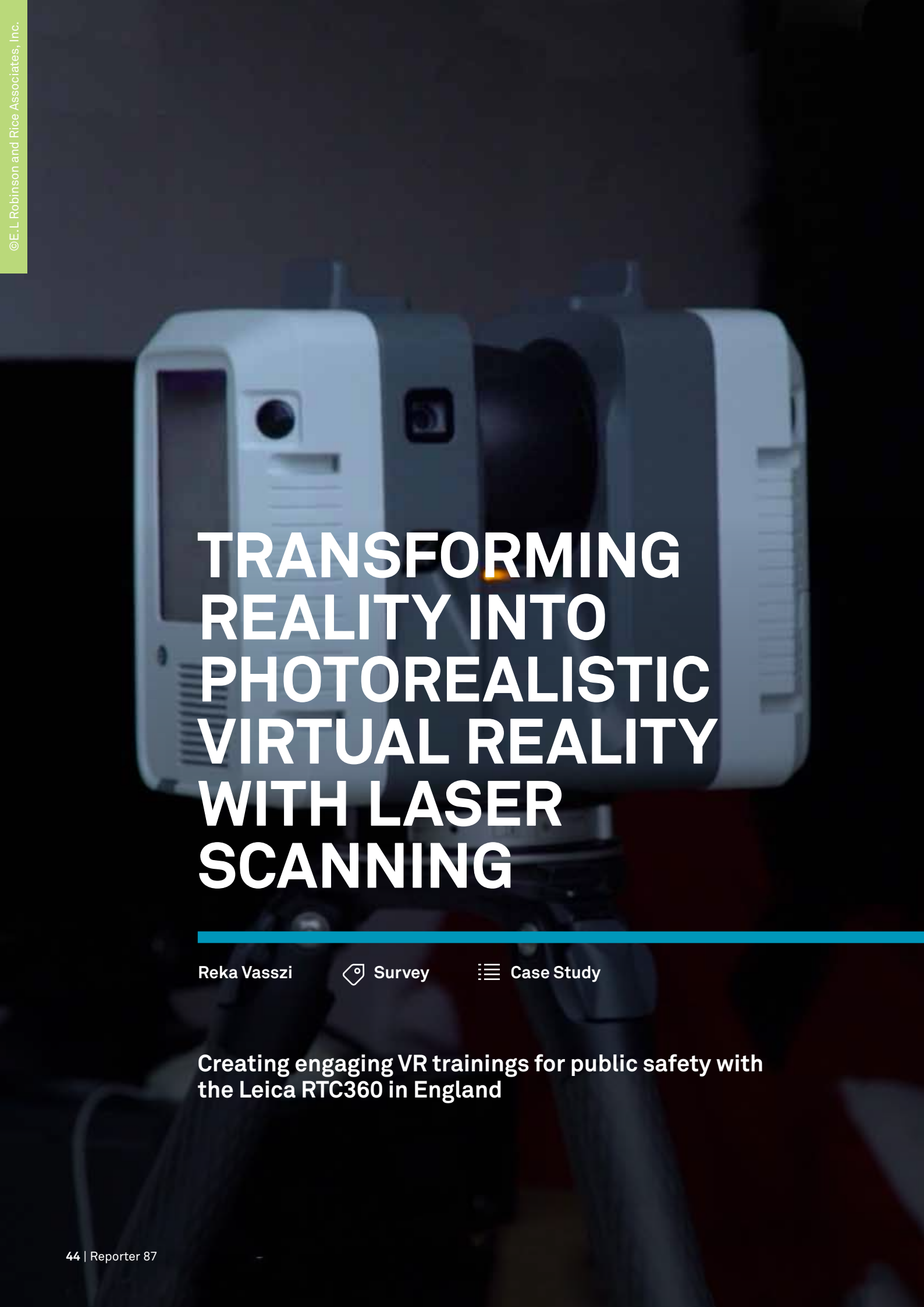
Denny Maynardi Dyatmoko from Redpath expanding the tunnel infrastructure of Deep Mill Level Zone (DMLZ) Underground Mine using Leica Viva TS15 robotic total station in Papua, Indonesia.

Building water pipes in Finland

Petri Junttila taking advantage of Leica MC1 3D machine control software with automatic tilt and tool identification while building new water pipes and sewer lines in Jyväskylä, Finland.

Mobile mapping in India

Vasanth Palani demonstrates the Leica Pegasus:Backpack for customers interested in building and interior road documentation in Chennai, India.



TRANSFORMING REALITY INTO PHOTOREALISTIC VIRTUAL REALITY WITH LASER SCANNING

Reka Vasszi

Survey

Case Study

Creating engaging VR trainings for public safety with the Leica RTC360 in England

©E.L Robinson and Rice Associates, Inc.

While Virtual Reality (VR) is commonly associated with video games, it is shaping many industries by opening a vast array of new possibilities to sell products, experience places or train employees. VR has multiple applications based on the ability to immerse users in a safe virtual world and fully experience a different environment by involving most senses.

Reality in Virtual Reality Ltd. (RiVR), a developer of VR experiences in England, is enhancing the way humans learn by offering immersive training and educational programmes for all industries. VR-based training programmes can immerse users in realistic situations, such as crime or fire scenes, that cannot be reproduced easily in real life.

The immersive experience RiVR offers is ideal for applications in the public safety sector where VR provides students a way to gain valuable experience of dangerous or life-threatening environments from the safety of a training room. The Fire and Rescue Service and the Department of Science and Technology Laboratory in the United Kingdom both requested RiVR to produce a hyper-realistic recreation of fire and crime scene scenarios based on real-world events to develop virtual training programmes for their trainees. The goal of the training is to prepare students for the appropriate behaviour and actions in stressful situations. A Virtual Reality Monitor (VRM) developed by RiVR allows the trainers to observe how the candidates interact with the scene and gives a comprehensive overview of the training session.

Using the Leica RTC360 3D laser scanner, in combination with photogrammetry, RiVR was able to develop life-like virtual environments where the fire and police officers of the future can be trained.

VIRTUAL FIREFIGHTERS AND DETECTIVES

Pioneering with its first product, RiVR Investigate, the company is complementing real-world training of firefighters, police officers and crime scene investigators with an immersive photorealistic VR experience. RiVR Investigate allows recruits to gain exposure in a controlled and consistent way. Exposing trainees to a real fire and dangerous situations for the first time might result in stress and fear for the job. VR technology also allows police officers and investigators to undertake a range of simulations and recreate any murder scene that would not be possible otherwise.

In RiVR Investigate training solution trainees get access to six different fire investigation scenarios, two hazardous material incidents, and two crime scenes. The RiVR software also records all the actions taken by the trainee for review. The team of developers is looking to work with more fire services and police forces to increase the VR scenario library year on year.

But, how are these real-life situations transformed into virtual simulations? RiVR partnered with Leica Geosystems and uses the RTC360 to produce high-resolution topology of large scenes. The highly-portable and automated RTC360 empowered the team to document and capture the crime scenes and the burnt-out buildings fast and to the finest detail.

“We use the RTC360 when we scan large environments that don't lend themselves to photogrammetry. Then onto the scans, we overlay high-resolution imagery to produce millimetre accurate photo-realistic environments of any size. We also find the RTC360 very useful in environments that are very hard to do a photogrammetry scan, such as a mainly white lab, which doesn’t have much randomness [points of reference] to it,” explained Alex Harvey, creative director at RiVR.

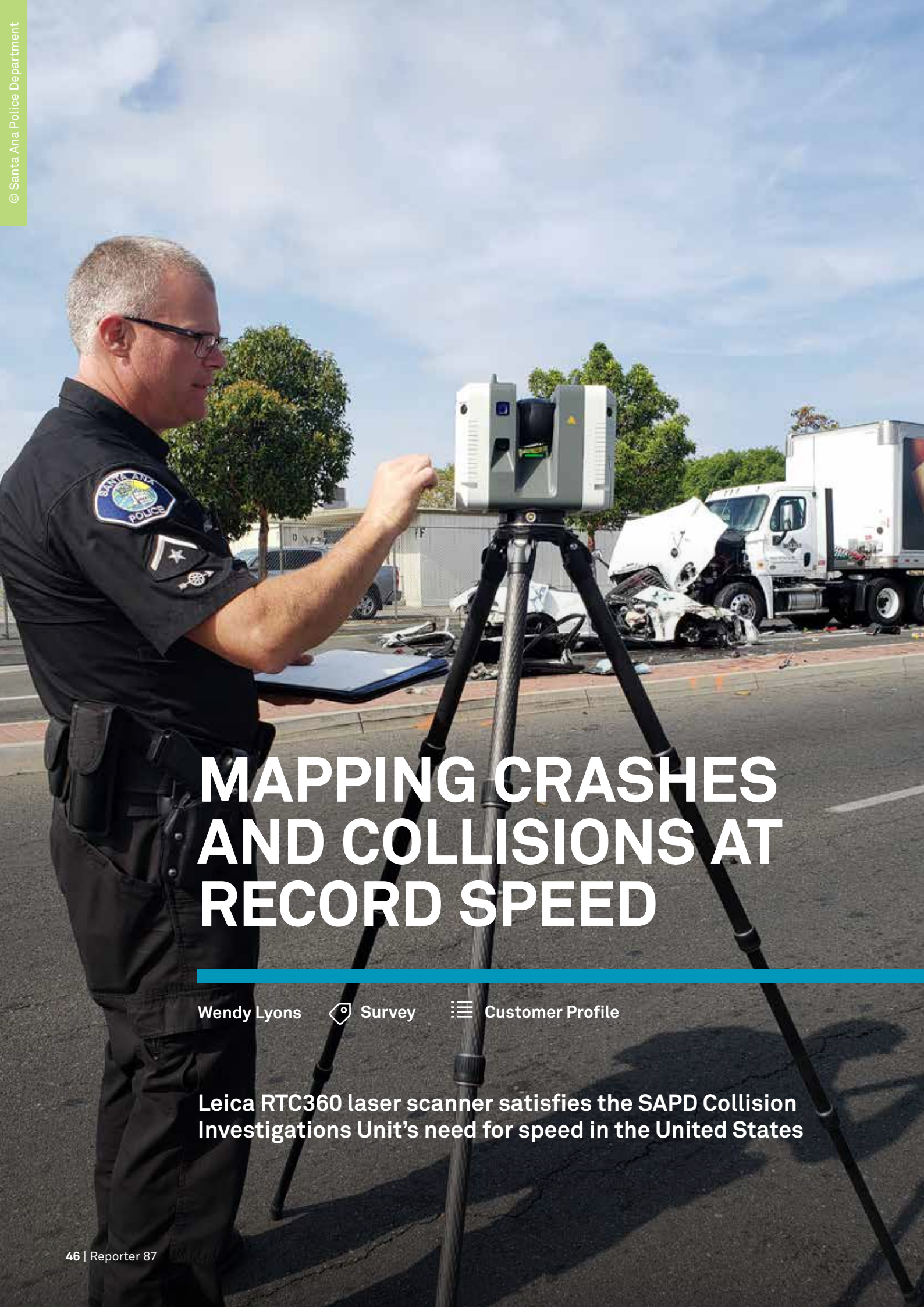
CAPTURING REALITY TO ENHANCE LEARNING

Experiencing new challenging environments for the first time, such as a murder scene or a fire, provides valuable context and locational awareness of situations for the candidates, otherwise difficult to replicate without significant costs. With the ability to mirror with millimetre precision the real world through laser scanning, professionals can create engaging real-life experiences for multiple applications, including photorealistic VR training for public safety.

In a BBC Click episode featuring VR applications, Paul Speight, watch manager at Leicestershire Fire and Rescue Service, states students trained in a VR environment are more engaged. According to a recent report by the National Training Laboratory in the United States, retention rate of learning using VR scored 75 per cent. In contrast, other lecture-style methods were at 5 per cent.

VR created with laser scanning and photogrammetry can place users in any number of different places, situations or environments, and can be deployed to teach awareness, build skills, and provide valuable experience to those who risk their lives to help others.

This article first appeared in the May 2019 issue of xyHt magazine. https://www.xyht.com/lidarimaging/rivr/



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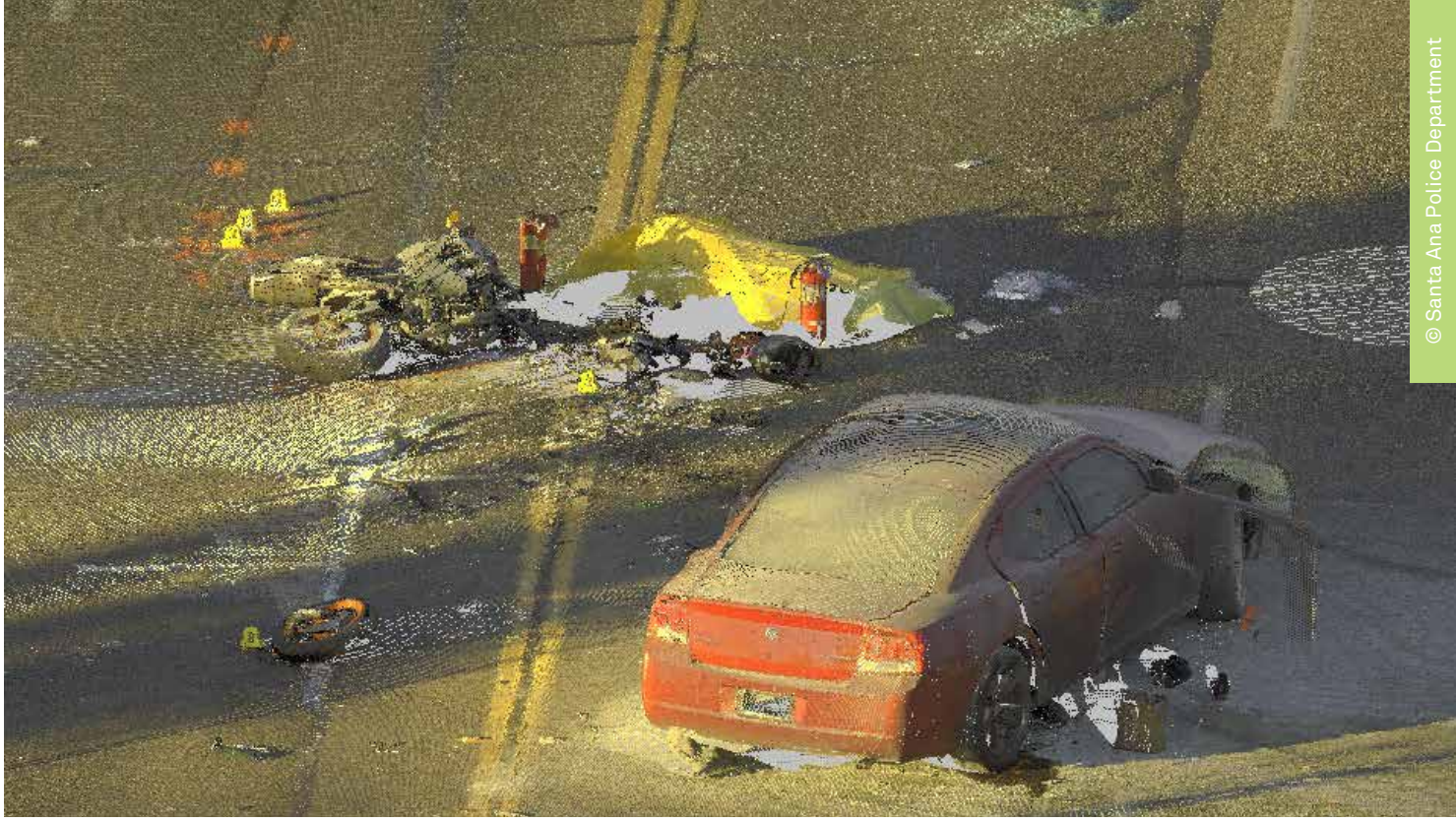
MAPPING CRASHES AND COLLISIONS AT RECORD SPEED

Wendy Lyons Survey Customer Profile

Leica RTC360 laser scanner satisfies the SAPD Collision Investigations Unit's need for speed in the United States



© Santa Ana Police Department

When your crime scene is situated in the middle of a busy intersection in one of metro Los Angeles' most densely populated cities in the United States, you need to get what you need and get out. "It can get pretty dicey out there," says investigator Weston Hadley, of the Santa Ana Police Department's Collision Investigations Unit.

Until recently, Hadley and his fellow investigators had been using a theodolite for their forensic mapping. "A theodolite can make very accurate measurements. The limitation is that it only is taking data points and measurements for items that you choose, and that process can be pretty time consuming," he says. "We were shutting down major intersections for four, five hours at times to take 200 to 400 data points." Like many public safety agencies, the Santa Ana Police Department held onto the obsolete device because there was no money in the budget to purchase faster technology.

Today, the Santa Ana Police Department is mapping at record speeds thanks to a technology lease that made it possible to upgrade to the latest state-of-the-art reality capture solution. Their brand-new Leica RTC360 3D laser scanner is capturing the entire scene—billions of highly accurate data points—in less than 30 minutes. The new laser scanner also pre-registers the point cloud data in the field automatically, which makes it easy to use and saves even more time back in the office.

"It's such a significant increase in our efficiency," Hadley says. And with fatal collisions occurring on a regular basis, efficiency is important. "It just doesn't quit here in Santa Ana," Hadley says. "We've had our Leica RTC360 since the end of December and [as of June 2019] we have already mapped our 12th collision scene."

Hadley says the RTC360 was an obvious choice. After seeing it in action, it's also become apparent that the fast, agile and precise 3D reality capture solution is paying off in more ways than one. "We immediately saw the value in how it collects data and the speed," Hadley says. "But the cost savings and benefits go beyond that in so many ways."

IMPROVES USE OF OFFICER RESOURCES

The RTC360 frees up patrol officers to respond to calls for service in a more timely manner. "We're a busy city, and when something goes down, especially in daylight and early evening hours, pulling five or six officers to block traffic puts an enormous strain on the resources we have available to handle calls for service. We're still going to get to those priority calls, but anything less than a priority is going to pend, and those patrol officers are going to sit for five, six hours until we finish the scene," Hadley says.

With the RTC360 mapping an entire scene in less than 30 minutes, that strain on personnel has been alleviated. "The RTC360 provides a better service for the community because we can put our resources to better use than blocking roadways," he says.


© Santa Ana Police Department

OPENS ROADWAYS QUICKER FOR COMMUTERS

The RTC360 minimises the impact road closures have on the commuting public. “I remember a scene we had several years ago. It was a terrible crash at one of the busiest intersections, and we had it shut down all the way through rush hour. We had tens of thousands of people who couldn't get through the intersection, that were late for work, that didn't get their kids to school on time,” he says. “That simply won't happen anymore.”

INCREASES OFFICER SAFETY

The RTC360 increases officer safety by decreasing their time in harm’s way. According to the National Law Enforcement Memorial Fund, of the 50 officers killed in traffic-related incidents in 2018, 14 were struck while outside their vehicles. It’s not unusual for impaired or distracted drivers to plough through active scenes. “I've had to run out of the street several times,” Hadley says. “Thankfully, we've never had any officers hit. We've had our cars hit. We've had buildings hit. We've had evidence hit. So the quicker we can get what we need and get out of that road and that right-of-way, the better.”

REDUCES HUMAN OVERSIGHT AND ERRORS

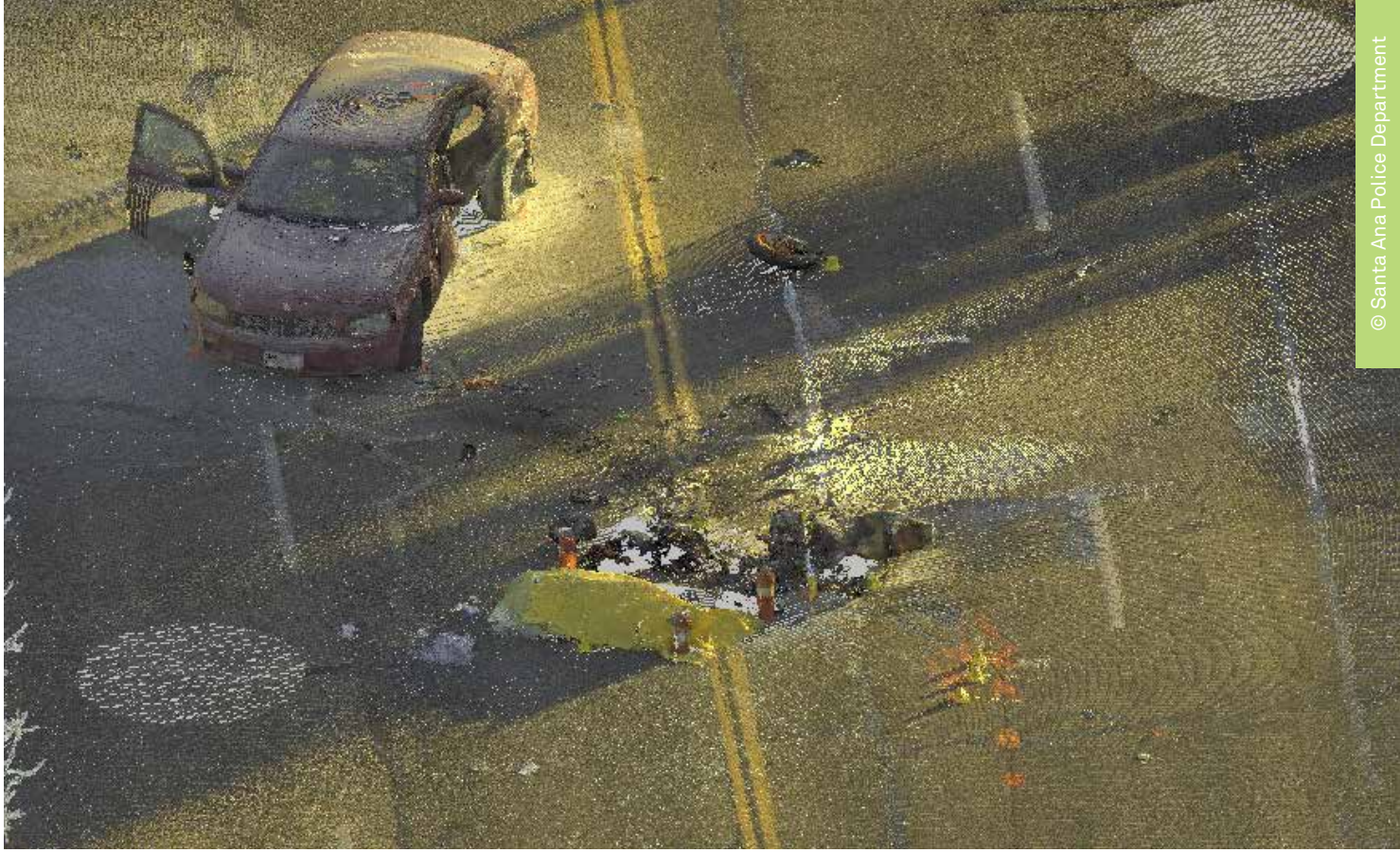
The RTC360 captures anything and everything in its line of sight at 2 million points per second. A theodolite can only take data points for objects the operator chooses. Even collecting an average of 200 to 400 data points, it was impossible to get everything.

“Sometimes, we get distracted or it's just such a big complicated scene that we can just overlook one piece of evidence,” Hadley says. He remembers one case where, after returning to the office, Hadley discovered the theodolite had malfunctioned. “It was an in-custody fatal DUI with a prior, so this guy's looking at a murder charge,” he explains. “We had to go out two more times and re-setup right where I initially placed the device.”

The first time, he placed the theodolite in the most efficient spot for gathering all the data. “It wasn't the most efficient when I had to go back and try to shut down lanes. It was really in a bad spot,” he says. “That was a real pain.” With the RTC360, Hadley can now walk away—after just minutes on the scene—confident that the scanner captured everything with millimetre accuracy. “And I'm certain I'm not going to be making any trips back out to collision scenes,” he says.

INCREASES JURORS’ DECISION-MAKING ABILITY

The RTC360 and its companion scene reconstruction software empower jurors to



© Santa Ana Police Department

make better-informed decisions. Previously, evidence mapped by theodolite was presented to the court as two-dimensional illustrations. But by overlaying millions of data points with high dynamic range (HDR) photography, along with geotagged photos and notes, the RTC360 provides an immersive 360-degree, 3D experience. And the data is admissible as scientific evidence.

“Now we can really bring someone into the scene as we saw it that day in a way that a two-dimensional drawing could never anywhere approach,” Hadley says. “You can talk about two cars colliding at 40 miles (64 kilometres) an hour. In concept, they really don't know what it looks like when a violent collision occurs—the crushed vehicles, the debris field—it can be overwhelming.”

When their laser-scanned cases reach court, jurors will no longer have to draw on their imaginations. “I think that it'll have a bigger impact when they can see with their own eyes what we saw—the violence of what occurred and the energy and all of those things,” he says.

LEVELS THE PLAYING FIELD WITH PRIVATE INDUSTRY

Forensic mapping experts in the private industry typically use state-of-the-art technology, especially for high-profile cases. Hadley believes it’s important for public safety agencies to maintain the same level of professionalism. “If we're going to get up in front of a jury during a deposition and talk about what wonderful experts we are and all the experience and training we have and we're using technology that is just way outdated, I think it undermines our initial message,” he says.

It can also undermine the ability to identify inaccuracies or mischaracterisations presented by private experts. “It could put us at a disadvantage if we're not aware of the current technology's limitations or nuances,” he says. “If we’re using current technology, at least gives us a starting point to say, ‘That is right’ or ‘That doesn't look right.’ Whereas if we don't have any experience in that technology, we basically can't say anything. Whatever they say is.” Documenting the scene with the RTC360 keeps the agency at the forefront of mapping technology and upholds their credibility in court.

CLOSING THE GAP

Thanks to their new RTC360, the Collision Investigations Unit has closed its technology gap. Today, the Santa Ana Police Department is now at the leading edge of laser scanning technology and mapping at record speeds. “The Leica RTC360 makes us more efficient in so many ways,” Hadley says. “I think if you really draw back and look at the proverbial forest, you just go, ‘Wow! Why haven't we been doing this for a long time?'”

© Elettric80

REVOLUTIONISING SMART FACTORIES WITH REALITY CAPTURE

Renata Barradas Gutiérrez

Survey

Customer Profile

Digitalising warehouses with laser scanning to design modern automated factories around the world

© Elettric80

Productivity and sustainability – these are the forces driving the need for connectivity and integration of technologies within the manufacturing processes. This integration, known as the Smart Factory, drives automated and connected factories, increasing productivity and value across all the supply network.

In autonomous connected ecosystems, data is connected seamlessly, converging the physical and digital worlds, and building intelligence into all processes. Autonomous connected factories, or Smart Factories, learn and adapt quickly to changing conditions in real time, pursuing perfect quality with optimised design, requiring fewer inputs and producing zero waste.

Digital copies of the physical world are one of the key elements of a Smart Factory. To manage and monitor physical processes in an autonomous decentralised way, numerous technologies need to be orchestrated within copies of the physical world.

MIRRORING THE PHYSICAL WORLD FOR AUTOMATION

Elettric80, a leading company specialised in the implementation of flexible and modular integrated automation solutions for high-volume consumer products manufacturers, uses 3D reality capture to design modern automated warehouses. This Italian company has installed more than 2000 automatic systems all around the world, earning worldwide recognition as one of the market leaders in integrated automation solutions.

“The use of the 3D laser scanning is becoming a standard in all our installations. With the digitalisation of the environment, we are able to develop and ‘virtually deploy’ our systems, so we can anticipate problems that may arise from the integration within the existing environment,” said Vittorio Cavirani, general manager at Elettric80.

To design and build effective and safe factories designed according to the manufacturer’s application needs, Elettric80 experts digitalise each plant before design and development. Using a combination of Leica Geosystems’ laser scanners and a total station, experts can produce various deliverables, including 2D layouts, 3D meshes and models to:

- Plant layout validation.
- Design and optimise trajectories and safety areas for Autonomous Guided Vehicles (AGVs) based on the available space and prevent vehicle collision.
- Place robot workcell respecting the actual clearances of the environment.

© Elettric80

- Automatically extract operation points (points where the autonomous vehicles perform tasks, such as pallet pick-up and drop).
- Perform a 'virtual deployment' by moving vehicles within the digital models.
- Complete ground quality inspection.

"The design of modern automated warehouses is a complex task that requires detailed and accurate models of industrial buildings. The common approach to update existing 2D floor plans is to perform surveys based on sparse measures, taken by hand-held instruments, such as laser distance meters, or total stations. Although these instruments provide very accurate point-to-point measures, the amount of data that can be acquired may not be sufficient, resulting in high costs and delays," said Mikhail Giorgini, R&D project leader at Elettric80. "Therefore, Elettric80 decided to apply 3D terrestrial laser scanning technology to overcome the limitations of traditional surveys. Thanks to this workflow, the real deployment of the plant becomes a straightforward and low-risk phase."

THE BASIS FOR AUTOMATION

Automated warehouses include AGVs that move along predefined paths, as well as fixed robot workcells. To automate palletizing robots, a wide range of Laser Guided Vehicles, high-speed robotic stretch wrappers, pallet control systems, robotic labellers, wrapping and labelling systems among other, designers need to have a full understanding of the built environment and work on actionable models that mirror reality.

"We adopted a novel workflow for the design of automated warehouses that improved the traditional development process by performing a 3D survey that combines terrestrial laser scanners and a total station. Then extracted high-level information about the environment, exploiting innovative algorithms for large-scale point cloud processing," said Giorgini.

The reality capture solution used by Elettric80 consists of:

- Leica Nova TS60 total station
- Leica ScanStation P30 laser scanner

- Leica RTC360 3D laser scanner
- Leica BLK360 imaging laser scanner
- Leica Cyclone REGISTER point cloud registration office software.

The RTC360 and P30 ScanStation are used for large-scale 3D surveys in conjunction with a TS60 total station for control point measurements. The BLK360 is used for preliminary surveys. The team registers scanned data in Cyclone REGISTER and re-imports data into Elettric80's proprietary software.

With a need to handle data at a large scale, the Italian company selected Leica Geosystems due to the high precision, reliability and worldwide support offered. "Leica Geosystems provides a state-of-the-art solution - both in terms of precision and reliability - when it comes to data acquisition. When we had some problems, we have always been assisted and we always have been able to get the job done, even in challenging scenarios," said Fabio Oleari, R&D team leader at Elettric80.

A SHARED BELIEF – EMPOWERING AN AUTONOMOUS FUTURE

Shaping urban and production ecosystems to become increasingly connected and autonomous is a goal that both Hexagon and Elettric80 are fulfilling.

Having a complete 3D model of a warehouse has helped Elettric80 to improve operational efficiency through optimisation of design, production routes, management of maintenance and positioning of machines. By integrating reality capture into its processes, experts know what is there without accessing the site, opening a competitive advantage.

"We'll continue to invest in 3D survey solutions to further reduce the deployment time of our custom solutions," said Domenico Di Terlizzi, R&D manager at Elettric80. "The benefits of this project have been disruptive, and drastically changed the way Elettric80 meets the needs of its customers."

© U's Factory

SURPASSING CUSTOMER NEEDS WITH 3D LASER SCANNING

Yoshie Katagiri

Survey

Customer Profile

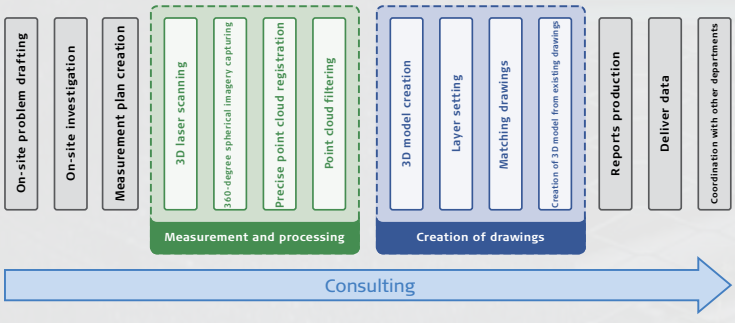
Capturing 3D point cloud data to create accurate as-built 3D models for AEC customers in Japan

U's Factory Co., Ltd. is a Japanese company established in 2013 as a Building Information Modelling (BIM) management company, focusing on BIM for building and construction. Since its establishment, the company has used point cloud data captured by laser scanners to generate 3D models. Having determined that laser scanning enabled a dramatic reduction in the total time required to prepare various drawings, the company purchased Leica Geosystems 3D laser scanners. U's Factory has built up the know-how to optimally combine devices depending on the on-site circumstances to capture point cloud data efficiently.

PROVIDING 'ONLY-ONE SERVICE' TO MATCH CUSTOMER NEEDS

Surveying, 3D CAD modelling, and various design drawings are conventionally prepared and conducted by various separate companies on a process-by-process basis, which is labour intensive. U's Factory CEO, Mr Yasushi Uejima, saw this as an issue while working as an engineer at a major general construction company. Based on his experience, he founded U's Factory with the objective of using IT to dramatically reduce on-site work and revolutionise the industry.

U's Factory provides one-stop services, including surveying and modelling for general construction companies and large design offices. The company offers not only 3D measuring and 3D modelling but also consultation services for customers to achieve their goal. This includes the delivery of optimised configuration, structural, construction and facility drawings – that is U's factory's 'only-one service'.



IMPROVING 3D LASER SCANNING SERVICES WITH BLK360 AND RTC360

The use of point cloud data is firmly established as part of U's Factory's business model. As part of the company's pursuit to further improve its services, U's Factory purchased in 2018 the Leica BLK360 imaging laser scanner, Leica RTC360 3D laser scanner and Leica GS18 T GNSS RTK rover.

“The BLK360 is lightweight, compact, and scans fast. You can simply set up the device and just press a button. We’ve even used it in a project to capture as-built data of the piping arrangements in a confined machine room, which we couldn’t enter without crouching,” explained Uejima.

As for the RTC360, the company purchased the first unit available in Japan, receiving it immediately after its market release in September 2018. “The RTC360 requires even shorter time to scan than the BLK360, and it automatically recognises its horizontal level with the built-in tilt compensator. Another breakthrough is the way that the point cloud data can be transferred to a tablet so you can check the scanned area on the spot in real time. The situation where you go back to the office, upload the data to a PC and realise ‘Oh no, I should have taken more measurements here or there’ is much less likely to happen, so it’s highly efficient,” said Uejima.

These RTC360 features paid off dividends when Uejima surveyed an 8,000-square-metre holiday home site located in a woodland area with many large trees. “There were no other staff or equipment available, so I went by myself and completed the scanning in just two hours,” explained Uejima. In such environments, the scanning positions and arrangements are hard to be recognised in the captured data. However, since the RTC360 tracks its positions with integrated cameras, 27 scans without targets were efficiently completed and pre-registered on the spot.

COMBINING SEVERAL DEVICES TO CREATE AN OPTIMAL SURVEY PLAN

U's Factory focuses its efforts on preparing the optimal survey plan to acquire the data that meets the objectives in the shortest possible time frame. The company delivers accurate measurements even quicker, having acquired several Leica Geosystems solutions, including:

- Leica Nova MS50 MultiStation
- Leica ScanStation C10 laser scanner
- BLK360
- GS18 T
- RTC360.

The shorter surveying time frame on sites pleases U's Factory's customers, especially when sites are still being occupied or have ongoing construction work. "By combining the RTC360 and BLK360, we were able to drastically reduce on-site survey work time. Of course, this does not mean that we can complete all the work with just the BLK360. Our starting point is to consider the client's needs, and then, plan the optimal survey workflow with a combination of equipment with various specifications," adds Uejima.

The company has built up knowledge and experience on how to make full use of all their equipment and perform on-site survey work in the most efficient way. U's Factory experts, for example, survey geographical locations with the GS18 T rover, use the C10 scanner at an interval of 300 m with targets measured by the MS50 MultiStation, and use the RTC360 or BLK360 to fill the gaps in between.

The purposes for measurements have changed from acquiring just distances between two points to creating 3D models with appropriate drawing sets that can be even applied in augmented reality and simulations. The need for accurate point cloud data will surely increase as business opportunities expand and diversify.

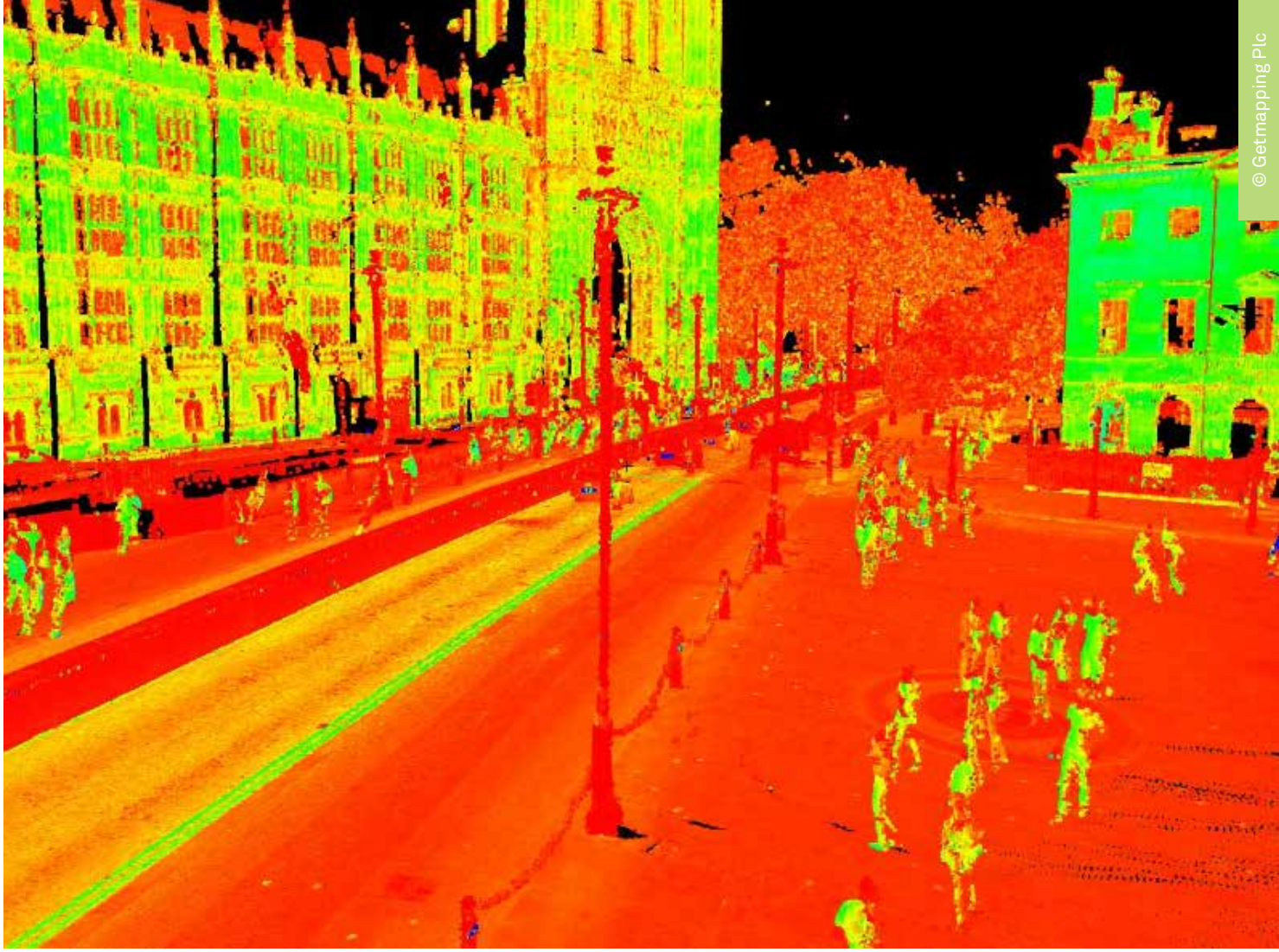
DOCUMENTING LONDON'S BOROUGHS TO SOLVE PARKING PROBLEM

Penny Boviatsou

Survey

Case Study

Helping drivers find and reserve parking spaces across London with mobile mapping



Spending hours looking for parking space on busy city roads and parking lots is a serious matter. Cities across the world keep struggling with the problem with wasted fuel, and emissions adding up to the economic and non-economic impact of parking hunting.

Parking app technology is on the rise offering users cashless payments and helping drivers find and reserve parking spaces and avoid parking tickets.

AppyParking, a London-based kerbside management and mobility technology firm, operates an award-winning parking app that allows users to see and understand all on-street parking areas, restrictions and operating hours in addition to off-street car parks, helping users make informed choices about where to park before they arrive.

"We're on a mission to make parking forgettable for drivers by providing the best on-street parking information so they can find the nearest and cheapest options for where they want to go. We also work closely with local authorities to help them better manage their kerbside assets with data-driven solutions that improve compliance and safe access for drivers and businesses," said Dan Hubert, CEO and founder of AppyParking.

AppyParking needed to survey London's kerbsides to create an accurate map of all parking zones across the capital. The parking company approached Getmapping Plc, a leading provider of aerial photography, mobile mapping, LiDAR, digital mapping and web-based services across Europe and Africa, to undertake mobile mapping surveys of car parking zones across London.

With more than 20 years of experience in capturing and processing large volumes of geospatial data, Getmapping invested in two Leica Pegasus:Two Ultimate mobile mapping systems to survey London's boroughs for the largest mobile mapping project in Europe.

EFFICIENT DATA CAPTURE THROUGH MOBILE MAPPING

Project planning was crucial for the project's success. Getmapping wanted to ensure the project would run smoothly according to a plan. The initial capture of parking data for six London boroughs was required in autumn 2017/18 with progressing phases through the first six months of 2018.

A team of three surveyors drove 25 kilometres per day with the Leica Pegasus:Two around London's boroughs to simultaneously collect imagery and LiDAR data. Surveying was possible throughout winter months of poor light, and

no surveyors or traffic management crews were needed in the road – all data was captured from the safety of the vehicle.

Once the data collection was completed, data was transferred back to the office in hard disks. Two team members processed the data using the Leica Pegasus:Manager to produce the Simultaneous Localisation and Mapping (SLAM) corrected trajectory, along with panoramic imagery and coloured point clouds.

"The progress of surveying methods and mobile mapping systems opens new perspectives for the collection of road data. With the Leica Pegasus:Two Ultimate we were able to smoothly collect data, travelling around the survey sites around London, with no traffic management or road closures required," said Martin Tocher, group innovation director at Getmapping.

MORE DATA, FASTER

The capture of parking data in further 13 London boroughs started immediately and was completed by mid-year 2018.

Getmapping purchased one Pegasus:Two Ultimate mobile mapping system and upgraded the existing Pegasus:Two to the Ultimate version to complete this project. The Pegasus:Two Ultimate allows capture in a variety of lighting conditions and vehicle speeds - a higher dynamic range is enabled by a large sensor to pixel ratio and a dual-light sensor. Photogrammetry and image quality are improved with the increased side camera resolution of 12 megapixels and onboard JPEG compression.

"The Leica Pegasus:Two Ultimate's higher resolution camera system offered better picture quality, plus the dual fish-eye camera system provided 'stitching free' pictures," said Alexandre Alves, European operations

manager at Getmapping. “By utilising Leica Geosystems’ latest mobile mapping technology, which has three times the resolution compared to a standard system, the volume of data handled by Getmapping increased threefold, and we upscaled our processing resources to handle the huge volume of data that phase two required.”

After 100 days of surveying, the results of the two phases were:

- Surveys of all parking zones across 19 London boroughs and five cities
- More than 6,500-line km captured in city environments with multiple passes to avoid data occlusions
- 1 million points of data captured per second
- 19 terabytes of raw data collected
- 52 terabytes of data delivered
- 27 features extracted per controlled parking zone
- Final relative accuracy better than 1.5 centimetres
- Final absolute accuracy better than 4 cm
- Maximised value – mobile mapping reduces the average survey time by 80 per cent compared to traditional survey methods.

The captured imagery and point cloud data, along with associated feature extractions, enables AppyParking to deliver high definition traffic management data to their smart parking systems. Getmapping’s mobile mapping team delivered the final data ahead of time and also surveyed Brighton, Cambridge, Oxford, Portsmouth and Coventry to support AppyParking’s smart parking proposition. The customer’s expectation is to survey now cities around Europe.

© Lido3D2D

REVOLUTIONISING THE LUXURY YACHT BUILDING INDUSTRY WITH LASER SCANNING

Reka Vasszi

Survey

Case Study

3D laser scanning revolutionises the luxury yacht building industry in the Netherlands

Listening as the wind fills the sails, feeling the heat of the sun and the wind blowing on your skin while sailing through the oceans. Royal Huisman, a Dutch maritime craftsmanship and superyacht builder, makes sure all this happens in the most luxurious environment possible.

Elfje, the fairy of the oceans, is a 52.36-metre-long eco-friendly luxury yacht, built by Royal Huisman in the Netherlands at their Vollenhove shipyard. The luxury vessel is replete with sophisticated exterior design and engineering by Hoek Design and a graceful interior by Redman Whiteley Dixon.

From concept to completion, the yacht took four years to be designed, built and dressed. To accelerate the workflow, Royal Huisman requested Lido2D3D, a Dutch luxury interior drawing company, to think about a solution to speed up the carpentry work for the deckhouses.

INNOVATING THE BUILDING PROCESS

Lido2D3D transforms customer's concepts into detailed 3D drawings to support the work of the interior builders. The company uses 3D laser scanners to map out the ships with millimetre accuracy – the resulting 3D models serve as the basis for creating detailed interior plans.

"Practice, experience and craftsmanship brought us knowledge and perfection, therefore we use state-of-the-art laser scanning technology to provide accurate results to our customers," said Folkert Boermans, founder of Lido2D3D.

The carpentry work of deckhouses is a lengthy procedure that requires skilled carpenters and no mistakes are allowed. The deckhouses are made from aluminium and covered with massive teak. To speed up the workflow of preparing individual mould forms for the coverage and preparing the teak, Lido2D3D captured the ship with a Leica ScanStation P20 laser scanner. The team created a digital 3D model to prepare the parts for Computer Numerical Control (CNC) manufacturing production.

With the combination of the ScanStation P20 and the Leica FlexLine TS09 total station, it took only eight hours to scan both deckhouses inside and out. The point cloud was then registered and cleaned using the Leica Cyclone REGISTER 360 point cloud processing office software. Once the meshed model was ready, the surface model was created and could be transferred into any CAD software. Thanks to the efficiency of the Leica Geosystems solution, the full job, from the initial scanning to the surface model, took only 58 hours for Lido2D3D experts.

Having a detailed 3D surface model with accurate

measurements, enabled Royal Huisman to prepare all covering parts via CNC, thus saving time and increasing quality of the final product.

"The use of a 3D laser scanner is unique in the yacht building industry. It is important to have a very detailed design of the ship because we create most interior drawings in 3D. Our Leica ScanStation P20 laser scanner is able to map out the ship with millimetre accuracy. The scanner provides us the best basis possible to create a detailed interior drawing," said Boermans.

PERFORMING RELIABLE DATA

Elfje has been optimised to cruise fast and operate at a professional level to take part in sailing regattas. Lido2D3D was, therefore, asked to measure the tender hatch for replacing.

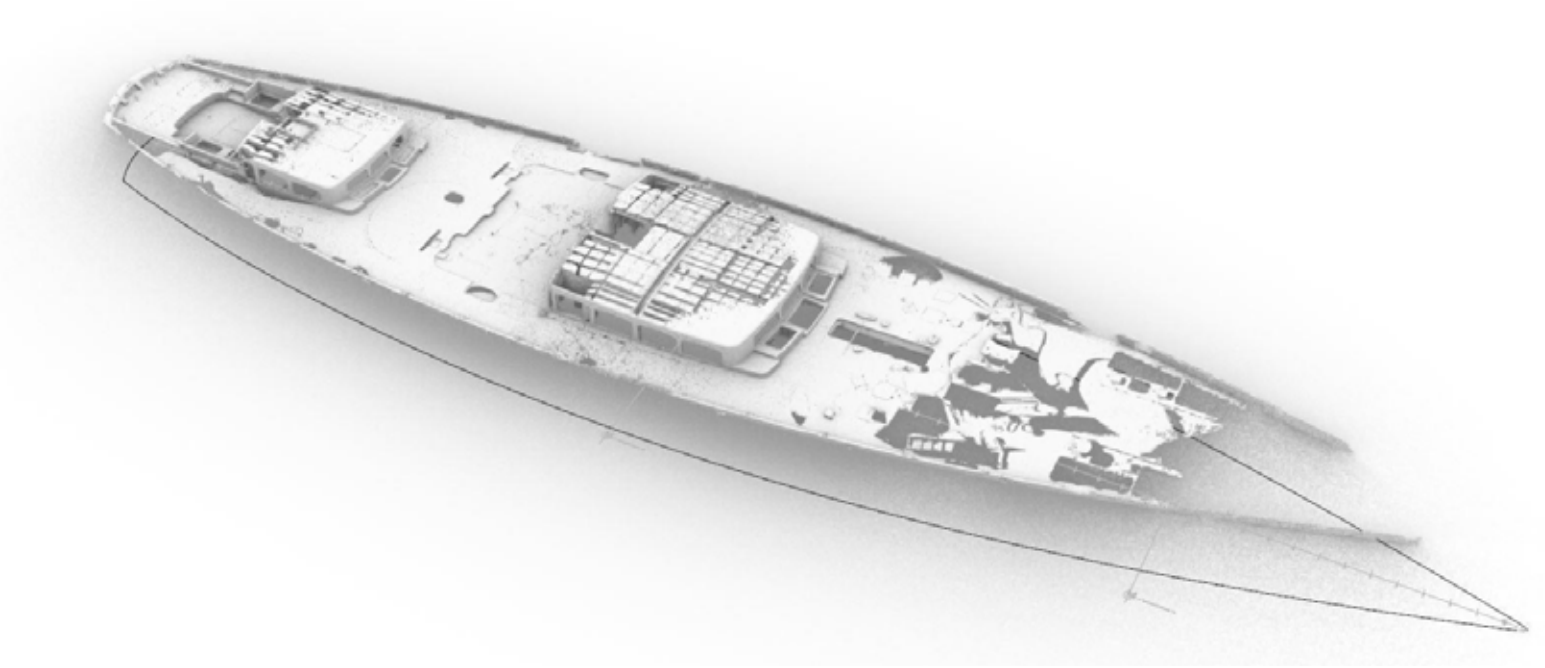
This task presented two challenges. First, the team could only carry out the survey once without any mistakes since the yacht was located in Antigua, but the hatch was going to be produced in the Netherlands. Once the new hatch is produced, it will be shipped wherever the yacht is sailing at the time and installed locally. Therefore, measurements needed to be accurate with a maximum deviation of up to 2 mm.

The second challenge was the ship was floating on the water and the team could not use the compensator of the scanner and the total station.

To overcome the challenges, the team used the ScanStation P20 in combination with the TS09 total station. Once Lido2D3D specialists scanned the hatch and the surrounding deck in a closed position, they repeated the same procedure with the hatch lifted above the deck. The deck calking and the outside shape of the hatch was also measured by the total station. To compare the data from the total station with the accuracy of the point cloud from the scanner, Lido2D3D used paper targets to double-check the data.

ANALYSING THE SMALLEST DETAILS

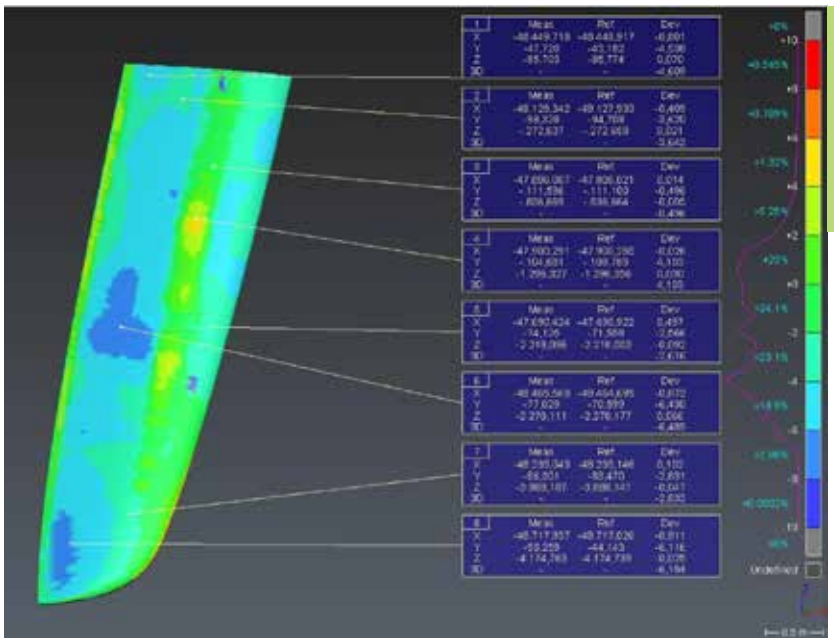
To maximise the speed of Elfje, Royal Huisman had to prepare a new rudder. The rudder blades

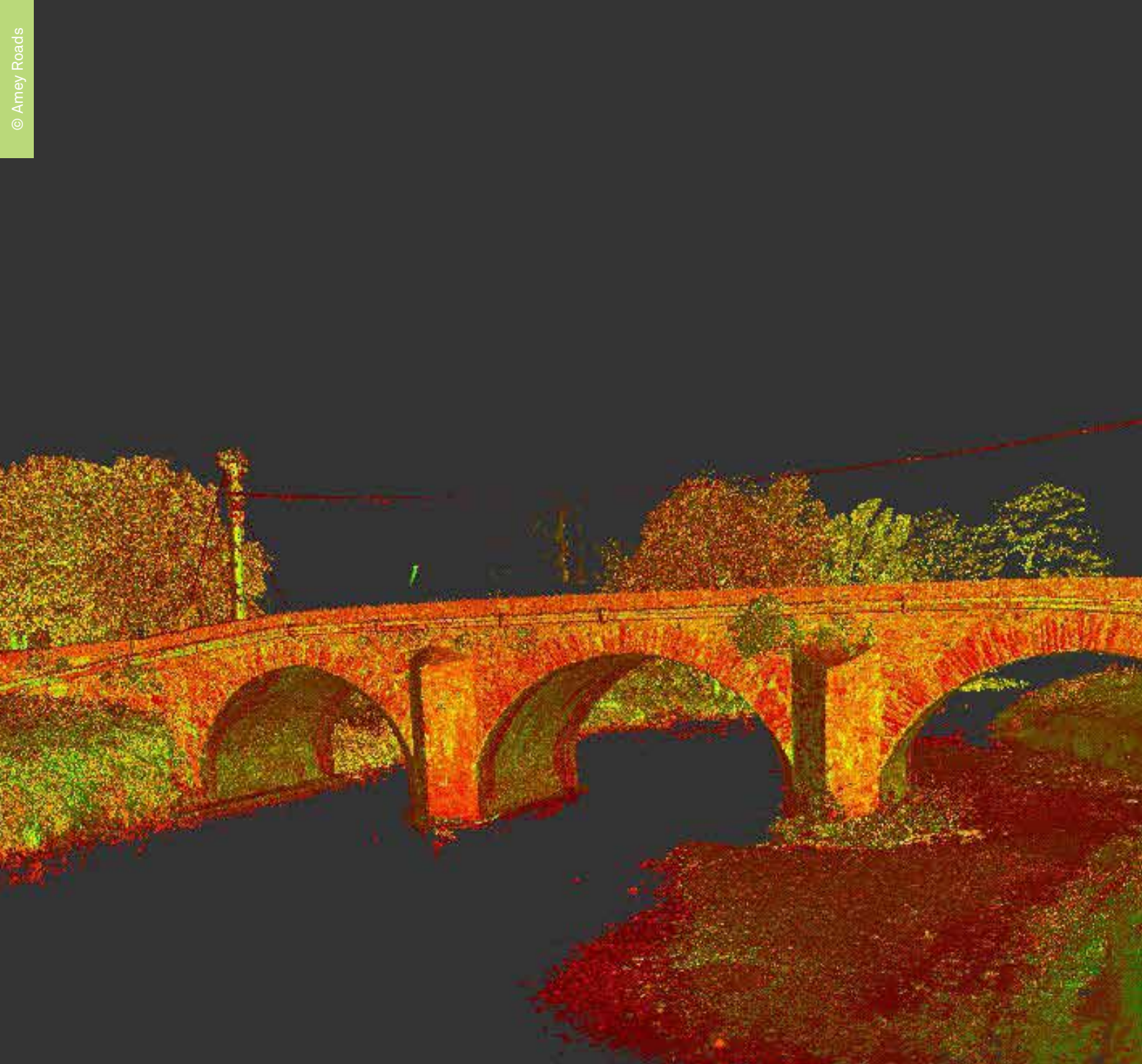


must be the same on both sides to achieve the perfect water flow, therefore the Dutch superyacht builder company asked Lido2D3D to perform an analysis and check for possible deviations.

After scanning Elfje with the ScanStation P40, the new blades were compared to a theoretical 3D model, allowing experts to identify the slight differences between the right and left part of the rudder.

Laser scanning is truly revolutionising the luxury yacht building industry by increasing quality and efficiency for a range of stakeholders. From planning to building and furnishing, laser scanning provides a reliable solution when it has to be right.





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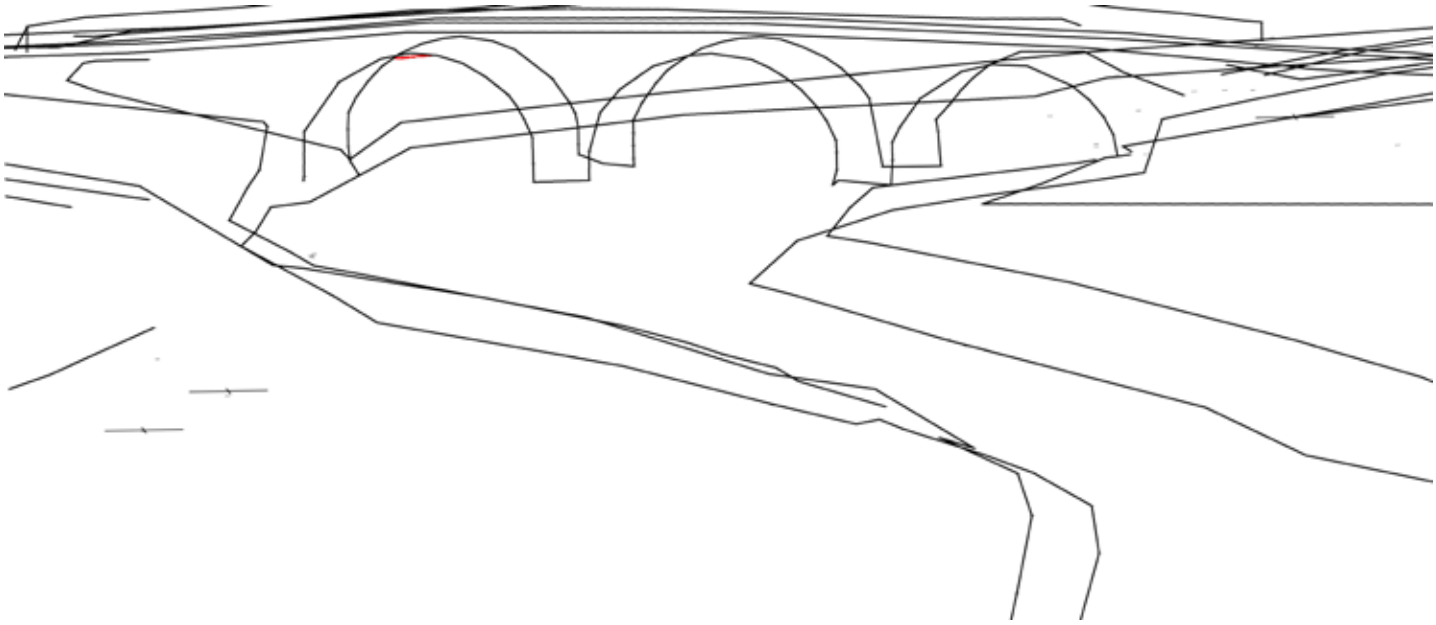
SCANS, SPANS AND AUTOMOBILES

Christopher Dollard

Survey

Case Study

Amey Roads uses BLK360 to survey bridges in Northern Ireland



As part of Northern Ireland's 'Building a Better Future' strategy to make it a better place to 'live, work, learn and grow', Amey Roads NI (ARNI) was tasked with building, operating and delivering improvements to a strategic road network across Northern Ireland (DBFO Package 2). But managing such a complex infrastructure had its challenges - from costly road closures to interpreting hand drawings from the 1960s. ARNI had its work cut out, so it turned to the latest reality capture technology, the Leica BLK360 imaging laser scanner, to create accurate 3D point clouds and images of the projects.

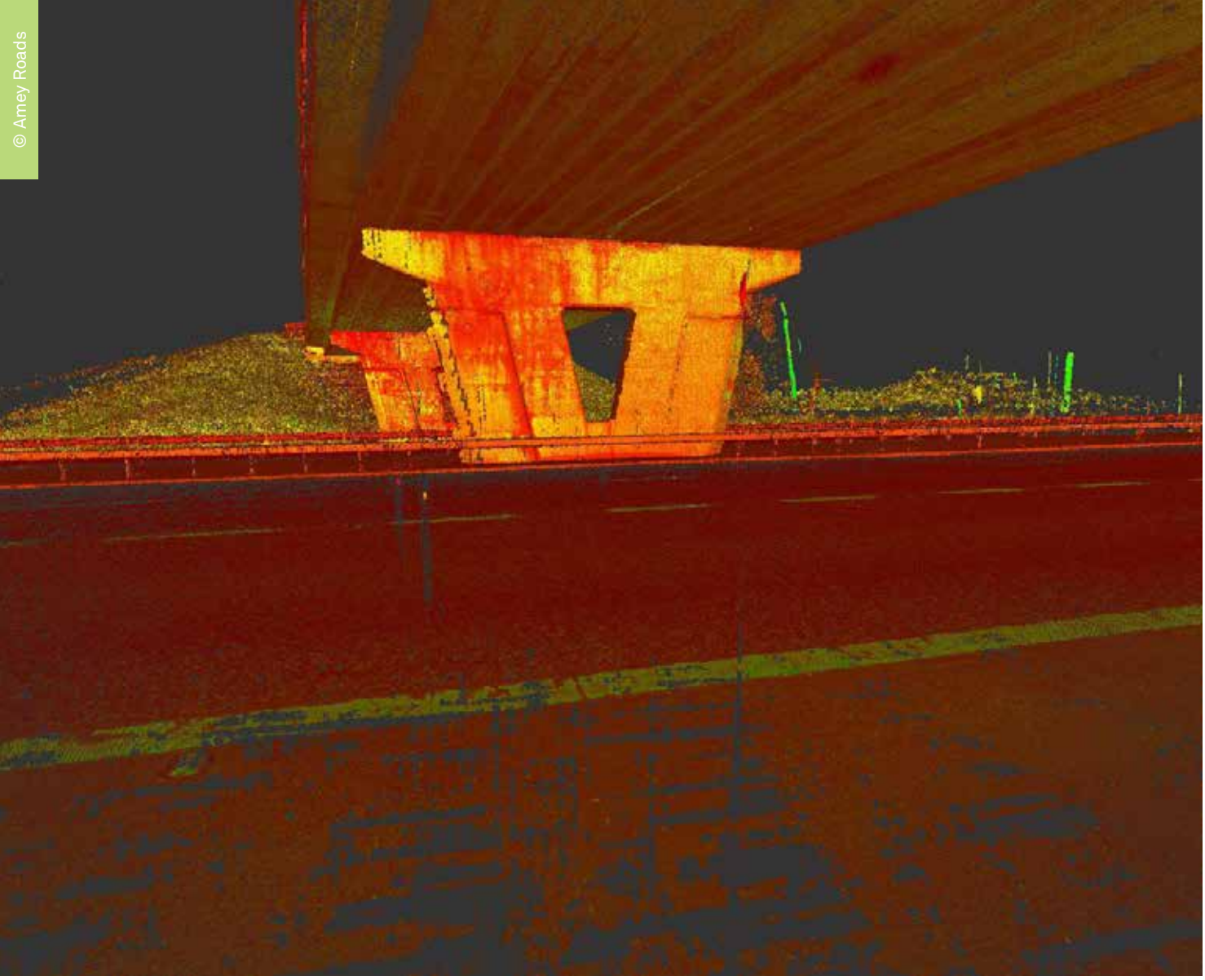
THE COMPLEXITY OF ROAD INFRASTRUCTURE MANAGEMENT

ARNI is responsible for 540 lane-kilometres of motorway and trunk road, 140 bridges and ancillary structures. The company employs Amey Consulting to manage the lifecycle risk profile of new and existing highway assets, and to complete surveys of the bridges to plan for essential repair and improvement works, and as part of a regular inspection programme. All while keeping roads open and structures operational at all times – no mean feat. Any road closures would not only cost the company money but also take a lot of lengthy planning, not to mention disrupt traffic flow.

3D REALITY CAPTURE TECHNOLOGY SIMPLIFIES AND DELIVERS DEEPER DATA

The BLK360 was designed to specifically address challenges like this. ARNI acquired a BLK360 and started to survey the bridges, create reference models and exact 3D scans to support remedial work and regular safety inspections. Using the intuitive laser scanner and its iPad software, Recap Pro, surveying bridges became a far simpler process. A single worker can park safely on the hard shoulder of the motorway and, at the press of a button, scan the entire underside of the bridge, securing detailed 360-degree, high dynamic range (HDR) spherical imagery and accurate point clouds in minutes.

The scans provide 3D point clouds, images of the bridges and its surroundings, and scan annotations highlight concrete delamination and exposed reinforcement. This helps to quickly identify the exact location and nature of defects or areas of disrepair, rather than needing to interpret site notes, sketches and images. Design teams use the point cloud in Civil 3D to create surfaces, elevation and section drawings, and plan repair works - including what parts, materials and resources are required - more efficiently. Once repair works are complete, a repeat scan can generate a complete as-built record for the health and safety file and can be used to substantiate the completion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of works and authorise payments.

NO TURNING BACK

Using the BLK360, ARNI can now carry out timely and accurate surveys and inspections of motorway bridges. For day-to-day use, the BLK360 is extremely portable, and the Recap Pro iPad software is very user friendly. Compared to traditional surveying, it produces highly detailed and accurate data within each scan.

ARNI recognised that the BLK360 would quickly return a sizable cost saving against the initial outlay. For example, previously, it could cost up to 4,000 British pounds (4,456 euros) to arrange a total road closure needed to complete a full bridge survey – and, over 140 bridges, that soon adds up. Using the BLK360 allows ARNI to quickly capture all essential data accurately, and without the need for costly and disruptive road closures and traffic management. It also makes it safer for surveyors who can now do their job from the hard shoulder or behind the safety barrier, removing the need to stand in the middle of the road.

The depth of detail captured by the BLK360 surpasses anything ARNI was able to capture previously. The scans are passed to designers, allowing them to immediately see where remedial work is needed, rather than having to interpret different plans, drawings and notes.

“Gone are the days of handwritten notes and zoomed-in photographs that no-one can figure what part of the structure we are looking at!” said John Jordan, lifecycle project manager at Amey Roads NI. “The BLK360 has already proven itself as an integral part of our team, and we look forward to continue exploring the possibilities of the BLK360 and identifying new ways it can transform our work, create efficiencies and reduce costs.”

© Amey Roads

Jordan was awarded the company's Amey Consulting Award in the 'Putting People First' category for his 2018 work with the BLK360. This specific category recognises individuals, teams or projects that have demonstrated the greatest impact on overall employee safety and wellbeing. "The use of the BLK360 technology helped remove surveyors from harm's way on a number of risky jobs, including the DBFO2 work on the motorway," said Jordan.

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DIGITALLY PRESERVING HUKURU MISKIY

Reka Vasszi

Survey

Case Study

Documenting digitally Malé Hukuru Miskiy and its exceptional coral stone carvings in the Maldives

A team of surveyors, programmers and heritage professionals is on a mission to unfold and virtually document the secrets behind the construction of the most important heritage site of the Maldives – the Malé Hukuru Miskiy.

The Malé Hukuru Miskiy, meaning the Friday Mosque, is located on the capital island of Malé in the Maldives and currently is included in the UNESCO World Heritage tentative list. To meet UNESCO's standards and become part of the final World Heritage list requires the detailed documentation of the mosque complex and additional conservation and refurbishment work.

Through centuries, no information or drawings have survived to describe the complex design and construction of the site and its structures, hence, the Department of Heritage of the Maldives asked Water Solutions Pvt Ltd. to capture and document the heritage complex in 3D.

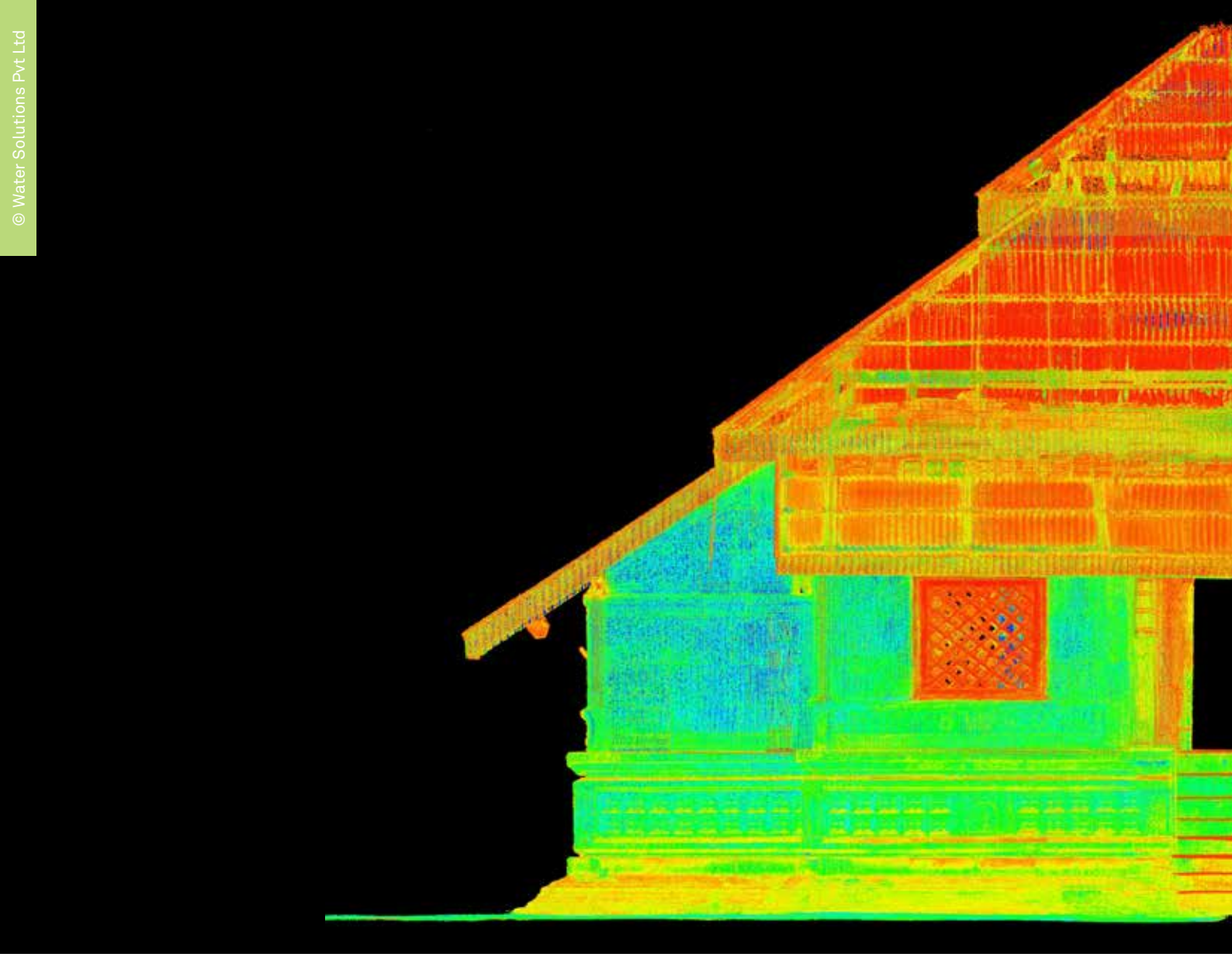
Water Solutions provides surveying, engineering and environmental consultancy services across the Maldives. The company strives to introduce new technologies and state-of-the-art equipment to improve its surveying services. To undertake a precise digital survey that would be the basis for 3D documentation and renovation of Hukuru Miskiy, Water Solutions used laser scanning in combination with a total station and the world's fastest GNSS RTK rover.

"Hukuru Miskiy is a historically and architecturally significant place; the work carried out by Water Solutions to digitise the mosque is priceless," said Yumna Maumoon, minister of arts, culture, and heritage in the Maldives.

SCANNING THE LARGEST CORAL STONE BUILDING IN THE WORLD

Hukuru Miskiy was built in 1658 under the reign of Sultan Ibrahim Iskandar. This mosque complex, the largest and finest coral stone building in the world, is a testimony of the fusion of Indian Ocean seaborne cultures and proof of the unique artistry of the Maldivian people.

The materials and techniques used in building Hukuru Miskiy display a significant stage in



ancient construction techniques of Maldivians. For the sake of preserving this cultural heritage and honour foregone Maldivian craftsmanship, Water Solutions captured and georeferenced Hukuru Miskiy in only a couple of days, using a combination of Leica Geosystems solutions:

- Leica BLK360 imaging laser scanner
- Leica Viva TS16 robotic total station
- Leica GS18 T GNSS RTK rover
- Leica Cyclone REGISTER 360 point cloud registration office software.

“Surveying is something I do with great passion. I love the technology and the sense of adventure that comes with working outdoors. Leica Geosystems has been innovating and changing the game with their latest surveying gear. Collecting data for this project in such detail has made this an exciting one,” said Mohamed Affan Shakir, offshore surveyor at Water Solutions.

BLENDING TECHNOLOGIES

The heritage site consists of the mosque surrounded by a 17th-century cemetery and a minaret. The sanctuary complex is still used to conduct the daily prayers, thus the team had limited time to scan the building. Besides, the many small rooms, the detailed carvings on the walls and the narrow loft encumbered the documenting process.

Water Solutions required a compact product that would capture scans fast with high-resolution images and can also fit in small places to document the fine details. With these challenges in mind, the team selected the BLK360 to capture the mosque, its roof structure, the cemetery and the minaret.

To reference the scanning targets, the TS16 robotic total station was used in non-prism mode to directly measure the coordinates of the targets. To georeference the final point

cloud, the GS18 T GNSS RTK rover was used to establish control points on site. Finally, the point clouds were transferred and post-processed in Cyclone REGISTER 360 3D laser scanning point cloud registration software.

“We put our trust in Leica Geosystems surveying equipment to collect accurate data and never had any issues with the equipment. It is vital to have a gear that you can rely on when carrying out surveying in any outdoor environment,” said Hamdulla Shakeeb, laser scanning expert at Water Solutions.

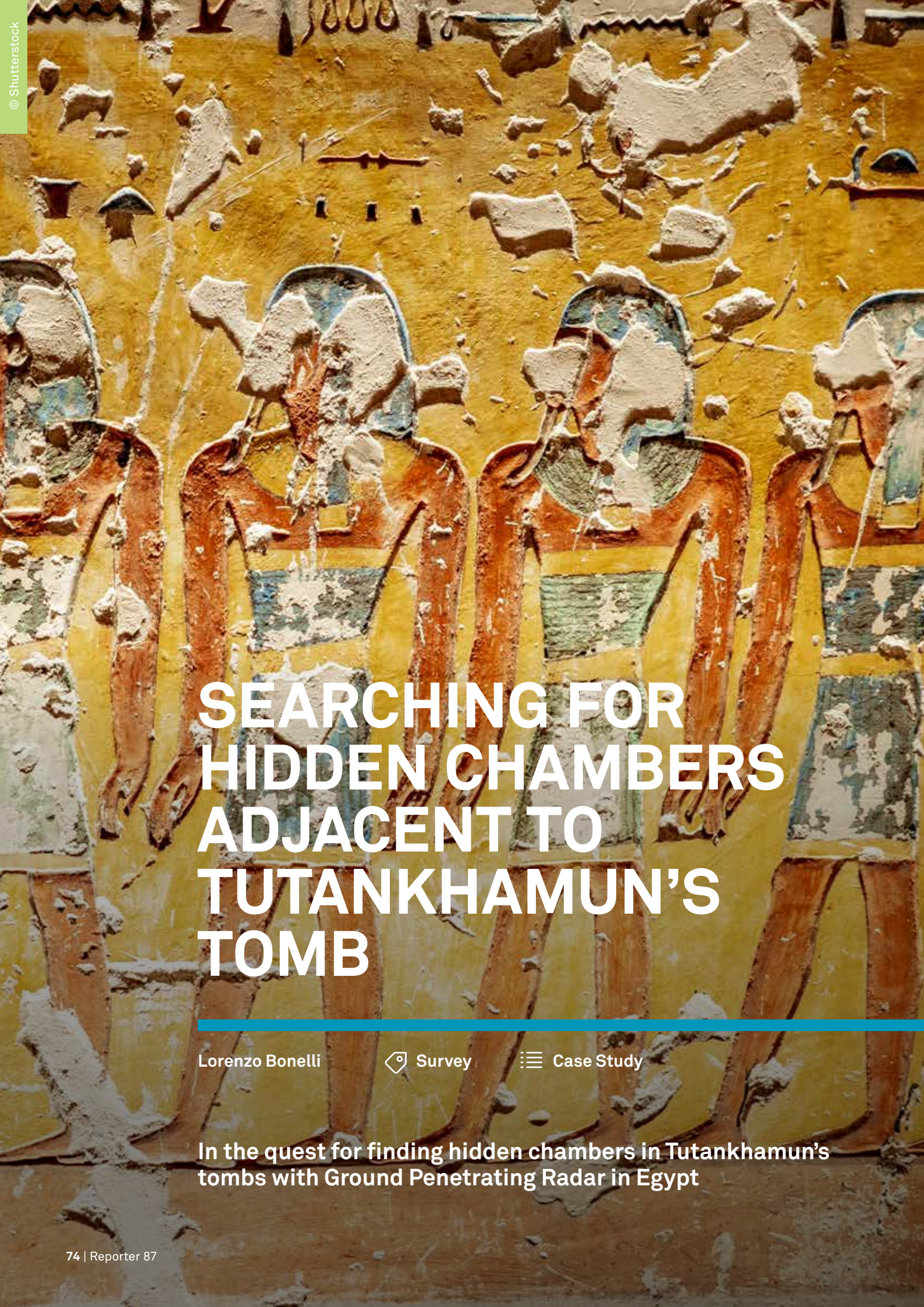
PUSHING THE BOUNDARIES OF HERITAGE PRESERVATION

The creation of this digital dataset can help preserve this more than 360-year-old heritage site and the detailed as-built map can be used in the rehabilitation of the roof structure and as baseline map for future restoration. The detailed 3D models allow heritage professionals to document, manage, renew or maintain Hukuru Miskiy and qualify the site for the final decision on its inscription on the World Heritage list.

“Using Leica Geosystems equipment has strengthened the confidence with our clients, helping to build long-lasting business relations,” said Shakir.

Besides the physical preservation of the heritage site, laser scanning enables the development of small-scale 3D models or Virtual Reality applications to teach students about Maldivian history, craftsmanship, traditional architecture and ancient construction techniques.

The BLK360, in combination with the total station and GNSS RTK rover, enabled Water Solutions to introduce laser scanning in the Maldives for the first time and showcase the potential of laser scanning to survey and document heritage sites.



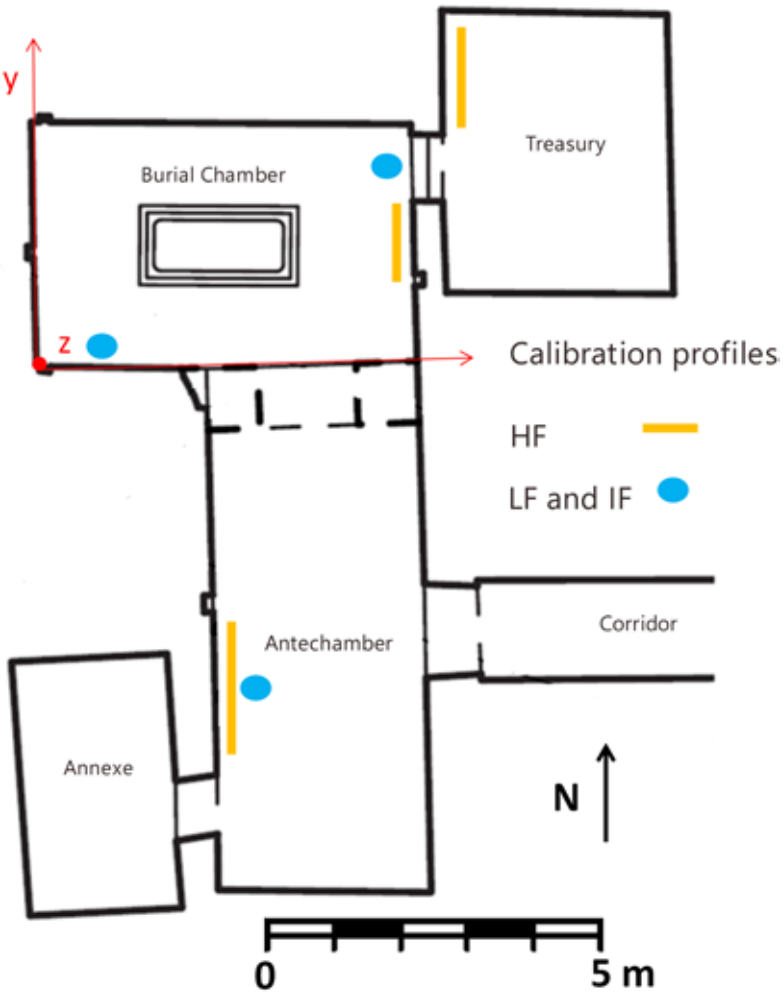
SEARCHING FOR HIDDEN CHAMBERS ADJACENT TO TUTANKHAMUN'S TOMB

Lorenzo Bonelli

Survey

Case Study

In the quest for finding hidden chambers in Tutankhamun's tombs with Ground Penetrating Radar in Egypt



The tomb of the young pharaoh Tutankhamun is the most famous of all the royal tombs within the Valley of the Kings (VOK) in Luxor, Egypt. This tomb was discovered, with an almost intact funerary treasure by Howard Carter in 1922.

The existence of hidden chambers and corridors adjacent to Tutankhamun's tomb (code name KV62) has been long debated. In 2015, it was suggested these chambers may host the yet undiscovered burial of Nefertiti. To test this hypothesis, two Ground Penetrating Radar (GPR) surveys conducted in 2015 and 2016 from inside KV62 were carried out but gave contradictory results. To solve these uncertainties and obtain a more confident and conclusive response, a third GPR survey was conducted in 2018 using IDS GeoRadar technology.

"This work was both a thrill and a challenge at the same time. The thrill is obvious – it felt like spying on the most famous Pharaoh's golden burial palace, only some 3,300 years later. In fact, our 21st-century state-of-the-art, multichannel and multi-frequency GPR instrumentation allowed an unprecedented scan through the chambers' walls, in terms of resolution and clarity of the results," said Gianluca Catanzariti, GPR specialist at 3DGeoimaging.

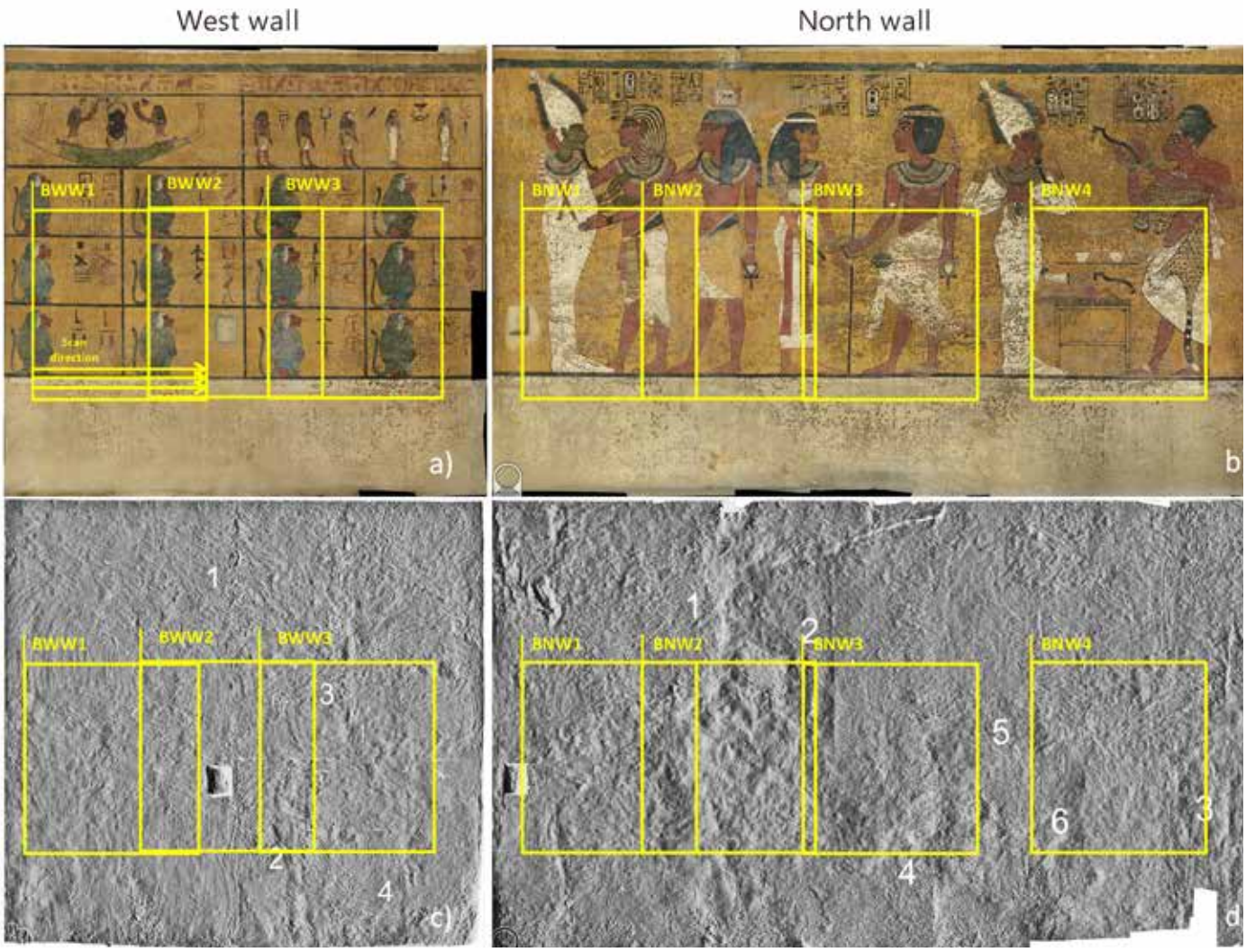
THE DISCOVERY OF THE CENTURY

GPR is commonly and successfully used in archaeological and forensic applications. Given the expected physical contrast between the bedrock in which the tomb is carved and the supposed sealed doorways as well as the possible presence of a wooden lintel above the doors, GPR is the most effective method to establish the presence of hidden chambers adjacent to KV62.

The first GPR survey indicated the presence of two distinct regions or cavities of significant empty space beyond the decorated North and West walls of the burial chamber. This finding was called 'the discovery of the century.'

The Ministry of State of Antiquities (MoA) in Egypt commissioned a second GPR survey to reconfirm the results of the first KV62 GPR survey. This second survey was carried out by a National Geographic team using medium/high GPR antennae to scan into the walls of the tomb. The second KV62 GPR scan, however, could not confirm the initial findings. Therefore, the conclusions of the second KV62 GPR survey were inconsistent with those of the first GPR survey.

The fact the two previous KV62 radar scans proved inconclusive was a strong indication that the complexity of



the task was somehow underestimated. Given this, the MoA called for a third, comprehensive geophysical survey of Tutankhamun's tomb capable of providing conclusive evidence on the existence of hidden chambers and corridors adjacent to KV62.

To counter potential technical difficulties, the Italian team from the Polytechnic University of Turin, Geostudi Astier, 3D Geoimaging, and the University of Turin carried out the third survey using three GPR systems covering multiple frequency bands, from 150 MHz to 3 GHz.

COMBINING HIGH- AND LOW-FREQUENCY GPR SURVEYS

Due to the requirement of scanning the walls without damaging their precious decorations, special equipment was designed and executed by the research team to move the antennae at a certain distance from the walls.

"The challenge resided in the peculiar instrumentation-target configuration – our GPR system had to 'slide' parallel to the vertical chamber's walls in order to scan the volumes beyond them, and this had never been tried before," explained Catanzariti.

High-frequency (HF) surveys allow higher resolution for potential identification of shallow anomalies related to the doorway corners and to the presence of a backfilling structure made by incoherent material, including non-shaped stones blocks. HF scans were planned in order to investigate a stripe, about 1.5-metre-high, along the West and the North walls. All the GPR profiles were acquired with a GPR unit composed by an Aladdin 2GHz IDS GeoRadar antenna box and an IDS GeoRadar K2 control unit.

Low-frequency (LF) GPR surveys promote electromagnetic wave penetration and the potential identification of deeper voids. Acquisition of LF scans happened with an IDS GeoRadar RIS TR200 shielded antenna operating in transverse electric (TE) mode



collecting data along the vertical direction, from bottom to top. The experts acquired intermediate frequency (IF) scans with a dual polarisation multi-channel IDS GeoRadar Stream C system.

Stream C allowed to simultaneously record, by a single swath, 23 radar profiles in transverse magnetic (TM) mode and 9 radar profiles in TE-mode.

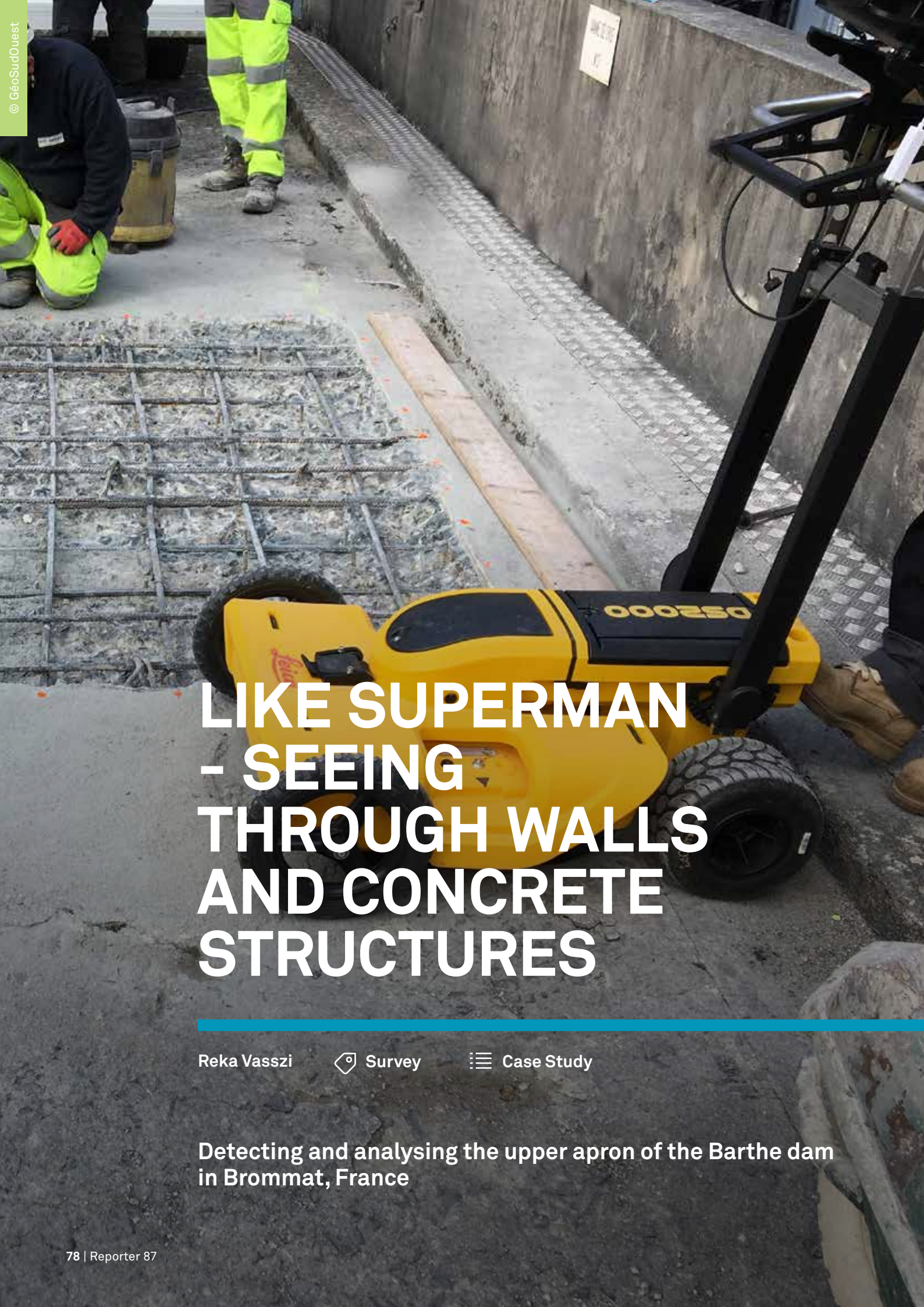
In the end, the collected data obtained during a very large number of horizontal and vertical scans of the relevant KV62 walls summed up to about 2.7 kilometres of radargrams.

IN THE QUEST FOR FINDING HIDDEN CHAMBERS

According to the processed data from HF acquisitions, the Italian research team found no evidence of a vertical plane (orthogonal to the scanned walls) that could be interpreted as the boundary between the rock and a blocking wall. Experts suggest the first KV62 GPR survey was likely misled in its conclusions by 'ghost signals', agreeing with the conclusions of the second GPR survey.

However, probably due to the limited time availability and spatial extension, the second KV62 GPR survey was unable to provide a convincing conclusive answer. With a high level of confidence, the research team concluded the theory concerning the existence of hidden chambers adjacent to Tutankhamun's tomb is not supported by GPR data.

The original full article by Luigi Sambuelli, Cesare Comina, Gianluca Catanzariti, Filippo Barsuglia, Gianfranco Morelli, Francesco Porcelli was published on the March–April 2019 issue of Elsevier: https://www.sciencedirect.com/science/article/abs/pii/S1296207418308124



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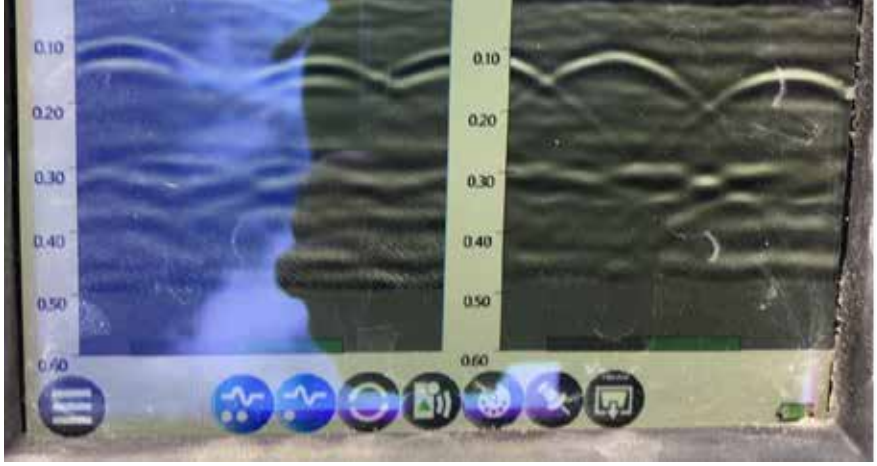
LIKE SUPERMAN - SEEING THROUGH WALLS AND CONCRETE STRUCTURES

Reka Vasszi

Survey

Case Study

Detecting and analysing the upper apron of the Barthe dam in Brommat, France



Regular monitoring and maintenance, as well as comprehensive inspection, ensure dams remain in a safe and working condition throughout their lifetime. The early detection of deficiencies can, furthermore, prevent failures. Precautionary operations, such as daily inspections of facility conditions or repairing defective spillways, gates and valves are among the routine maintenance activities of dam operators.

Reaching the ambiguous areas for inspection on the dam's downstream face can be challenging considering the height and accessibility of the dam's apron. To reach the valves and carry out maintenance work on the Barthe dam in France, MEIJE, an electromechanical company, and the Electricite de France (EDF), producer of renewable electricity, came up with a solution. With the help of a winch mounted on a crane built on the upper apron of the dam, professionals can descent down to perform maintenance on the valves.

The project was quite challenging. To construct the crane, the team had to drill 20, 80-centimeter-deep holes into reinforced concrete, where three different layers of steel bars located at three different depths – 10, 30 and 50 cm deep from the surface. To avoid hitting the steel grids, the team requested GéoSudOuest, a surveying company, to precisely locate the buried assets.

TRACING ON THE GO

In accordance with the company's principles; "privilege the person and the quality of work," GéoSudOuest experts deliver tailor-made, effective solutions for their customers.

With the need to locate and avoid the steel grid while drilling the holes into the upper apron of the dam, the customer required a real-time tracing and imagining solution.

GéoSudOuest professionals used the Leica DS2000 utility detection radar together with the IDS GeoRadar C-thrue, all-in-one Ground Penetrating Radar (GPR) to precisely visualise and analyse in real time buried assets before drilling into concrete. Once the layers of steel bars were detected with the DS2000, the team used the C-thrue to confirm and double check the results. Thanks to the dual antenna polarisation of both GPR, the team simultaneously detected the rebars at both deep and shallow levels and determined their exact position within a range of 80 cm depth.

"Despite the difficulty related to the dense rebars, GéoSudOuest team could detect the buried assets with high accuracy. Leica Geosystems' solutions allowed us to properly locate the position of the rebars at each level," said Boulade Gérard, surveying expert at GéoSudOuest.

The automatic position and navigation system of the DS2000 increased productivity and saved survey time for GéoSudOuest. Once data was collected, experts analysed the hyperbolic signatures with intersections to estimate the location and size of the target. After verifying the results, the team marked the surface with yellow and orange lines signing where the rebars were running at different depths.

REVEALING RELIABLE DATA

Unless we possess Superman's wondrous vision, GPR is the most reliable tool for effectively locating underground utilities. Accurate scanning and real-time analysis of the dam's upper apron enabled the team to safely locate and drill the 80-cm-deep holes avoiding the rebars crossing at different levels to perform the maintenance work needed.

The DS2000 and C-thrue revealed reliable data in real time, and the real-time visualisation helped the team to make optimal decisions on the spot.

IN YOUR WORDS

WELCOMING THE NEW LEICA BLK2GO

Introducing an extensive list of world's-first hardware and software solutions, Leica Geosystems, part of Hexagon, has revolutionised the world of measurement technology for 200 years.

Measurement professionals startled once again with the newest additions to the Leica BLK series introduced at HxGN LIVE 2019. The Leica BLK2GO is the smallest portable, completely integrated handheld-imaging scanner in the industry that seamlessly captures 3D environments while the user is in motion.

With the BLK2GO, professionals can take advantage of never-before-seen mobility for scanning complex indoor environments. The handheld-imaging laser scanner combines visualisation, LiDAR and edge computing technologies to scan in 3D, allowing users to be much more agile and efficient in capturing objects and spaces. Efficient and mobile capturing opens opportunities for new businesses from adaptive reuse projects in the architecture and design industries to location scouting, pre-visualisation for media and entertainment.

This revolutionary mobile 3D handheld-imaging scanner has gained the ovation from people around the world. Check how the crowd in social media welcomed the BLK2GO.

Bennet and Francis

On the way home from **#HxGNLIVE** where perhaps the bigger announcement for us was the **#BLK2GO** – a 700,000 point per second handheld scanner with **#SLAM** + VIS for trajectory - we have a few use cases in mind already. Great few days, learnt a lot, talked more.

Datum Tech Solutions

Leica Geosystems unveiled a real game changer this week at HxGN LIVE... The BLK2GO, placing reality capture in the palm of your hand. **#BLK2GO #HxGNLIVE #datumtechsolutions #comingsoon**

Highways Today

New BLK2GO handheld imaging laser scanner delivers unprecedented efficiency. **#BIM #CAD #Geosystems #Laser #Scanning #Digitization #BLK2GO**

Gavin Schrock

They are real, and they are magnificent... the BLK2GO; a new SLAM handheld. **@LeicaGeosystems @xyht**

Crevo Interactive

#BLK2GO #LeicaGeosystems The ultimate way to scan a property or open space.

NSS Canada

Have you heard the latest news from Leica Geosystems? We were lucky enough to have experienced the first reveal of the revolutionary BLK2GO, while we attended HxGN LIVE last week in Las Vegas!

Andrew Reid

The **#BLK2GO**, a handheld LiDAR and SLAM device with cameras announced at the Geosystems keynote. Very cool stuff. I wonder what they will be looking at next.

Geoffrey Stoneham

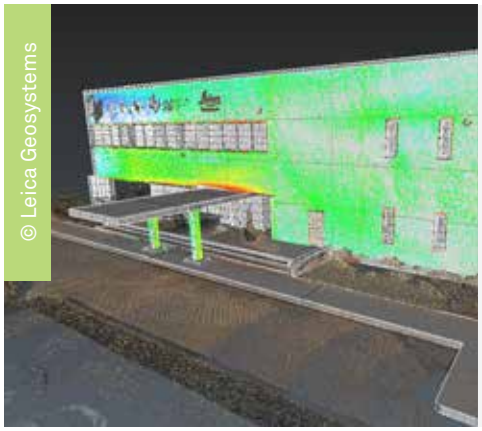
#HxGNLIVE was a fantastic networking and learning experience this past week. The **#debut** of the **#BLK2GO** and the introduction of Cyclone 3DR has me very excited about the future of reality capture in construction. **#LeicaGeosystems #3DLaserScanning**

New handheld imaging laser scanner offers unprecedented efficiency

The Leica BLK2GO is a wireless handheld imaging laser scanner that seamlessly captures 3D environments while the user is in motion, and continuously creates a digital representation of reality in the form of 3D point clouds. The BLK2GO's compact and handheld design allows a much greater degree of mobility, as well as access to spaces and objects that may have been difficult or impossible to scan before.

New real-time reality capture sensor for building management and surveillance

The Leica BLK247 provides professionals in security or building operations with a second line of defence that alerts them to unauthorised or abnormal activity as it's happening. The BLK247 uses LiDAR, 3D digital fencing and continuous scanning to monitor buildings and spaces 24 hours a day, 7 days a week, making it ideal for protecting private and public spaces including airports, hospitals, schools and museums.



New reality capture software brings point cloud processing into one streamlined application

The Leica Cyclone 3DR is the new reality capture software that fuses technology for centralised, full-scale point cloud management from Leica Cyclone with advanced, automated point cloud analysis and modelling from 3DReshaper. The new software delivers a simplified platform for surveying, architecture, engineering and construction (AEC) and tank inspection applications.

New Ground Penetrating Radar solution revolutionises underground utility detection

The Leica DSX, a portable Ground Penetrating Radar (GPR) solution, allows users to easily detect, map and visualise underground utilities safely and reliably with highest positioning accuracy for utility repair and maintenance, civil engineering and surveying companies. Unlike any GPR system, the Leica DSX maximises productivity with cutting-edge software that automates data analysis and creates a 3D utility map on the field.

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Peel back the surface on underground utility detection

Quickly and easily locate, visualise and map underground utilities with the new Leica DSX and DXplore non-destructive detection solution. Delivering instant, clear and accurate visualisation of underground utilities in the field.

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- when it has to be **right**

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