REPORTER

Geosystems Division

October 2020, English Version

Surveying Germany's biggest aqua park

5G wireless network design relies on 3D aerial data

Bringing BIM4ALL

An invitation into the piling rig cabin of Henrik Bergman

Changing business models with digitalisation strategies

Learn how companies across the globe are successfully treading new ways in order to strengthen their competitive advantage.

HEXAGON

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President's Message

Thomas Harring
President, Hexagon's Geosystems division

Many industries and companies describe 2020 as a "lost" year. We definitely do not! Though this year has dramatic humanitarian and economic challenges affecting us all, requiring a lot of flexibility and adaptability, we also see countless impressive success stories from our customers.

Throughout our long history, we have overcome many external market changes and technology changes, all while keeping a high pace of innovation. Customers are the focus, and we strive to never let them down. I have been able to participate in various leadership positions during the past 17 years, and now, as president of Hexagon's Geosystems division, I present you my first Reporter President's Message with a dedicated focus on the digitalisation boost, which industries are experiencing right now.

For a long time, and now reinforced, we are experiencing a digital acceleration within the industries. Companies are on a journey using digitalisation to automate tasks and quickly bringing all relevant stakeholders together in ecosystems, which lead to autonomous solutions. It is impressive how customers use our solutions to digitise their business models. In this edition of Reporter, we present companies that have left traditional paths and are successfully treading new ways in order to strengthen their competitive advantage.

Surveying methods enable digitalisation of real estate. Hollis, a leading firm of independent real estate consultants in the U.K., use Leica Geosystems 3D laser scanners and software to digitalise commercial and residential properties. The reality capture experts now manage vast amounts of digital data making it accessible across the company so CAD work can begin sooner. With point cloud registration times minimised, the firm delivers final scans to clients quicker and more cost-effectively.

Building construction benefits from streamlined workflows and faster interaction with customers. Kolb GmbH, a scaffolding provider in Germany, has modernised its consultation workflow with the Leica BLK3D real-time 3D measurement solution. Automating measurements on handheld devices, the company has reduced its time on sites by more than 80%. By connecting the field data to technicians back in the office, the company is now able to provide fast quotations.

Heavy construction historically has been a digitally underserved industry. Al Nisr, a world leader in the construction of airfields and supporting infrastructure in the UAE, turned to Leica iCON 3D machine control solutions to create digital construction sites that connected all project stakeholders. Moving to stringless paving, the company automated stakeout procedures while tripling its capacity length in paving airstrips and cutting project times in half.

HxGN Content Program supports automating tasks with maturing technologies, such as Artificial Intelligence (AI). These technologies, though, rely on consistent information to feed and train algorithms. With imagery being collected on a regular schedule and providing normalised datasets, the HxGN Content Program enables advanced analytics and automatic updates of location-based information. Updates are then performed efficiently, leading to automation of tasks like change detection.

The digitalisation journey is gaining speed and the momentum of the "next normal" will accelerate the convergence of real and digital worlds into autonomous solutions, providing and creating business opportunities. At Geosystems, experiencing the digitalisation boost ourselves, we will continue to strengthen our customers with innovative sensor and software solutions to lead by example and demonstrate what can be done. Join us in co-creating an autonomous future.

Have an interesting and enjoyable read.

CREATING SMART DIGITAL REALITIES WITH REALITY CAPTURE

Editorial

Burkhard Boeckem — Chief Technology Officer for Hexagon, based in Switzerland.

Sensor fusion to create the latest digital reality visualisation platform, HxDR.

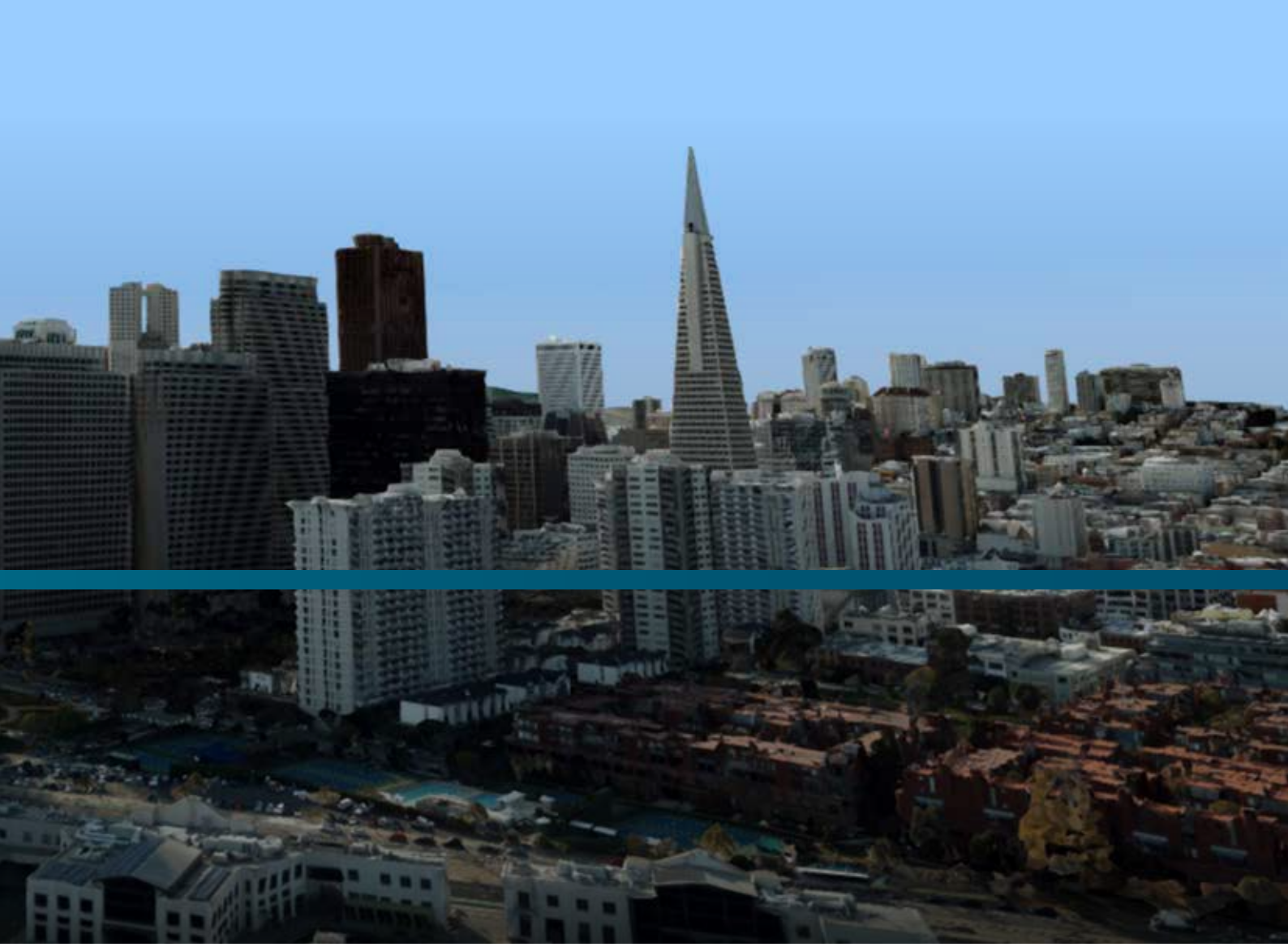
With reality capture, the world can be completely digitised and digitalised, creating valuable digital twins. These are a replica of the physical world — city streets, power grids, construction sites, factories, and more, which are used to digitally transform our cities, infrastructures and environments.

There is a long list of applications and use cases for reality capture from industries spanning engineering and construction to project scheduling of buildings on time and built to plan, to monitoring the evolution of a mine, making manufacturing truly digital, or in media and entertainment where information from the digital twin of a film set is used to make edits in a post or virtual production.

The act of reality capturing is important for the following reasons:

- It enables users to create products such as real-world high definition maps or 3D design models;
- It enables virtual design, simulation and testing based on the real world (e.g., if you need to check the safety of an autonomous vehicle using reality capture, you can carry out driver simulations);
- Finally, reality capture also enables you to be able to develop autonomous services including, for example, auto collision systems at a reduced cost in testing.

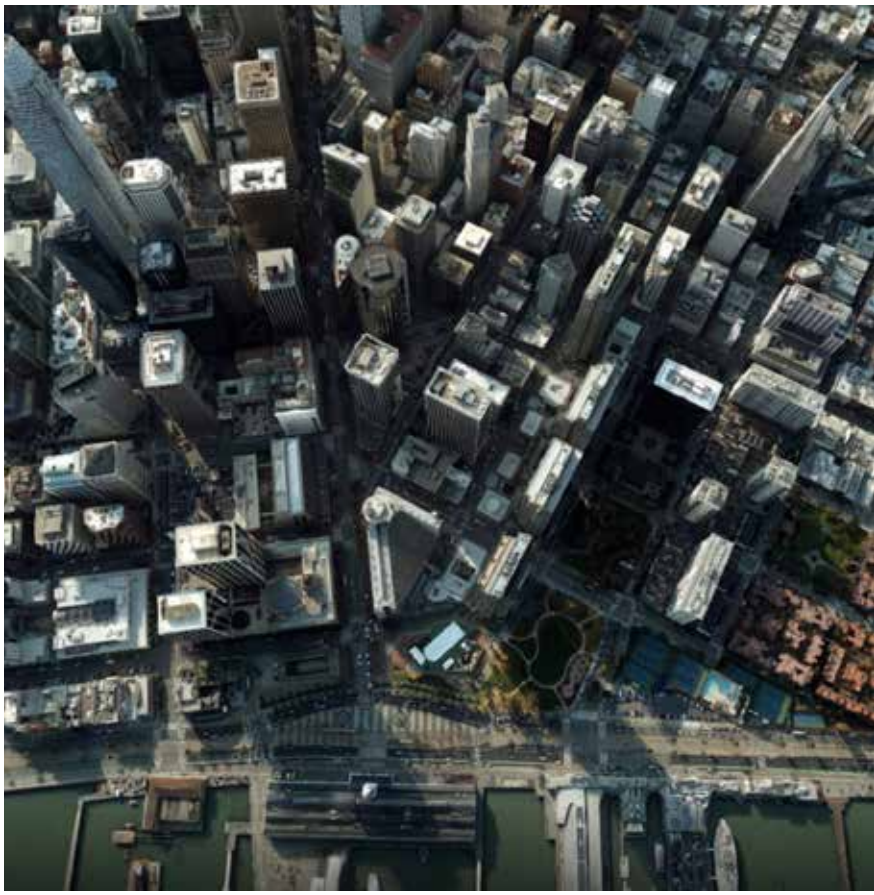
The more quality data sources you have, the more insightful and valuable your digital twin will be. Our world-leading sensor and visualisation services portfolio includes terrestrial laser scanners like the Leica RTC360, imaging scanners such as the Leica BLK360 and the Leica BLK2GO, and our mobile mapping solutions (e.g., the Leica Pegasus:Backpack) and — now, introduced earlier this year, our HxDR platform. HxDR is a new cloud-based, digital reality visualisation platform. It creates accurate digital representations of the real world through the seamless fusion of reality capture data from airborne, ground and mobile sensors, which are



used to visualise and share 3D design projects and models within real-world context of the data that's been captured.

Hexagon is uniquely placed to accelerate the innovation in Smart Digital Reality and connected and autonomous technologies through its sensor and visualisation portfolio — and the connection of value that we find between them.

It's a truly exciting time to be in the industry, and I look forward to sharing with you our next set of innovations that will bring us a step further in delivering on our vision of an autonomous future.



SURVEYING FOR A CONSTRUCTION ROBOT — TRUE HUMAN-MACHINE COLLABORATION

Editorial

Richard Ostridge — Senior Product Engineer for Leica Geosystems based in Switzerland.

What will automation in construction bring for surveyors? With rising expectations to design better and construct faster there will likely be plenty of opportunities for surveying businesses providing services to construction companies.

Every time I look at my social media feeds, I see at least one post about Artificial Intelligence or Machine Learning. However, I recently read about an equally impactful technology revolution that seems underrepresented in such discussions — robot builders.

Previous technological advances already reduce the effort required to build – diggers, cement mixers, jackhammers, electric drills and screwdrivers, to mention just some equipment, that simplifies construction tasks. In the last few years, though, another significant advance has started to come into focus — automation.

AUTOMATED SYNTHESIS

An article from the World Economic Forum titled "Built by Robots: This Swiss Company Could Change the Construction Industry Forever" made me think about how the fundamentals of building are rapidly changing. The article features a proof of concept three-level 'DFAB' house in Switzerland, featuring 3D-printed ceilings, energy-efficient walls and timber beams assembled by robots on site. A researcher responsible for the project quoted in the article, Matthias Kohler, had a clear vision of how machines and humans would work together in the future. According to Kohler, robots should not be expected to synthesise human craftsmanship, but rather humans should reverse engineer the design to allow robots to build materials and structures that suit their strengths.

Off-site house construction is not new — in the last 20 years, brands like Huf Haus have refreshed the public's enthusiasm for prefabricated buildings. What's different about the DFAB house is the scale use of 3D printing and basic robotic assembly, which omits an entire layer of human effort to create elements of the building. Of course, these elements still require human assembly, but if architects and builders fully take on Kohlers' vision, the building design can be simplified so robots can also do some of this assembly.

AUTOMATED ASSEMBLY

Automated assembly is not something to expect to see happening on a large scale in the next 20 years, but there's growing examples of the edge cases of robots doing more kinetic labour. For example, Construction Robotics' Semi-Autonomous Mason, the Sam100, is currently at work on a handful of building sites across the U.S. It can apply mortar to any size brick and place one every 8.5 seconds. Where a human mason can lay 300-600 bricks in an eight-hour shift, the Sam100 can lay more than 3,000. Videos of Sam100 in action get millions of views on video-sharing platforms, indicating that there is interest and excitement in this topic.

Sam100 joins Hadrian X from Australia's Fast Brick Robotics, which both 3D print, lay bricks, and can complete the superstructure of a conventional masonry home in just two days. Another interesting example of an advanced construction robot is a robotic hot-wire cutting robot from Danish company Odico, which uses electrically-heated wire to cut through industrial foams, replicating the geometry by a given CAD-model. Also, EffiBOT from Effidence in France can follow workers carrying tools and materials.

Naturally, there's hesitancy in any industry about robots automating more workload. Nevertheless, despite the amazing examples described above, robots won't be building houses in volume for

several years. Of course, many positives can easily be identified — such as cost, time and impact on the environment. However, so can some of the cons, where issues like retraining of parts of the workforce do need to be considered critical for long term acceptance and success.

As a surveyor reading about technology like this, I don't immediately think about the impact on construction projects. Instead, I think what does this automation mean for the survey industry? The good news is that with rising expectations to design better and construct faster, I believe that there will likely be plenty of opportunities for surveying businesses providing services to building construction companies.

HYBRID SURVEYORS

If a robot is going to produce an object, accurate sizing information is mandatory. If a robot is going to place something into the correct location on site, accurate position information is required.

Tolerances will be tight, accuracy and precision will be demanded, compromise won't be an option — and that sounds like the calling card of a surveyor to me.

Whereas a human on a construction site can see a small discrepancy and instinctively know how to handle the problem, I am not convinced a robot would be able to self-solve the issue on-the-fly. Perhaps it would detect the problem and then request human assistance — reducing the efficiency gain that was one of the motivations for using robots in the first place. Undeniably, the best way to maximise the efficiency of robots is by providing them with quality information that truly represents reality.

So, will a survey ever be captured without a human? Well, in some data capture scenarios it can be argued that the role we play has already slightly shifted — for example, shifting from selecting which exact points to measure towards picking an area and density to let the instrument capture. Mainly, this is thanks to the advancements, acceptance and use of technology, like the Leica RTC360 3D laser scanner, or mobile technology, such as the Leica BLK2GO, which automatically capture 3D point clouds as an operator walks through and around a site.

Data collection without a human, maybe - but a survey (including deliverables), no. Yet, we surveyors might have to adjust what it means to be a 'surveyor'.

WHAT'S NEXT FOR SURVEYING?

For years surveyors have been valued on deciding where to set up, what control to use, and what checks to build in. More recently, additional emphasis has been put on deciding

which technology to use, how to measure, and how to process the data.

For the next generation of surveyors, it seems likely that even more weight will be put on sifting through data, identifying quality, understanding what is relevant, and deciding how to present it. Maybe the job will have more of an emphasis on determining what checks to build in, or how to evaluate and process data. And most likely, more weight will be put on deciding what data is relevant and how and when to present it.

I believe that now is the right time to be assessing our workflows, evaluating new methodologies, and embracing new technology. We can then establish ourselves as the service providers who produce the best data, the ones who can be trusted to assess and verify the quality of other data, as well as the ones who can extract meaningful results from it all.

If we do this right, we will be in the position to not only protect our own short-term employment future but also to ensure the future of the survey industry — even when we are surveying for construction robots to use our data.

PAVING THE ROAD TO REAL-TIME CHANGE MODELLING

Editorial

John Welter — President of Geospatial Content Solutions, Hexagon's Geosystems division, based in the United States.

Changing mapping to keep up with an ever-evolving world.

My job requires frequent travel, and one thing that becomes very obvious during my trips is that we are living in a time of rapid change. Cities are changing due to growth, rural areas are developing as transportation infrastructure evolves, farmlands adapt to feed a growing population, and our urban areas seem to multiply overnight to provide housing.

At Hexagon, we are fond of the saying: "You can't manage, what you don't measure." In the context of these changes "measure" means "map."

The challenge with such rapid change is that it breaks the way we map – we recognise that changes have occurred, start a lengthy process to secure a budget, tender, and acquire new data to capture the changes. The new maps are often too late to be useful to manage the change and simply confirm what we already know.

To keep up with our changing world, mapping also needs to change. To achieve this, the old model needs to evolve to programs that continuously capture and make updated map data easily available. These Content as a Service (CaaS) programmes collect data according to consistent specifications and continual refresh schedules, creating a standardised product, suitable for many applications. The users of these applications are collectively underwriting the collection cost and can, therefore, pay a significantly reduced price. Using the principle of a sharing economy giving everyone equal access to the same data, and as such, democratising high-quality aerial data, a previously highly exclusive commodity.

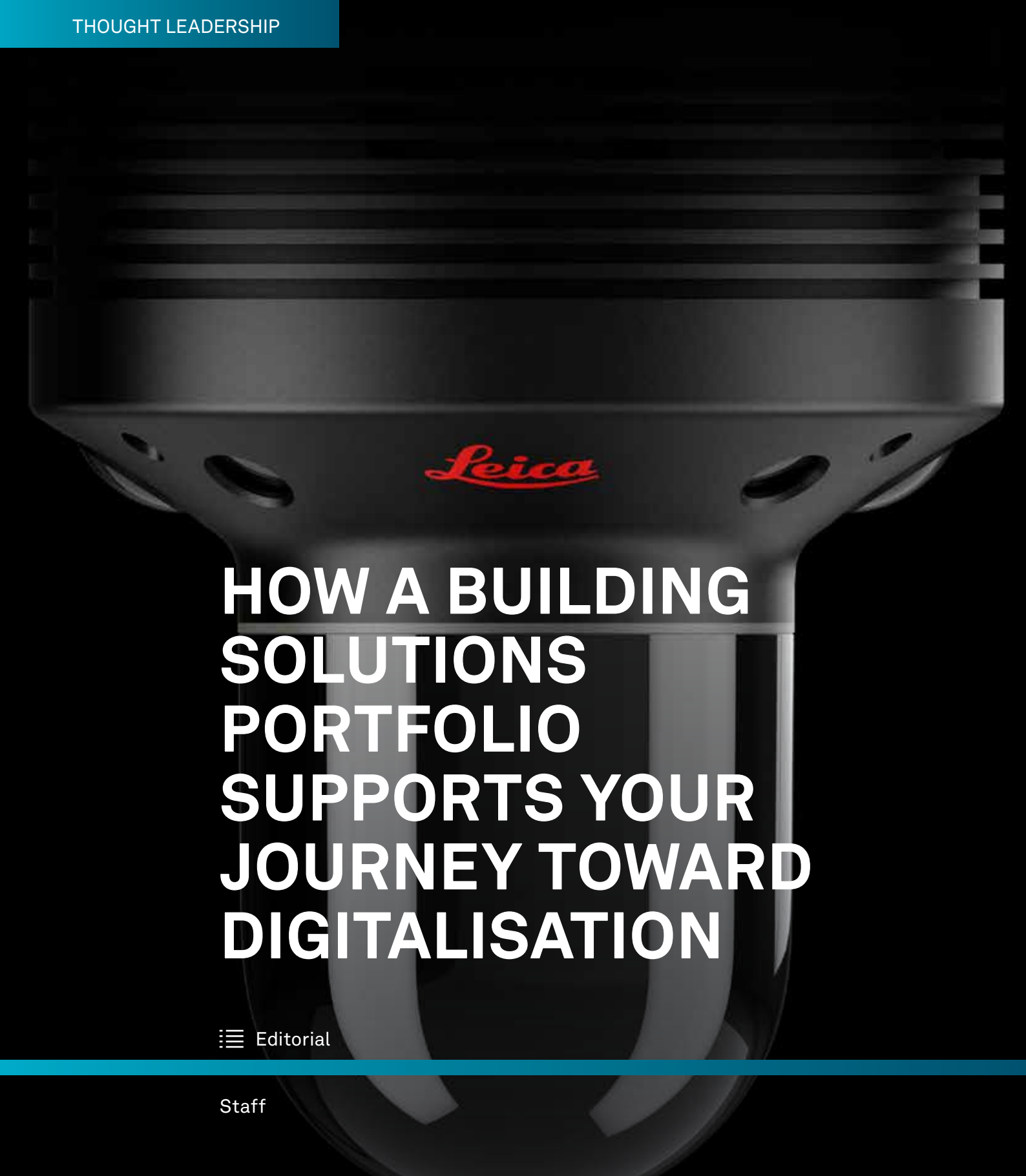
The second necessity is more efficient airborne sensing technology which enables the collection of more data in a single flight to reduce the time and cost of making maps. However, the sensor alone does not get the job done. With growing amounts of collected

raw data, processing speeds need to be increased in parallel, allowing for the swift delivery of the processed data to the end customer. Hybrid sensors and workflows that capture and process imagery and LiDAR data simultaneously will be the driver to map large-scale projects, more frequently.

At Hexagon, we have invested in making this a reality and will continue to do so. With our network of collection partners, the HxGN Content Program, our CaaS initiative, is now entering its seventh year of continuous collection. The program has captured 25 million kilometres squared of data in North America and Europe, which is easily available online via purchase or subscription models.

In 2016, we launched the world's first airborne sensor that simultaneously captures nadir and oblique images and LiDAR elevation data, the Leica CityMapper and HxMap workflow. In 2019, we announced a 40% productivity enhancement with the CityMapper-2, allowing airborne mapping companies to collecting more data during every flight.

A version of this article first appeared in GIM International — https://www.gim-international.com/content/article/paving-the-road-to-real-time-change-modelling



HOW A BUILDING SOLUTIONS PORTFOLIO SUPPORTS YOUR JOURNEY TOWARD DIGITALISATION

Editorial

Staff

Introducing Building Solutions portfolio.

Digitalisation is no longer an upcoming trend in the construction industry. It is here. It is now. It can be seen, in some form or another, in nearly every building that is constructed around the world. The industry's evolutionary journey may have accelerated more in some locations than others. Manoeuvring within COVID-19 environments may have won over a few more digital converts, but these are not just short-term adjustments. The evolutionary march toward digitalisation is underway.

Hexagon's Geosystems division is also evolving. Our product portfolio keeps expanding with many new and exciting innovations, such as a reality capture device, CAD conversion and design software, layout and verification sensors, project documentation software and services, and much, much more.

Of course, customers and markets are the real drivers behind an expanding portfolio, and the Geosystems customer base stretches across multiple industries. It is a high priority for us to support our customers as they adopt digital innovations into their existing workflows — or as they adjust their workflows to best utilise the productivity gains these innovations offer.

To expand our industry solution offering, Geosystems is focusing on selected industries like Survey, Building, Heavy Construction, Mining and Geospatial Solutions. This gives us the ability to serve each of these industries better. Each industry has its unique characteristics, and for the Building Solutions industry, it provides an opportunity to focus on the five key stages in the life of a building.

DESIGN & ENGINEERING

Capturing the as-is environment of an upcoming construction site helps to visualise existing conditions and make informed decisions when planning the design of a new project or the renovation of an existing building.

Hexagon provides best-in-class software and sensor solutions to capture existing conditions and verify the as-built with the required accuracy and efficiency, for instance:

- Our reality capture sensors capture point cloud and imagery data of existing conditions;
- UAVs equipped with photogrammetry technology enable measurements from photographs, especially for recovering the exact positions of surface points;
- GNSS captures key survey measurements along the perimeter and between key points on a jobsite;
- And also, utility detection equipment using ground penetration radar technology identifies potential risks lurking under the ground in the form of utility pipes and cables.

For all four examples, CAD conversion software quickly converts the data into new 3D models or adds the information into existing models. Whatever modelling software you are using, our

workflows are integrated, allowing you to stay in your daily working environment.

CONSTRUCTION & RENOVATION

When construction starts, design data is transferred to the field where it is read by machine control systems that guide earth-moving equipment along routes within the perimeter while avoiding utilities. As the building begins to go vertical, design data is transferred to Leica iCON total stations to lay out the foundation and location of key embedded objects, such as rebar and MEP objects, as well as validate the final as-built status to the model. Construction progress and object locations can be documented before they are covered with measurable images so that as the jobsite winds down, the information is properly handed over to facility management.

Each of these key steps — and more — are supported by sensor, software and services within the Building Solutions portfolio.

OPERATIONS & MAINTENANCE

The Building Solutions portfolio helps to prolong the life of mission-critical assets by facilitating remote maintenance, providing management cockpits with accurate and reliable information, and creating digital twins for indoor navigation or location-based services.

Building assets can be tracked based on 2D floorplans, or for those customers who have existing CAFM/IWMS maintenance software platforms, 3D location-based information can be integrated for accurate asset tracking. It can also go a step further. Building assets can be replicated by reality capture devices for 3D asset management. And, on a larger scale, the entire building and surrounding area can be captured to facilitate indoor and outdoor navigation.

Another great solution is the Leica BLK3D, the first compact 3D handheld imager on the market today. It provides real-time, in-picture 3D measurements with professional-grade accuracy. Every image captured is a complete and precise 3D measurement record of any given environment. This ensures that assets are not only documented, but the measurements within the image also enable maintenance crews to plan the appropriate modifications.

SAFETY & SECURITY

The digitalisation of buildings impacts all safety and security related systems, whether these are integrated or closed-loop control systems.

The award-winning Leica BLK247 is a real-time reality capture device that uses sensor fusion technology to detect and report physical changes within a space. Powered by Ethernet, the BLK247 is always-on and continuously scans the environment around it, providing 24/7 situational awareness of the current situation while anticipating future events.

Pre-incident plans for potential emergencies, such as fire or other damages, leverage automated or semi-automated 3D building models to help first responders navigate floorplans and indoor maps.

Buildings are subject to vibration, ground movement, extreme weather conditions and construction activities that need to be monitored to ensure they continue to have structural health and viability. Our portfolio of highly-innovative sensor and software technology provides real-time building displacement and deformation analysis without interrupting construction activities.

ENTERPRISE

Each building is unique. Managing the building performance throughout its entire life cycle requires a constant flow of real-time data among the stakeholders.

Our Building Solutions portfolio helps collect data and provide valuable insights throughout a building's lifecycle by providing a solid foundation of geospatial building information, such as floorplans, 3D models and digital twins.

Hexagon's innovative solution, HxGN Smart Build, is crafted especially for the AEC industry to optimise building design and construction. It connects the office and field for visibility into project status by linking model, schedule, and cost information to support 3D, 4D and 5D process in a simple-to-use cloud and mobile solution.

HxDR is Hexagon's cloud-Based visualisation and collaboration platform for spatial data and services. Models can be placed into accurate 3D maps of cities, towns and landscapes for visual context in real-world locations.

And finally, our geospatial and reality capture solutions provide the space, layout and as-built drawings that are so important for real estate due diligence. Our solutions provide accurate visual details for existing buildings as well as records of as-built conditions that can be used by sellers or buyers.

Hexagon's Geosystems division's Building Solutions portfolio is quite extensive and covers a wide range of applications. Ease of use is important to us as it makes it as easy as possible for users to adopt digital tools and workflows. And for the most advanced users, the products in our portfolio have many extensive features that allow you to optimise your way of working and stay at the forefront of the latest trends.

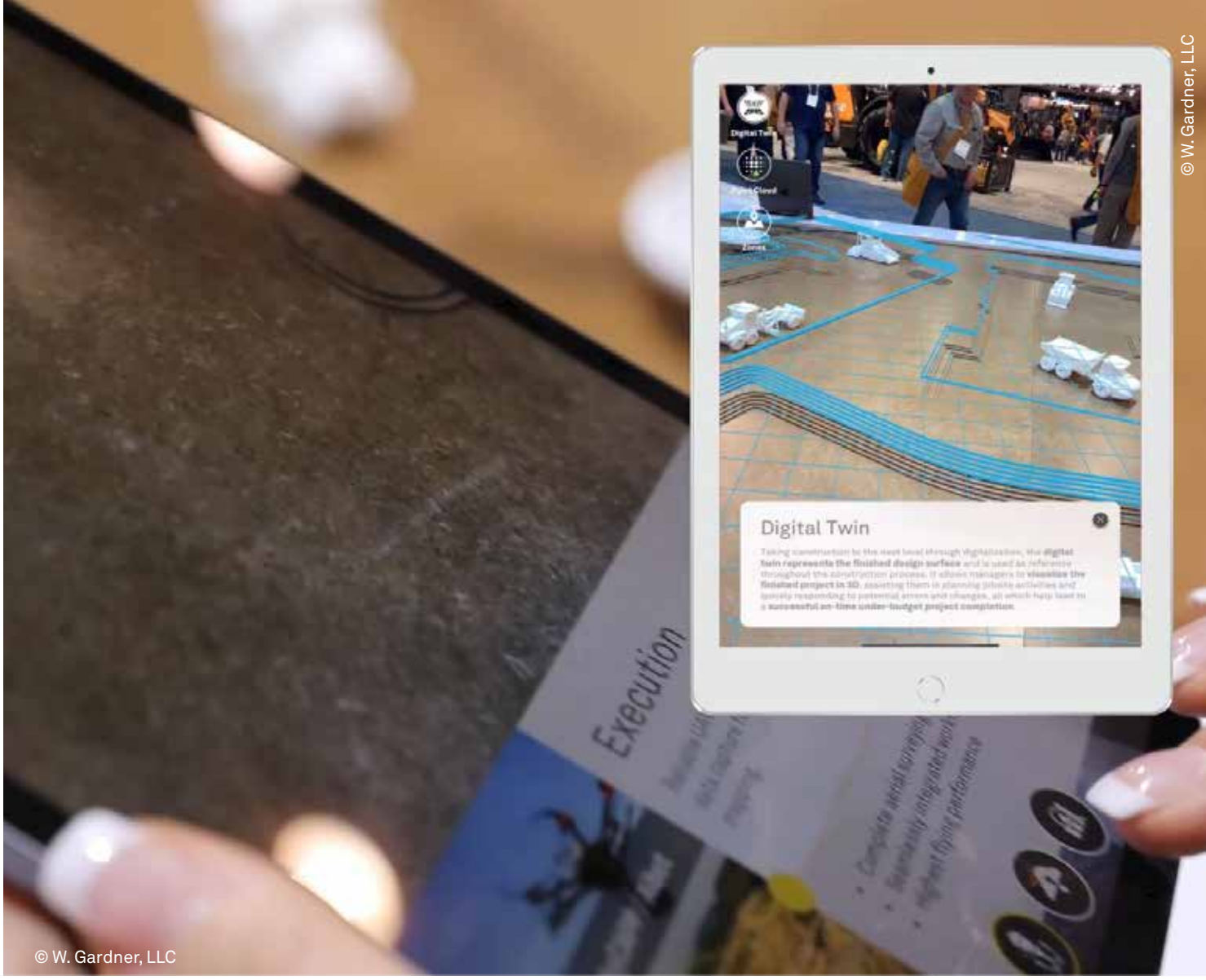
Regardless of where your organisation is on this journey, Hexagon is a partner who is ready to walk alongside you. We look forward to collaborating with you as we take this journey towards digitalisation together.

SURPRISING FACTS ABOUT #DIRTSIMPLE MUTE DIGITAL TWINS

Editorial

Holger (HoPi) Pietzsch — Vice President of Marketing for Heavy Construction at Hexagon, based in the United Kingdom.

How to build digital twins and why construction professionals would need them. Learn more about how IoT transforms the heavy construction industry.



Not too long ago I was involved in a campaign about talking machines. Indeed, thanks to increased connectivity, billions of gadgets can now connect to the Internet of Things (IoT). The data streaming through countless devices feeds the most sophisticated platforms, gets churned by mind-blowing algorithms and gives birth to new business models.

Talking machines are part of our future. And do they talk a lot? They tell us about their health, their energy consumption, their on-off status, and the list keeps growing. Today, most of them talk in different languages. To drive increasing standardisation across the many 'machine dialects' in the cloud, recently, a new agreement has been reached on construction machine data standards at a general meeting of the Working Group Machines in Construction MiC 4.0 in Berlin.

The goal of this collaboration between manufacturers and users is to deliver a quality assurance system to guarantee a uniform standard for the construction industry. Manufacturers, machine users and system integrators are continuously working on a coordinated industrial standard to democratise technology and modernise the heavy construction industry.

WHY AND WHICH MACHINES NEED TO TALK TO US?

Surprisingly, despite this ever-increasing choice of insights, most things that people want to know about objects are quite simple. Where is it? Where is it not? And slightly more meaningful: is it where it is supposed to be, or is it where it is not supposed to be? Like my socks, that randomly appear or disappear in the strangest places.

Indeed, other objects should be interested in the location of their peers, too. Do the fridge and the milk know of each other's existence in space? Which machine algorithm will minimise the Euclidian distance, for instance, put the milk back in the fridge? I could hook up the milk to the IoT, and the fridge, and the beer, and run them all through an app. As I'm adding grocery to my cloud, why not add the car, the garage, the trees, and the whole garden and connect them? But, wait, you can't hook up a garden or the trees in the backyard. That makes no technical or economic sense. Even the milk is questionable if you ask me. Beer maybe.

So, what do we do about all of these quadrillions of inanimate objects? Will they be damned to eternal muteness? None of them will ever get to meet their digital twin. They're stuck in ordinary earthly reality.

HOW TO CREATE DIGITAL TWINS?

Leveraging digital twins is of critical importance for entire sectors in our economy, and heavy construction is a prime example for that. Contractors move large amounts of material every day. Earth needs to be accurately cut in one place and asphalt precisely laid in another. Machines need to be operating in the right location and workers need to move in and stay out of other areas. How do you capture and coordinate all of this without micro-chipping every stone on-site? How does one find a mute ditch in the cloud?

The answer to this question is the ditch does not need to know of its own existence and talk about it. You need to know about the ditch's location. The underlying technology to digitally capture large surfaces in the real world and gain the most accurate interpretation of the project conditions is called reality capture. Reality capture doesn't need to listen to a ditch. However, it sees it, measures it, digitises it, and runs the captured data up the cloud for further processing and sharing.

Advanced GNSS technology determines the exact geo-location of the 'eyes,' and through triangulation, any 'seen' point can thus be located. Reality capture uses radio, lasers, LiDAR and traditional cameras. It runs advanced surveying algorithms to map millions of points per second.

Data can be captured from multiple sources through the use of 3D laser scanners and UAV photogrammetry, producing 3D datasets such as point clouds and meshes and shared with everyone involved in the project via cloud-based collaboration tools. The ability to monitor the project conditions in real time not only gives the benefit of better planning, design and execution but also provides the base for as-built validation.

WHICH REALITY CAPTURE TECHNOLOGY TO CHOOSE?

There are an array of reality capture technologies available from small handheld to more static, terrestrial laser scanners. When choosing a reality capture solution for your next project, it is key to understand why you need data, what data you need, how best to capture it, and how you plan to use it.

Small portable and handheld imaging scanners give access to difficult areas and capture detailed data and images at the touch of a button. To capture large, inaccessible or hazardous areas, aerial imagery and generated 3D deliverables from UAVs or drones are ideal solutions.

When using mobile mapping solutions carried as a backpack or mounted on vehicles, the technology helps to capture data across large areas, highways, tunnels, railways and much more. However, for large scale jobs and inaccessible places, the latest terrestrial laser scanners allow long-range data capturing from a safe position on site.

To find the reality capture solution fit to your project, start with understanding the data and information needed to make informed decisions and, ultimately, keep the project on-time, on budget and to specification.

DIGITAL TWINS FOR A SMARTER FUTURE

Digital reality builds an infinite number of digital twins, stores them in time capsules and compares the measured reality against the desired reality in countless feedback loops. Edge computing or cloud processed data can then be transmitted to anything and anybody providing complete spatial awareness. Digital reality provides space and time to the IoT.

Today, Smart Digital Reality™ is the most promising technology to enable smart sites, smart infrastructures and smart cities. The Smart Digital Reality™ approach will enable Hexagon's technology to work everywhere, and to provide real-time location intelligence for the places and times that matter the most. A Smart Digital Reality™ is much bigger than the digital twin. It captures events as they happen in real time, autonomously extracting from the digital twin and fusing that live data to a complete reality capture.

It enables the interaction of objects, collaboration of people and coordination of tasks to work things safer, more efficiently and more sustainably because everything has a place and there's a place for everything — even my socks.

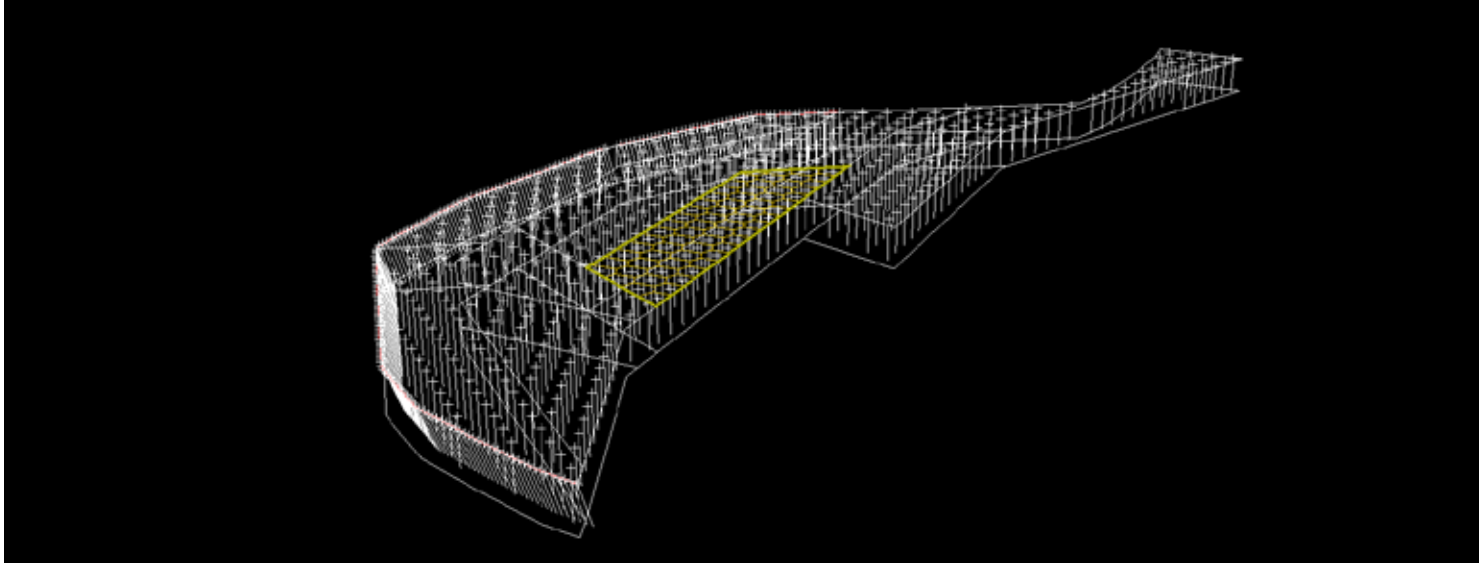
SCAN QR CODE TO VIEW VIDEO

WHY THE BMT ACQUISITION CHANGES EVERYTHING

Feature

Andrew Crose — Managing Director for EMEA Region for Hexagon's Mining Division, based in South Africa.

Hexagon recently acquired Blast Movement Technologies, the latest in a string of acquisitions by the company but potentially the most significant for the industry in years.



Hexagon recently acquired Blast Movement Technologies, the latest in a string of acquisitions by the company but potentially the most significant for the industry in years. The implications are profound with parallels to the 2018 acquisition of Guardvant, which paired leading systems for collision avoidance and fatigue and driver distraction monitoring. That acquisition saw peanut-butter-meet-jelly for mobile mining equipment safety. The BMT acquisition could be bigger.

Like many catchy mining phrases, "Drill to Mill," "Pit to Plant," "Mine to Mill" and "Mine to Market" are deceptively simple descriptions for complex, multi-layered processes. In the mining cycle, drill and blast (D&B) is arguably the first and most important step to get right.

Without a holistic approach built on an integrated solutions portfolio, it can also be the hardest and most costly.

Mine operational costs all start with the blast. A correct blast not only optimises the cost of your blast, it improves the total cost profile of the entire mine. Correct fragmentation means easier digging, reduced rework, lower-cost crushing, and improved tonnes per hour through your processing plant.

Improved dilution tracking elevates this by ensuring the right material is sent to the plant versus the waste dump. Not only does this improve your ore recovery, it has a downstream impact on your processing plants where vital blending can be required to ensure your plant operates efficiently. Add to that the high accuracy machine guidance drills and shovels, powered by Hexagon's state-of-the-art positioning capabilities, and now you wield a formidable trifecta; yield, fragmentation and dilution.

From a cost perspective, this trinity improves the entire cost profile of the mine. Reduced blasting costs, reduced rework, improved diggability, increased ore recovery, less crushing, higher TPH through the plant, and improved efficiency for your ore processing.

A UNIQUELY HOLISTIC APPROACH

No one can touch Hexagon's portfolio: MinePlan Blast designs the pattern; MineOperate High-Precision Drills accurately execute that plan; and MineOperate QA/QC allows holes to be inspected and tracks blasting material used.

HxGN Split technology tracks post-blast fragmentation; BMT minimises loss and dilution; MineOperate HP Shovels uses the improved polygons from the BMT data to better track ore; and MineOperate Fleet Management tracks total yield. All of this combines back into the next design in MinePlan Blast as a continuous process to optimise the next round. No other technology provider offers this holistic approach.

Of course, just like OEMs offering fleet management, the explosive supply companies are innovating in a near space. This is strategic for their business, but maybe not the mines. Explosives are a commodity, and mines buy a lot of them. By offering technology, explosive suppliers are hoping to avoid that commodity pricing challenge they face by differentiating over the whole blast activity.

Why let them?

IMPROVE D&B WHILE CONTROLLING EXPLOSIVES COSTS

The technology is not the most expensive part of your drill and blast program; the bulk commodity explosives are. By standardising on technology from one of the explosive manufacturers, you are taking away your purchasing power to get the best rates on the commodity explosive material.

Hexagon's comprehensive offering gives you that power. You can improve the most vital part of your mine, where everything starts with the drill and blast, without losing your purchasing power over the bulk commodity blasting material — all from a single technology vendor.

This is more than peanut butter and jelly. This is surf and turf paired with a good wine on a five-course meal that pays for itself. I can only wonder what Hexagon will do next?

NEWS

Most versatile GNSS RTK rover with Visual Positioning announced

The Leica GS18 I, a versatile GNSS RTK rover with Visual Positioning, allows users to capture points of interest from a distance and measure points from the images in the field or the office. Visual Positioning technology, sensor-fusion combining GNSS, IMU and a camera allows users to reach previously inaccessible or obstructed points safely and efficiently. Unlike other GNSS RTK rovers that utilise imaging, the GS18 I gives users a simple workflow to measure points with survey-grade accuracy from images.

Leica iCON site solution for better construction positioning

With the new upgrade of the Leica iCON site software solution, construction companies can perform all positioning related tasks with just one easy-to-use software solution. With new functionalities, the improved iCON site software enables integration and connectivity between office and field, increasing site productivity and accuracy. Its innovative, straightforward software design, smart workflows and easy-to-understand user interface make work a pleasure and increase productivity on site.

Planon, Leica Geosystems Announce Global Partnership

Planon and Leica Geosystems have announced a global partnership to integrate Planon's software for real estate, space and asset management and Leica Geosystems' reality capture, cloud-based visualisation and collaboration solutions to accelerate digital transformation in the building industry. With the digitalisation of the real estate and facility management business and the ongoing adoption of property technology (PropTech), there is a demand for digital twins throughout the entire lifecycle of buildings.

Leica Geosystems, Geomap cooperate to facilitate digitising facility management

Leica Geosystems and Geomap, a cloud and GIS-based Integrated Workplace Management System (IWMS), announced a global cooperation to support customers in the digitalisation of their facilities and asset support services. Geomaps' IWMS platform integrated with Leica Geosystems' reality capture solutions provides customers with the ability to extend the life of mission-critical assets, assess maintenance remotely, provide managers accurate and reliable information and use geospatial information for indoor navigation and location-based services.

APEI first to purchase Leica CityMapper-2

Aero Photo Europe Investigation (APEI), an international survey firm with headquarters in Moulines, France, has become the first customer to purchase the Leica CityMapper-2 oblique imaging and LiDAR hybrid airborne sensor. With the new technology, APEI expands its business to the rapidly growing smart city market, which today requires more detailed and more accurate data on larger areas in fast-changing urban environments. Increasing productivity significantly and data quality for the creation of digital twins of cities and metro areas, the CityMapper-2 now offers a newly developed optical system incorporating two nadir (RGB & NIR) and four oblique 150 MP metric camera, using CMOS technology and equipped with Leica Geosystems' Forward Motion Compensation (FMC) technology.

MEASURE WHAT YOU SEE — HOW NEW GNSS TECHNOLOGY IS HELPING SURVEYORS IMPROVE EFFICIENCY

Feature

Anne Pitkaenen — Product Marketing Manager for Leica Geosystems, based in Switzerland.

The Leica GS18 I is a GNSS RTK rover that enables you to measure hundreds of survey-grade points in minutes from a safe distance. It allows you to capture the site and measure from the images in the field or later in the office — whatever is best for your task at hand.

Many variables can complicate a surveyor's job. Measuring a point where the view to the sky is limited can be difficult. Surveyors often face a race against time to survey a site before the first foundations are laid.

Improving efficiency is often the first step toward a more profitable business. Whatever challenges you face on-site, relying on fast and accurate surveying equipment helps overcome hurdles easily.

CAPTURING HARD-TO-ACCESS OR OBSTRUCTED POINTS

Hard-to-access points are as much a part of a surveyor's job as hard hats and high-vis clothing. Tackling them often requires additional equipment, which can complicate things and slow you down.

You might, for example, need to map a point of interest on the other side of a busy road. Crossing roads safely is difficult, and blocking the traffic consumes time at the site. Another common challenge is obstructed points. Take, for instance a point under an overhanging canopy. Without a view to the open sky, measuring with a traditional GNSS rover will be a challenge.

In most cases, and with most conventional RTK rovers, you have little choice but to measure the point using additional equipment such as a total station or a DISTO™.

There's nothing wrong with this approach. It works. But the additional equipment needed means more to transport between sites, longer set-up and processing times and extra costs — all of which slows you down.

With its integrated camera, the new Leica GS18 I makes this process far simpler. When faced with a hard-to-reach point, like our canopy example, there's no need to try and reach it with other means. The GS18 I allows you to walk alongside the structure capturing images as you go. These images are used to measure survey-grade points, which can be further processed into a point cloud. Also, the GS18 I automatically defines the position and orientation of the images, making them ready to use for measuring instantly in the field.

MEASURING HUNDREDS OF POINTS IN MINUTES

Accurately mapping hundreds of points, whether the entire façade of a building or several pipes crossing in a trench, can be time consuming. This is particularly true if the tool you use measures the structure point-by-point, as is the case with some conventional RTK rovers.

The GS18 I is capable of capturing the site in images as you walk. These images can be used in the field or office for measuring points in them. This means even vast structures, which would typically have taken hours to measure can be captured much more quickly and efficiently. Also, you never miss measuring a point.

You don't have to return to the site to measure additional points because you can measure them from the images even when new needs for points arise.

In the office, points can be measured with Leica Infinity office software conveniently on a larger screen. Office time is, in general, less expensive than time on site — there are no disturbances and frustrations from weather and fewer risks.

VIEWING DATA ON-SITE

Some imaging GNSS systems don't allow you to review what you are doing on site. Those systems that use a GNSS together with a camera but don't have Visual Positioning technology, like in the GS18 I, often require processing back at the office before it can be used for measuring. This means waiting to return to base to check whether you've captured everything correctly.

This just isn't practical. If you're visiting multiple sites in a day, you need to be able to review and upload work on the go and ensure you have everything you need before continuing to the next job. Anything else risks multiple site visits to correct errors, having a negative impact on your productivity.

The GS18 I approaches this more efficiently. When you use the GS18 I's Visual Positioning, it automatically defines the position and orientation of the images, making them ready to use for measurement. Also, there is no need to pick a point across multiple images — the GS18 I automatically matches the point. All you need to do is pick the point and hit measure to compute coordinates instantly.

This means no waiting until you're back at base to check whether you have mapped everything you need and the quality matches the project requirements. With the GS18 I, everything is available instantly. So, you can access the quality of the results on-site and leave the rest of the measuring for the large screens back at the office.

Points can be reviewed at the scene, cutting down the risk of mistakes. You don't need to return to site to correct mistakes or delay a project while you wait to return to the office.

GNSS TO EMPOWER YOUR BUSINESS

Surveyors will probably always face complications in their projects, but the right technology certainly makes things easier. Visual Positioning technology is providing access to many points that were previously unreachable with a conventional GNSS rover alone. And, with the GS18 I, surveyors now have a simpler, faster more efficient tool for handling whatever they encounter on site.

Tackling inefficiency in your surveying business starts with your equipment. And the GS18 I provides an answer to many of the common problems that cause it. Get everything you need to start transforming your business in a single, easy-to-use device.

WHAT IS LEICA GS18 I?

The Leica GS18 I is the most versatile survey-grade GNSS RTK rover, allowing you to measure remote points from images or to measure with the pole tip. It has all the same functionalities as GS18 T but with added Visual Positioning technology. Visual Positioning technology, sensor-fusion combining GNSS, IMU and a camera allows users to reach previously inaccessible or obstructed points safely and efficiently.

INTEGRATING SLOPE STABILITY MONITORING WITH MINE OPERATIONS

Feature

Neville Judd — Communications Director for Hexagon's Mining division, based in Canada.

Integration between IDS GeoRadar and Hexagon's MineProtect portfolio now connects systems for safety and radar-based slope stability hazards.

Safety, sustainability and efficiency can suffer at any mine where the data from planning, operations, safety and business analytics are siloed. Integration between IDS GeoRadar and Hexagon's MineProtect portfolio now means that these important data sources can be shared in one platform, connecting systems for safety and radar-based slope stability hazards.

Via real-time equipment visualisation, integration ensures timely alerts about hazardous areas for people and machinery. This additional layer of information means better risk evaluation. It's also one more way to ensure everyone gets home safely.

MineProtect Portfolio Manager Marcos Bayuelo and Francesco Coppi, Director of Monitoring Radar Product Management with IDS GeoRadar, recently discussed the implications in a podcast interview.

MINES CAN BE DANGEROUS PLACES WITH BUSY TRAFFIC, BLIND SPOTS, NOISE, DISTRACTION AND POOR VISIBILITY. HOW DOES ROCK BEHAVIOUR AND SLOPE STABILITY AFFECT THIS SCENARIO AND WHO ARE THE PEOPLE MOST AT RISK?

FC: Slope failure and rockfalls are among the main causes of casualties in mines. Mining companies invest a lot of money every year in monitoring equipment to keep that risk under control. In particular, the most dangerous areas in the pit are where the extraction is in progress due to the instability induced by blasting activities and material removal, which can continuously affect ground stability.

HEXAGON ALREADY HAS SYSTEMS FOR COLLISION AVOIDANCE, PERSONAL PROTECTION AND TRACKING RADAR. WHY DID IT MAKE SENSE TO INTEGRATE WITH IDS GEORADAR?

MB: This is really enhancing and enabling the opportunity to close the loop between our rock monitoring and our on-vehicle or onboard devices. Now every vehicle with a collision avoidance device or every person with a personal alert tag can take action from alerts or dangers detected by our InSAR (Interferometric Synthetic Aperture Radar) radars. It enables near real-time decision making for our vehicle drivers and our people in the field to prevent an accident. But it also enables understanding from a remote perspective without having to be in the field to understand who is in the danger zone for the management of our assets and our people.

WHO BENEFITS MOST FROM THIS INTEGRATION AND WHY?

MB: Vehicle drivers immediately know in real time which zone they should not go to because it's closed. Mine management also benefits. In the past, if we have an alert, the geo tech needs to call the supervisor, the supervisor needs to go to the specific field and close the road. This might take from half an hour to a couple of hours. Now it's instantaneous. Everybody in the mine knows without any single human intervention beyond the click from the geo tech, to really know where not to go. Or if they are already in the danger zone, they can evacuate automatically.

FROM A PRODUCTIVITY PERSPECTIVE, WHY WOULD IT MAKE SENSE FOR A MINE TO INVEST IN THIS KIND OF INTEGRATED SOLUTION?

FC: As we know, mine productivity and safety are strictly related to each other. Closing an operation because of an incident can cost millions per day. Therefore, a higher safety level means higher productivity. I think this is the reason why a mine should invest in this integration.

To hear the full interview, visit https://hxgnspotlight.com/

OUR 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 support them with a comprehensive portfolio of digital solutions that capture, measure and visualise the physical world and enable data-driven transformation across industry ecosystems. 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 Hexagon solutions. Send us your photos at reporter@leica-geosystems.com to be featured in ***Reporter***.

Dormeson SA used Leica Geosystems reality capture and imaging solutions to create the first digital shopping centre in Peru.

Henrique Werneck, Davi Fluck and Renato Tavares mounted the Leica iCON iGD4SP system on a dozer for Nexa Resources, working on a dry tailings disposal in Vazante, Brazil.

Tommy Berntsson, the founder of Lerbergs Entreprenad AB, performs ground and construction work with 25 excavators equipped with Leica Geosystems' machine control solution in Kungsbacka, Sweden.

Maiden Voyage with the Leica GS18 T surveying the old Pipestone Hot Springs on a snowy day in Montana, United States, by Brent Pilon.

Renovation project from building in Den Haag, Netherlands, using the Leica TS16 total station by Marijke De Cleer.

Monitoring job in London, UK, using the Leica TM50 by Lauren Holland.

HOW HOLLIS CAPTURES, PROCESSES, MANAGES, DELIVERS REALITY CAPTURE DATA

Case Study

Renata Barradas Gutiérrez — Communications Manager and Editor of *Reporter* for Hexagon's Geosystems division, based in Switzerland.

From data collection to delivery, building consultancy firm Hollis used a full end-to-end Leica Geosystems solution to capture and model a 16,000-square-metre building in the United Kingdom.

Reality capture experts know that capturing data is just one step in the process. Processing, managing and delivering data are part of the workflow. Processing and producing CAD and other deliverables can sometimes be the most time-consuming parts of the workflow.

Tim Beach, Chartered Geomatics Surveyor and Measured Building Specialist from Hollis, has been relying on laser scanning in the U.K. since 2003. Hollis is a leading firm of independent real estate consultants with 24 offices in the U.K., Ireland and mainland Europe. Beach is based within the Measured Survey team and is responsible for AEC level-detail projects.

Within his role, he gets to test hardware and software to ensure the solutions are as efficient as possible for their clients. Beach has successfully incorporated laser scanning into existing measured building survey workflows at Hollis.

Within its 25-service offering, Hollis' measured services integrate into several of the others, such as MEP where the team uses laser scanning for plant and environments requiring Revit modelling for clash detection exercises. The unit uses laser scanning for other applications, such as the rights of light (ROL) analysis to examine impacts of new developments, project management for refurbishing, and redevelopment of existing buildings.

Hollis owns several Leica Geosystems instruments, including:

- 2 Leica ScanStation P40s
- 3 Leica RTC360 3D laser scanners
- 2 Leica TS16 and 4 Leica TS12 total stations
- 3 Leica Builder total stations
- 2 Leica Viva GS16 GNSS and 4 Leica Viva GS08 plus GNSS
- 4 Leica Cyclone REGISTER and Leica Cyclone REGISTER 360, 2 Leica Cyclone MODEL, 12 Leica CloudWorx for AutoCAD, 12 Leica JetStream Connectors, 2 Leica Cyclone PUBLISHER PRO.

"Hollis has invested quite heavily in Leica Geosystems equipment in recent years. Having tested various hardware and software providers, we chose Leica Geosystems. We found Leica Geosystems gave us the solution that fits best into our business model. We have a number of ScanStation P40s, total stations and GPS for control and putting our surveys in the correct location," said Beach.

LASER SCANNING A 16,000-SQUARE-METRE BUILDING

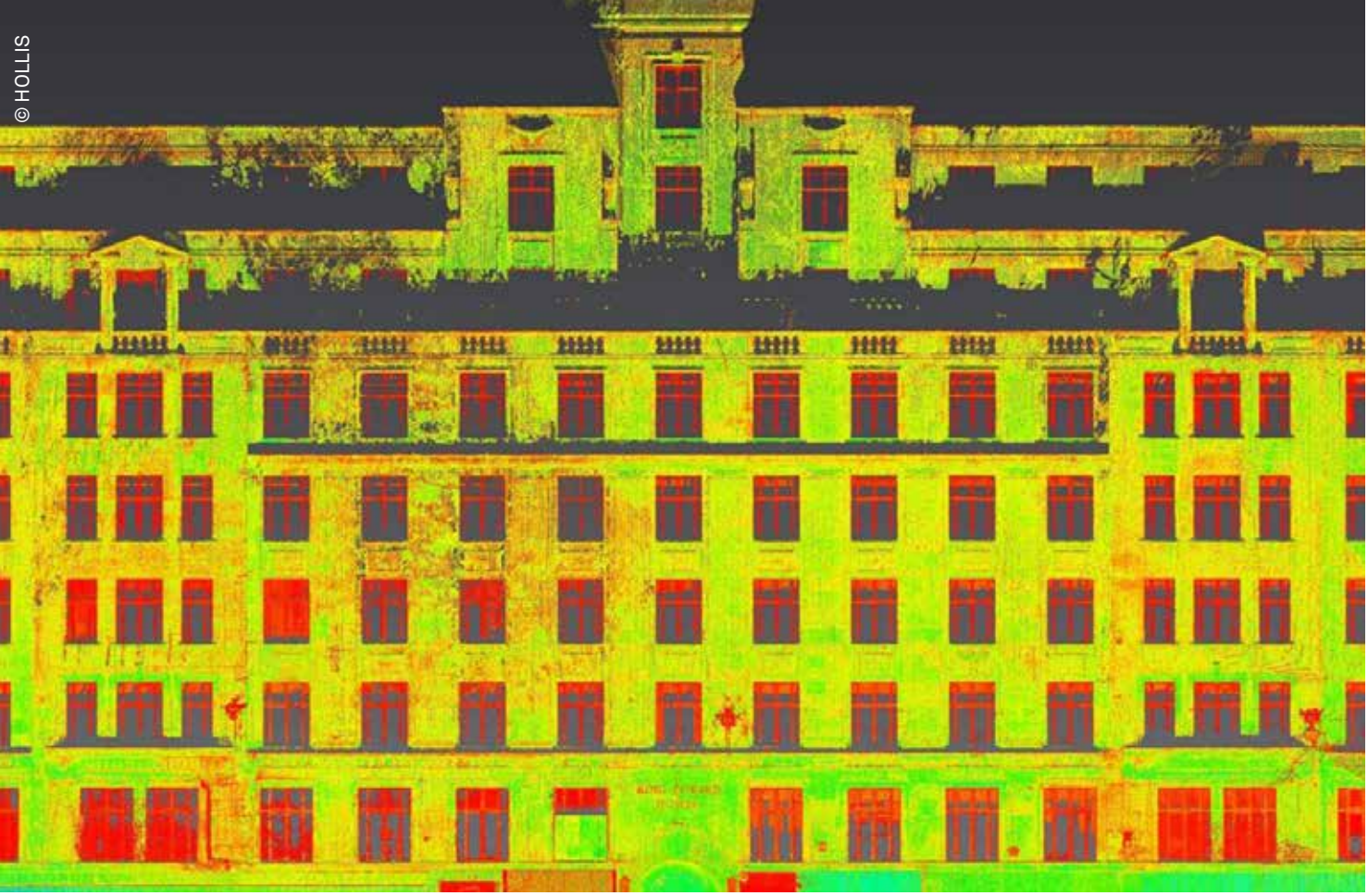
The challenges of laser scanning an 11-floor 16,000-square-metre building in central Birmingham, U.K., go beyond the building itself, including finding locations that provided visible access to each face of the building in an already congested area. Hollis opted for laser scanning given the scale of the building, its complexities, and the client timescales and deliverables.

To scan each of the rooms on every floor, Hollis had to coordinate access arrangements with all tenants. "Laser scanning in conjunction with accurate survey control allowed us to move around the building, scan what we needed to in the areas we had access to at that time, knowing that we would be able to register the captured scan data together at the end, and be confident that we would be able to get the correct result," said Beach.

The deliverables requested by the client included standard 2D CAD information of floor plans, elevations and cross-sections. During the project, the client required additional information, including structural soffit and slab details in various locations, a full topographical survey of the immediate surroundings, façade deviation reports and monitoring work.

DATA CAPTURE

Due to the tight deadlines, Hollis deployed two teams each with a ScanStation P40 and completed the survey in just five days. Eight-man days on-site were required to capture the



inside of the building, plus one day to install survey control around the property and to do the external laser scanning. The team collected data with confidence, without the need for excessive survey control, generating 90 GB of raw data from approximately 1,500 scan positions. The Viva GS08 plus RTK GNSS was used to geo-reference multiple points around the site to transform the data to Ordnance Survey Grid and Datum.

PROCESSING DATA

Hollis began registering the captured scan data after the first site inspection day. The two survey teams on-site sent the collected raw data at the end of each day to the local office to begin import and registration. All registration elements were carried out during the day and auto alignments left to process overnight. This workflow minimised the processing time and permitted the team to start the CAD work early on. In total, Beach's team took six days for registration, resulting in a final database of 259 GB.

Beach and his team registered all scans using Cyclone REGISTER with local control and cloud-to-cloud techniques. Cyclone REGISTER allowed the team to split the registration into logical parts and combine them to generate a final master data set.

"We found that cloud-to-cloud provided the greatest flexibility in the site work and the registration of a building with such complex geometry. Being able to register your data together, combined with the P40 with a dual-axis compensator, ensures we are confident that the data we are producing is correctly orientated and we don't have any issues downstream. [...] Cyclone REGISTER gave us an incredibly flexible approach to how we undertook the registration," said Beach.

MANAGING DATA

Hollis has 30 employees in the measured service team distributed across multiple offices who could require access to data for any given project at any given time. To generate the deliverables for the clients, cross-regional teams collaborate using a high-performance streaming and centralised project platform to access data over internal and external networks — JetStream. Using this simplified point cloud access, Hollis measured survey experts can import and render full-density point cloud data in real time within CAD applications and share JetStream Viewer files with various stakeholders. Using this approach, the real estate consulting company streamlines collaboration in projects.

© HOLLIS

"The use of Leica JetStream has allowed us to host our data centrally in London, where everyone can access. If our regional offices undertake a scanning project, they can upload to the JetStream Server overnight, opening up the data to everyone else. For other teams who are not power users of scan data but occasionally need to use the data, we can host and archive their project's data," said Beach.

Using JetStream allowed the team to disseminate the final data set amongst various teams in various locations to complete the project on time and budget. "JetStream enabled us to complete the project in the most efficient manner and as accurately as possible," said Beach.

DELIVERING DATA

Surveyors generate a great amount of data using laser scanning that is captured, processed and managed to provide actionable data that supports decision making.

Leica TruView is the collaborative tool Hollis surveying team relies on to share point cloud data and design models. One of the many uses for TruView within Beach's team is as a Q&A tool to 'walkthrough' models and for checking congested environments remotely and safely.

"Leica TruView provides a location-based view of data from the sites. We use it to produce the deliverables using all information available — not just relying on slices in CloudWorx where features can be missed. For the building project in central Birmingham, our team could split the data logically by building and by floor. TruView allows viewers to measure, add geometry, incorporate hot links and embed geotags for asset management needs," said Beach.

FULL END-TO-END SOLUTION FROM DATA COLLECTION TO DELIVERY

Using a complete reality capture workflow from Leica Geosystems, Hollis produced deliverables of floor plans, sections and elevations for its client in the most efficient manner. Through re-use of previously-collected data, the team could accommodate the clients' additional requirements quickly. Geared with JetStream, surveyors saved time by loading and accessing data from one central location, helping to deliver the project on time and budget.

PRESERVING ROMANIA'S SPELEOLOGICAL HERITAGE WITH POINT CLOUD, GNSS DATA

Case Study

Renata Barradas Gutiérrez — Communications Manager and Editor of *Reporter* for Hexagon's Geosystems division, based in Switzerland.

3D laser scanning and GNSS sensors were used to generate data to study and manage a 6,298-metre cave in Romania.


© Top Geocart

3D laser scanning provides a high-resolution, non-invasive documentation method to understand natural and cultural sites and manage its exposure to natural and man-made threats. Researchers in diverse fields are unlocking numerous applications using this technology, just like speleologists who are using laser scan data to study and measure caves with millimetre-level accuracy in a non-intrusive way. Point cloud data allows experts to extract cartographic information and calculate areas and volumes to study the evolution of topographic and bathymetric features in caves.

To preserve and understand Romania's speleological heritage, Top Geocart, the Leica Geosystems' dealer in Romania, laser scanned the Meziad Cave, a 6,298-metre natural wonder in the western Carpathians. The Meziad Cave, the first cave adapted for tourism in Romania, is known for its spectacular subterranean landscapes with beautiful speleothems (stalactites, stalagmites, columns and curtains). The cave is also home to one of the largest colony of bats in southeast Europe and microscopic endemic organisms (some of them confined to the Meziad Cave).

This high-resolution 3D documentation aimed to accurately capture the site's complexity and to introduce positive conservation measures to maintain or restore the site before conducting any archaeological and palaeontological invasive research that can modify the original site. Moreover, Top Geocart created 3D models and other deliverables to enable its customer, Spelemat, to store, organise and retrieve information for further analysis. The data provided documents and records the state of this natural and cultural heritage.

A MISSION INSIDE THE CAVE

Together with specialists of Spelemat, Top Geocart designed the project and planned for this mission inside the earth. This group of specialists, that understands, respects and promotes the use of techniques and geospatial data, collected field data without impacting the environment. Besides using non-intrusive/ non-invasive techniques, the team also had to consider the right timing to enter the cave as weather and the cave's river flow were crucial factors to succeed in this mission.

Specialists from Top Geocart used best-in-class technology, including:

- Leica RTC360 3D laser scanner
- Leica BLK360 imaging laser scanner
- Leica Viva GS16 GNSS smart antenna
- Leica GS18 T RTK GNSS rover
- Leica DISTO™ S910

For point cloud alignment, modelling and GNSS network the team relied on:

- Leica Infinity software
- Leica Cyclone REGISTER360 point cloud registration software
- Leica Cyclone MODEL
- Leica Cyclone 3DR
- Leica GNSS Spider software

The team scouted the mountain area and geo-referenced it with the GS16 and GS18 T GNSS RTK rovers with real-time corrections from the Romanian National Reference Stations Network

© Top Geocart

(ROMPOS), running on GNSS Spider software. SmartLink corrections were necessary since the mountainous environment with slopes and trees obstructed the area and from time to time GSM/GPRS signal was lost. The capability of GS16 and GS18 T to use the SmartLink Service was key to cover these gaps and always have a precise position. To deliver the most accurate positions, the team also relied on the Leica RTKplus technology in both RTK rovers as it intelligently adapts to changing conditions by selecting the optimal GNSS signals.

In the interior of the cave, the team moved through the river's water with special clothes and accessories to safely transport the equipment. Inside of the waterproof containers and floating bags, the RTC360 and BLK360 drifted from location to location. Speed and precision are key while scanning with a water level above your chest in temperatures below 10°C.

Geared with the RTC360, the team captured the larger parts of the cave and artefacts, creating coloured 3D point clouds in under two minutes. With a scanning speed of up to 2 million points per second, advanced HDR imaging system and automated target-less field registration in the RTC360, Top Geocart captured the sites of interest inside the cave in two hours at 750 metres per hour.

At the push of a button, Top Geocart captured full-colour panoramic images overlaid on a high-accuracy point cloud for the narrow parts of the cave with the smallest and lightest imaging laser scanner — the BLK360. For those areas where it was not possible to set on a tripod the laser scanners, measurements were made with the DISTO™ S910.

THE MISSION'S DELIVERABLES

Outside of the cave close to the entry, the team automatically and seamlessly transferred data from site to office using Leica Exchange, the exchange service provided by Leica Geosystems, reducing time in the inhospitable environment. Transferring the data easily between the field and the office with Exchange allowed the experts to perform a first check of the data onsite with Leica Cyclone FIELD 360, Leica DISTO™ Transfer and Leica DISTO™ Plan App.

Back in the office, point cloud data from the BLK360 and RTC360 was registered with Cyclone REGISTER 360. The GNSS data was checked and processed with Infinity software. In the GNSS project were imported the


© Top Geocart

DISTO™ data, too. Together with Spelemat, Top Geocart created a unified point cloud, as Cyclone REGISTER 360 project, and exported in E57 and LGS formats to visualise it with JetStream Viewer, a light-weight point cloud viewing tool. The E57 file was imported in Leica Cyclone 3DR to create meshes and compute digital terrain models (DTM) from point clouds.

Experts also created 2D topographical maps and 3D DTM with data from the GS16 and GS18 T RTK rovers to develop new tracks and paths for visitors. Distances and CAD files with 3D points and pictures were extracted from the data collected with the DISTO™ S910.

The data provided will support researchers, tourists and facility managers alike. It will guide feasibility studies for touristic plans and be used as marketing material to invite visitors to explore this natural wonder. Point cloud deliverables provide researchers with a digital twin of the cave where they can extract any profile and 3D measurement. At the same time, GNSS data helped to identify the areas and paths to create access for tourists and scientists.

“Leica Geosystems and Top Geocart provide complete software and hardware set for the entire workflow. The sensors have the capabilities to work in difficult environments and meet the highest standards in measurement excellence. The management and specialists from Spelemat admitted they were capable of working more efficiently and in more challenging environments than ever before,” said Viorel Lascu, cave management expert at Spelemat.

The success of capturing the Meziad Cave convinced Spelemat to invest in RTC360, BLK360 and DISTO™ to keep exploring and understanding Romania’s natural wonders.


© Top Geocart

FIGHTING TIME, TIDE TO CAPTURE 5-HECTARE COASTAL CONSTRUCTION SITE IN 3D

Case Study

Hazlinda Mohd Nuron — Marketing and Communications Director for Asia for Leica Geosystems, based in Singapore.

Using 3D laser scanning solutions to visualise Hyosung Vina Chemicals Port, Vietnam.

In 2018 the construction of Hyosung Vina Chemicals Port began in the Ba Ria-VungTau province, southern Vietnam. A collaboration between the Vietnamese government and South Korean industrial conglomerate Hyosung Corporation, the new port is a part of the Hyosung Chemical Complex. Once completed, the Hyosung Chemical Complex will include a propane dehydrogenation (PDH) production plant, a polypropylene (PP) plant, a liquefied petroleum gas (LPG) storage tank, and an LPG and petrochemical product warehouse in the Cai Mep Industrial Zone in Ba Ria-Vung Tau, located near Ho Chi Minh City.

One of the final tasks in the development was the construction of the port's LPG jetty. With more than 30 years' experience in marine, waterway and transport infrastructure, Portcoast are Vietnam's leading port and coastal survey consultants. The company was engaged in creating the 3D mapping for the topographic survey, the as-built model of the LPG jetty and facilities, and to conduct the inspection report for the revetment protecting the jetty.

The topographic survey covered an area of more than 5 hectares — and with much of the area located in the water, Portcoast's level of specialist knowledge and experience was essential for collecting data in these hard-to-reach areas. To compound the inaccessibility challenges, whilst some areas of the complex were still under construction, others were already operational.

Dr. Hoang Hiep, the Portcoast team leader on the project commented, "The main challenge for scanning the whole port was the selection of scanning positions in a complex where there was significant traffic and where disturbances from the ongoing construction work could compromise the stability required for precision scanning."

To mitigate the challenges of working in this disruptive, heavy traffic environment, Portcoast decided to conduct the scans from elevated locations above the internal road.

"Working from high above the site required a scanner that could deliver a high level of precision over a long measurable range," said Hiep. "The Leica ScanStation P50 delivered an accuracy of up to 3 millimetres so we could cover the full range with confidence and precision."

Whilst the ScanStation P50 was used to capture the data on top of the bridge, under the bridge the team used specially modified equipment, such as customised cranes to install the Leica RTC360 3D laser scanner and Leica BLK360 imaging laser scanner to measure and capture highly-detailed data in the complex, narrow and inaccessible areas, such as the liquid tanks, the pipeline systems, access bridge and the marine loading arm.

TIME IS MONEY

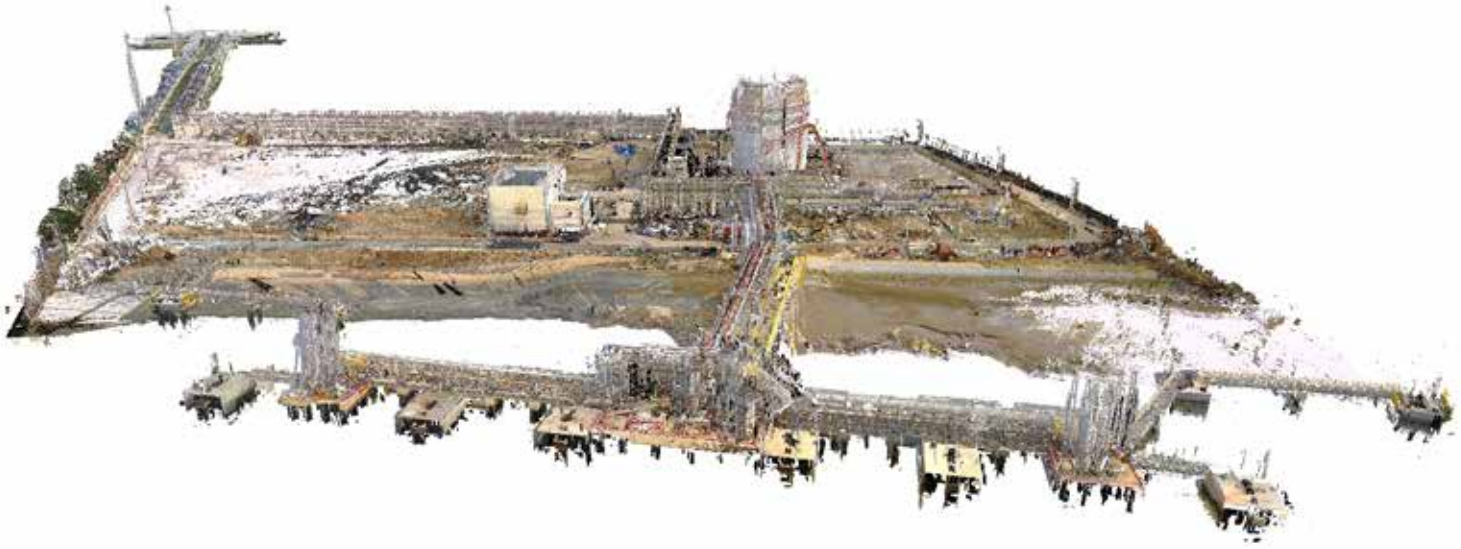
Promising to offer significant economic benefits for the region, the construction project alone is estimated to have created jobs for about 2,000 workers during its construction. Once completed, the port is estimated to contribute $80 million (about 71 million euros) annually to the state budget, so it was imperative to ensure the port can be fully operational as quickly as possible. Speed was, therefore, a key factor in the selection of equipment for Portcoast and in training the team in the use of this equipment.

“Not only was the training time for the team almost halved by working with the Leica Geosystems team, but the high speed of capturing data with Leica Geosystems equipment significantly reduced the survey time,” explained Hiep. “In a project like this, the topographic survey of revetment would usually take around 12 hours with a survey grid of 20 metres per setup. Whereas it can be reduced to three hours when using the ScanStation P50. Accelerating the process also reduced our operational risk and the number of employees required for this work.”

ENHANCING COLLABORATION BETWEEN SITE AND DATA ANALYSIS OFFICE

To scan the port, Portcoast needed to combine thousands of points and to combine the data from different devices, such as total stations, GNSS and laser scanners — something that would usually prove to be a complex and time-consuming process. The seamless integration of Leica Geosystems equipment and software solutions meant the data could easily be passed between the off-site team processing the data and the field team.

Having worked in similar projects across Southeast Asia, Pakistan and U.A.E, Portcoast was particularly conscious of the importance of fast data transfer in tropical countries. The rapidly changing weather conditions demand fast data transfer between field and office teams to verify data and prevent any loss of



data. After collecting the point cloud data from the geodetic equipment, Portcoast used Leica Cyclone, Leica Cyclone 3DR and Leica Infinity software off-site to process the data.

“The high-speed and high-level accuracy of capturing field data helped to avoid delays in office post-processing as the software helped us to check the points every time we needed to. With Infinity and ConX, it is easy to transfer data between the field and the office within one minute,” added Hiep. “The outcome map produced by Cyclone is a very accurate model, which we can use to create a 3D model and VR system. Using Cyclone 3DR we can then further refine the model to provide high levels of accuracy and visibility.”

By collecting point cloud data at different times and using Leica CloudWorx for Revit to convert this into as-built drawings, the margin (a matter of millimetres) for settlement or displacement of the pipe racks could be estimated with the utmost precision.

The as-built drawings and BIM will support the facilities management aspect of the port, providing a reference for the inspection report and enabling Hyosung to plan and model future developments and renovations for the port using the digital model.

The work that took the team of seven engineers just weeks to complete will significantly reduce the site visits required for future maintenance and can be used to enhance and protect the operations of the port for decades to come.

“When we took on this project, only half of the team had any prior experience with this geodetic equipment. The increased efficiency from the integration across the Leica Geosystems product ecosystem saved considerable time, and now the whole team is eager to use the Leica Geosystems geodetic equipment regularly,” concluded Hiep.

SURVEYING GERMANY'S BIGGEST AQUA PARK

Case Study

Renata Barradas Gutiérrez — Communications Manager and Editor of *Reporter* for Hexagon's Geosystems division, based in Switzerland.

By expanding his surveying portfolio, Keller has been able to provide all surveying services for the plan and construction of a water park in Germany.

Before the indoor water world Rulantica, in Rust, Germany, opened its door for all visitors, all pieces of the puzzle needed to fit together to create this 32,600-square-metre indoor park.

Saladin Keller's company, Keller planen + bauen, was in charge of planning the entire traffic infrastructure, as well as measuring the positions of points, distances and angles between the structures that conform Germany's biggest water attraction park, Rulantica. Part of Europa-Park company, Europe's second most popular theme park resort, the water world themed in Nordic style features 25 attractions, including 17 water slides, a wave pool and a 250-meter lazy river.

PRECISION FOR WATERFALLS, SLIDES AND LAZY RIVERS

Keller accompanied the plan and construction of Rulantica since its start in 2015. The surveyor started staking out a sewage canal of more than 2 kilometres in length that today connects the entire park.

Equipped with Leica Geosystems hardware and software, Keller has been able to provide all surveying services for the plan and construction of the water park. To measure and position the complex geometry of the aquatic fantasy world, Keller used:

- Leica Viva TS16 total station
- Leica CS20 field controller
- Leica Viva GS16 smart antenna
- Leica RTC360 3D laser scanner
- Leica Captivate surveying field software
- Leica Infinity survey software
- Leica Cyclone REGISTER point cloud registration software
- Leica CloudWorx

This portfolio has enabled him to work on diverse projects within Rulantica. Some of his tasks included staking out pipes, performing construction survey, including planning roads, parking spots, and staking out for construction companies (street height, kerbs, green areas, pools).

"Working on diverse tasks within the Europa-Park complex, including the new water park Rulantica, is a challenging but rewarding project. I feel privileged to be working on it and love seeing how new attractions are being constructed," said Keller. "The project timeline often demands instruments of the highest precision and accuracy that also enable me to work under any given weather conditions. With the Leica Geosystems instruments, I am able to react fast to my customer's needs and deliver the best results."

Once Keller surveys an area, he works with craftsmen who need the gathered data, namely electricians and construction workers. Depending on the needs, Keller provides planning documentation, such as site and location maps, longitudinal profiles and cross sections in diverse formats, such as dwg, dxf, rcp, and pdfs.

SHIFTING FROM CONSTRUCTION TO SURVEYING TOTAL STATIONS

As some surveyors do, Keller studied civil engineering and entered the surveying business through construction projects. Keller started to measure and stakeout points with GNSS for construction. As his projects grew in complexity, he acquired a TS16 total station and GS16 smart antenna to position himself on the field after comparing and testing surveying brands. After only two days of training by a representative from Leica Geosystems, Keller was ready to transition from construction to surveying instruments.

"The biggest advantage of working with the Leica Viva TS16 is re-sectioning with a SmartPole as it helps me to save a lot of time. Repositioning the instrument is also extremely comfortable. The prism-tracking functionality of the TS16 in case of lost line of sight makes my life easier, so does the range between the controller and the total station," explained Keller.

SCANNING EUROPA-PARK

After the surveying total station and GNSS, Keller added to his portfolio an RTC360 3D laser scanner. Geared with the 3D laser scanner, he is able to scan Europa-Park by himself — a challenging undertaking where he needs to be fast, agile and precise. Having the RTC360 in his toolbox also allows Keller to address any urgent requests on site. When time is premium and maintenance work needs to be done, his laser scanning services are requested to help re-build parts, adjust pipes and map utilities.

"After doing a laser scan test in an area of the park with the RTC360, everybody was thrilled about how amazing it looks and how fast it is," said Keller.

SELF-MADE SURVEYING BUSINESS

Keller got started in surveying with GNSS and, as projects started to rise, he expanded his portfolio with robotic total stations. Today, equipped with the fastest laser scanner, he is even able to beat tenders and take on the comprehensive task of providing laser scanning services for construction and maintenance to Europe's second-largest theme park. By expanding his equipment portfolio, this entrepreneur has been able to provide new services to his customers.

HXGN CONTENT PROGRAM ENABLES MACHINE LEARNING, ADVANCED ANALYTICS

Feature

Linda Duffy — Independent freelance writer who has been supporting the geospatial community as researcher since 2003, based in the United States.

Providing consistency for algorithms with the HxGN Content Program.

The HxGN Content Program conveniently provides subscribers access to its aerial imagery library covering the United States and large parts of Europe through the streaming service or via direct pixel delivery. Each dataset is ortho-rectified, accurate, and available at multiple resolutions ranging from 15 centimetres to 30 cm Ground Sample Distances (GSD). In addition, stereo imagery and Digital Surface Models (DSM) of various resolutions are offered to assist with 3D modelling, and oblique and LiDAR data will be available in select areas starting in 2020.

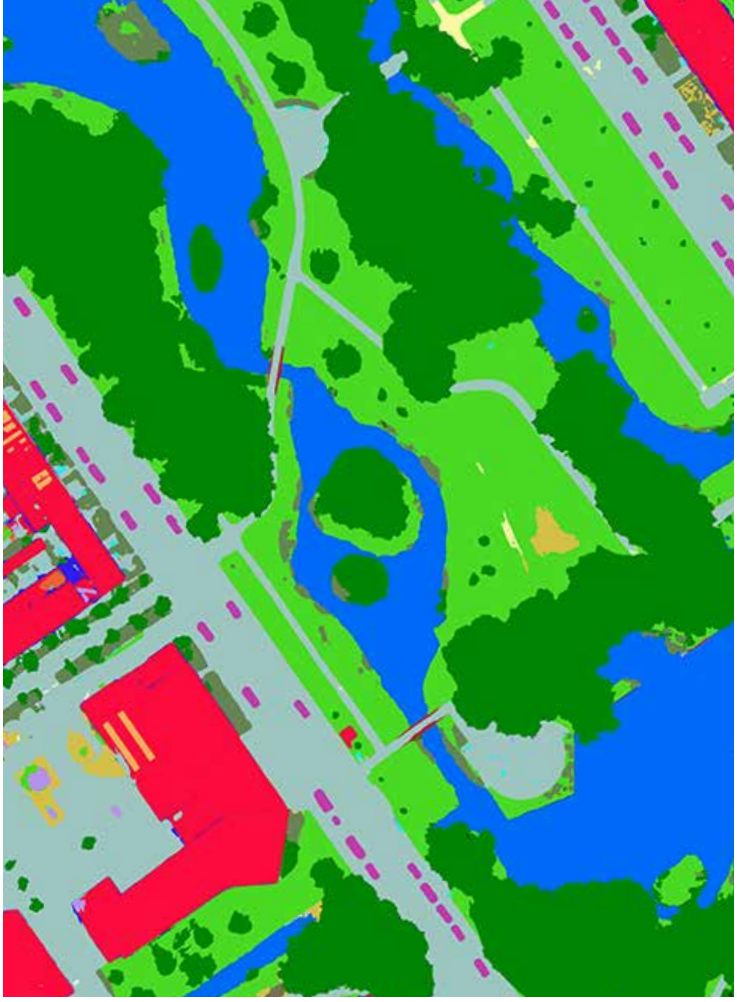
Already well-established as a source of orthophotos for use in GIS, the value of high-resolution aerial imagery has moved far beyond visualisations. The HxGN Content Program is an excellent source of large quantities of highly accurate and consistent data to train machine learning algorithms. Artificial intelligence (AI) expands the opportunities for numerous applications that benefit from automated extraction of valuable information.

BENEFITS OF AERIAL IMAGERY FOR MACHINE LEARNING

Machine learning and AI provide the efficiency to perform analytical tasks that are beyond the capabilities of human beings. By training algorithms to automatically recognise attributes unique to an object, feature extraction, analytics and other measurements can be applied to imagery to produce actionable, location-based information.

However, machines are confused by variations in data, such as data source, resolution, seasonal differences or radiometry. Therefore, machine learning algorithms depend on large, consistent data sets to be successful. Hexagon achieves consistency by emphasising repeatability in sensor technology, flight planning, acquisition parameters and processing techniques. Hexagon normalises its datasets to offer consistent input so that engines can focus on detecting the correct objects. Entire states and regions are collected in the same season to avoid a patchwork of irregular images.

A ready-made service like the HxGN Content Program provides access to large volumes of multispectral ortho imagery, DSM and stereo imagery, consistently collected with high-performance Leica Geosystems aerial sensor systems. Since its inception in 2014, the HxGN Content Program has collected 20.5 million square kilometres of 30 centimetre resolution aerial data and more than 1 million sq km of 15 cm data in



urban centres. Database access reduces the amount of time required to curate and prepare training data and improves the algorithm success rate.

Hexagon's service is scalable to the unique demands of machine learning. The multispectral source data is stored in a non-proprietary cloud optimised geotiff format ready for direct access through Amazon Simple Storage Service (S3), allowing high performance for customers that use major cloud providers like Google Cloud, Azure, IBM and others.

Since there is no official standard that can be used to stream DSM and Stereo to multiple applications, Hexagon provides these datasets as download deliveries using non-proprietary formats with well-defined metadata.

HEXAGON ENCOURAGES PRODUCTION OF DERIVATIVE ANALYTICS BASED ON MACHINE LEARNING

Hexagon offers data access to any company in the artificial intelligence/machine learning space that wants to produce analytics products. The Hexagon technical team works with a multitude of engines and will provide guidance on how to maximise the value of the aerial-derived datasets.

Hexagon's acquisition of Melown Technologies in 2019 brought advanced expertise in-house. Melown uses aerial images to train algorithms in automated feature extraction of various thematic layers.

Using this knowledge, Hexagon can provide additional services to its customer base and assist resellers and partners that are interested in developing analytics products. The HxGN Content Program encourages the creation of derivative products without excessive restrictions. Resellers and other partners may participate in a free pilot program to demonstrate that their engine works with the streaming or pixel delivery service.

LEVERAGING THE HXGN CONTENT PROGRAM

The use of analytics across many industries has grown remarkably over the past few years. With greater computing power and more accurate input data, machine learning is recognised as a highly useful tool to support decision making. An on-demand library of high-resolution aerial imagery that covers large geographic areas, such as the HxGN Content Program, provides the necessary algorithm training data as well as a wealth of current information.

When used together, machine learning and high-resolution aerial imagery automatically update location-based information faster and at a lower cost as compared to traditional methods of extracting information. The HxGN Content Program allows customers from different industries to select their area of interest and extract a variety of features, including man-made structures such as buildings, roads, pools, driveways and solar panels.

For example, a developer may create a feature extraction algorithm that identifies risk factors for insurance providers. Another developer may build a solar panel quotation tool that searches for roof obstructions that would add to installation costs. More accurate estimates reduce cost overruns and save the installer time and money.

Change detection, land classification and updated cadastral databases are also generated faster and more accurately with machine learning. Natural objects like trees can be identified to monitor deforestation, tree diseases and pests. Other applications include comparing as-builts against building and zoning regulations, optimising the location of 5G network towers, and enhancing augmented/virtual reality applications.

A consistent, current and accurate image dataset is a necessary component of machine learning products. Through partnerships between source data providers like Hexagon and developers of machine learning technology, value-added products are being generated that extract the required information to meet the end-users' needs. Revenue sharing is a common model when it comes to data sales and offers a low barrier of entry to data access. It allows the engine developer to benefit and the data provider to be compensated for the value the data contributes.

For more information, please visit: hxgncontent.com

SIMULTANEOUS CAPTURING OF LIDAR AND IMAGERY

Case Study

Mathias Lemmens — Independent geomatics consultant, based in the Netherlands.

Collecting LiDAR and multispectral data of urban areas with the Leica CityMapper in the United Kingdom.

People continue to migrate from rural areas to major cities, driving sustained urban growth and increasing the demand for accurate, detailed and up-to-date 3D city models. The creation of such models is still a cumbersome endeavour, but new advancements, such as the combination of three sensor types — nadir camera, oblique cameras and a LiDAR unit — in one and the same geodata acquisition system, may bring relief. Aerial surveys conducted in major cities in the UK and Ireland demonstrate the potential of this solution.

Cities will continue to grow as long as the world's population keeps flocking to urban areas. In western countries, migration from rural to urban areas started in the early 1800s, and by the early 1900s 15% of the global population was living in cities. This will have increased to 60% by 2030, thanks in part to the large-scale shift toward urban living in Africa and Asia, which began in the mid-1990s. This population concentration has created dozens of urban agglomerations with more than 10 million inhabitants, called megacities. According to a study of the world's demography by Euromonitor International, in the decade between 2020 and 2030 six new megacities will emerge: Chicago, Bogota, Luanda, Chennai, Baghdad and Dar es Salaam. By 2030 there will be 39 megacities, which between them will be home to nearly 10% of the population and produce 15% of the world's gross domestic product (GDP). The liveability and sustainability of megacities rely on well-functioning roads, subways, railways, bridges, schools, hospitals and other public services.

3D CITY MODELS

Most modern cities and megacities have become complex, multifaceted 3D landscapes. Those responsible for the management, security and development of these major cities require detailed 3D models of buildings and infrastructure to support them in their tasks. 3D models are usually produced manually from stereo photogrammetry. Accurate and detailed 3D city models are in high demand, but expensive to produce. Realistic views require rendering with images, which is a labour-intensive activity. Often 3D city models consist of rendered polygon meshes that are common in computer graphics, gaming and animation. For 3D city modelling, mesh models are used for visualisation, line-of-sight analysis, risk assessment, noise modelling, flood modelling, master planning and much more. They are also indispensable for creating smart cities.

MESH MODELS

A mesh is a group of edges, lines and faces that define the surface shape of a 3D object. The faces often consist of a network of triangles, usually referred to as a triangular irregular network (TIN). The higher the point density is, the denser the mesh and the more detailed the representation of the 3D object will be. If the points constituting the triangles are represented in the same reference system as images, photorealistic 3D objects can be combined to create an entire city highly automatically. Airborne LiDAR and vertical and oblique aerial images are well suited to the creation of 3D city models. Mesh models are often regarded as purely visual 3D models. However, limiting their use to visualisation purposes alone would do an injustice to their full potential. Particularly when georeferenced at decimetre accuracy or even higher, such 3D data can be used for measuring distances, heights, surfaces and volumes. In addition, it allows line of sight and other types of analysis, shading and flood modelling. Once it is known that a collection of adjacent meshes form a building or other coherent object, it is possible to assign an address, market value, BIM information or other information to the conglomerate of meshes. Attributing semantic information allows queries and intelligent analysis to be conducted.

BOTTLENECKS

There are several bottlenecks in the creation of 3D mesh models of cities. One of the bottlenecks concerns the acquisition of homogeneous data over the entire survey area. Point clouds generated from images show impediments, even if the images are acquired with high overlaps and using dense image matching techniques, resulting in the extraction of no — or unreliable — points for some areas. Reasons for these shortcomings include:

- Occlusion: in narrow streets or urban canyons, some objects may block the view of other objects such as building facades. To extract 3D points from images, it is a fundamental requirement that objects are visible in at least two images.
- Presence of shadows: although dense image matching based on semi-global matching is highly robust against the absence of edges and texture, it may still cause unreliable matches.

Today's airborne LiDAR systems are able to create point clouds with high point density. However, the points have only one spectral value, which is the intensity of the return pulse. Nevertheless, the returns are not affected by the presence of shadows caused by sunlight, which is a clear advantage compared to photogrammetry. Since objects only have to be visible from one viewpoint, airborne LiDAR is less affected by occlusion than photogrammetry.

LEICA CITYMAPPER

To tackle the above-mentioned bottlenecks of photogrammetry on the one hand and airborne LiDAR on the other, Leica Geosystems has combined three sensor types in the world's first hybrid airborne geodata acquisition system. Called CityMapper, this system combines – in a single pod – one RCD30 CH82 multispectral camera for capturing nadir imagery, four RCD30 CH81 m cameras for capturing oblique imagery and one LiDAR unit. The nadir and oblique-looking heads are arranged according to the Maltese cross concept. The images of nadir camera captures RGB and the near-infrared (NIR) at 0.78 to 0.88 µm. The four oblique cameras capture RGB imagery at 45 degrees forwards, backwards, left and right. The nadir imagery can be captured at a ground sample distance (GSD) of 3 centimetres with a potential accuracy of 6 cm root mean square error (RMSE). At the centre of the image, the GSD of oblique images is approximately 75% of the nadir GSD due to a combination of looking angle and focal length. When the nadir imagery has a GSD of 5 cm, the GSD of the oblique imagery at the centre will be 3.7 cm. The LiDAR unit emits laser pulses with a wavelength of 1,064 µm and a pulse repetition frequency of up to 700 kHz. The accuracy is 6 cm and the point density is 15 points per square metre at a flying height of 750 metres. None of these three sensor types nor their specifications are new. The workflows of generating outputs from the three data types are well established and operational in many photogrammetric companies. What is new is that incorporation in a single pod and using a single control unit enables the imagery and LiDAR point clouds to be acquired simultaneously. This simultaneous data acquisition offers many advantages for the creation of 3D city models. For example, LiDAR pulses are able to penetrate street canyons where there may be shadows due to obscured sunlight, and in narrow streets – where occlusion might prevent cameras from obtaining two views — LiDAR can double the chance of successful data capture.

USE CASES

CityMapper has been extensively deployed in Asia for accurate and detailed 3D mapping of new megacities with huge skyscrapers, which have been constructed at a breathtaking rate since 2000, and interest is now growing in Europe, too. In 2018 and 2019, U.K.-based

aerial mapping company Bluesky captured parts of London, Manchester, Birmingham, Cambridge, Oxford and several other U.K. cities. The nadir and oblique images as well as the LiDAR point clouds are processed using HxMap, which contains tools for data download and raw quality control. Additional tools for aerial triangulation, radiometric adjustments and point cloud registration and georeferencing are available. Subsequently, the data is further processed to digital surface models, digital terrain models, orthoimages and other products derived from CityMapper imagery and LiDAR point clouds, which Bluesky calls 'MetroVista.' As part of a major transport infrastructure project, a photorealistic MetroVista 3D mesh model was used to gain insight into the impact of the proposed construction by adding the object to the accurate 3D mesh model at the exact location and orientation. The model of the existing real world combined with the proposed development allowed the nature and scale of the development to be communicated to stakeholders and the general public.

CHALLENGES

Needless to say, the creation of sophisticated, high-accuracy products that benefit city governments, managers and planners alike is not without its challenges. An aerial photogrammetric survey produces large data volumes that require parallel processing and hence significant investment in hardware and software in order to process, disseminate and share them efficiently and reliably. Other challenges include the weather in the U.K., which is often not ideal for conducting aerial surveys. The flying height — between 1,000 m and 1,800 m — is lower than standard aerial surveys, which can be beneficial since it is often below cloud cover. However, the lower flying height can also draw increased attention from air traffic control in the crowded airspace above cities and megacities, leading to delays. Moreover, the flying speed — which at around 220 km/h is slightly slower than for traditional survey flights — increases the data capture time, which may cause issues with permissions or weather windows.

This story first appeared in GIM International — https://www.gim-international.com/content/article/simultaneous-capturing-of-lidar-and-imagery

Major efficiency improvement for airborne urban mapping solution

In September 2019, Leica Geosystems announced a significant upgrade to the Leica CityMapper sensor system, called the Leica CityMapper-2. This next-generation hybrid oblique imaging and LiDAR sensor was first delivered to customers in June 2020. Providing fast and efficient digitisation of cities, the latest version of the sensor was designed to provide faster updates while preserving image quality over a wide range of flying conditions. The CityMapper-2 comes with a newly developed high-performance optical system incorporating two nadir (RGB & NIR) and four oblique 150 MP metric cameras using CMOS technology and equipped with Leica Geosystems' unique mechanical forward-motion-compensation (FMC). The LiDAR sensor's pulse repetition frequency has been increased to 2 MHz and features gateless Multiple-Pulses-in-the-Air (MPiA) technology. For more information, visit leica-geosystems.com/citymapper-2.

5G WIRELESS NETWORK DESIGN RELIES ON 3D AERIAL DATA

Case Study

Linda Duffy — Independent freelance writer who has been supporting the geospatial community as researcher since 2003, based in the United States.

Reaching 5G in the United States with the HxGN Content Program.

The development of fifth generation wireless technology (5G) is spreading rapidly around the world. The initial improvement of up to 10x in speed and 400x in latency, as well as a much larger capacity for simultaneous users, will create endless opportunities for autonomous vehicles, virtual reality, smart cities and the Internet of Things (IoT). In the future, by using additional spectrum, speed improvements could reach 100x and enable applications that we have not even imagined yet. To maximise performance of new 5G networks, telecommunication operators require high-resolution 3D data to develop signal propagation plans and select ideal locations for small antenna systems.

OPTIMISING 5G NETWORK PERFORMANCE

The exciting next phase of wireless technology will operate in the high to very-high frequency domains, with low-band 5G offered on a nationwide basis, and high-band 5G (also known as millimetre wave) offered in dense urban areas and centres with large crowd gatherings like sports stadiums. These high-band signals are easily blocked by obstructions, such as buildings and trees, so the network must consist of many small cells (radio equipment/antennas about the size of a pizza box) located within line of sight to provide maximum coverage and capacity.

Radio frequency (RF) engineering models, based on geographic data including aerial imagery and Digital Surface Models (DSM), are used to identify the best locations for the antennas to optimise network performance. At this time, high resolution (≤15 centimetre) aerial imagery products are the best data source to attain the levels of detail and accuracy required for high frequency 5G networks.

Increased demand from the 5G wireless market helped put Land Info Worldwide Mapping LLC on the 2019 Inc. 5,000 list of fastest growing private companies in the U.S. To meet the specific data requirements for 5G networks, Land Info invested heavily in object-based image analysis and Artificial Intelligence (AI) to build out models used by large 5G carriers. The efficient,

automated workflow was developed using high-resolution aerial imagery from the HxGN Content Program.

"Hexagon removes all the hurdles so we can easily and quickly access the data and apply our value-added processing," says Nick Hubing, president of Land Info Worldwide Mapping. "The high-quality imagery and digital surface models allow us to produce accurate 3D building footprints, trees and clutter (land cover) maps that meet the stringent requirements for 5G wireless network development."

The HxGN Content Program has built a comprehensive library of high-resolution wide area, leaf-on aerial images and DSMs that now cover the contiguous United States and most parts of western Europe. Wide-area coverage is available at 30 cm resolution, and cities with populations larger than 50,000 in the U.S. are available at 15 cm. Starting in 2020, wide-area collects will be made at 15-cm resolution across the United States.

"Resolution is an exponential relationship — 15 cm aerial has over nine times more detail/pixels than 50 cm satellite," explains Hubing. "The extra detail gives very noticeably improved edge definition, allowing us to best segment the smaller, multi-level (height change) features of a building."

5G CHALLENGES

Wireless providers are investing large amounts of money to stake a claim in the 5G wireless market. The winners of this race will have the fastest coverage for the greatest number of people, which makes signal propagation planning critical. Particularly in urban areas, the placement of small cells must be close together to avoid obstructions, which increases complexity and cost of the network.

Due to the increased sensitivity of the 5G signals to obstructions, which degrade performance, networks require the most accurate data available. Data layers must identify accurate height above the ground for individual buildings and trees. Four-band leaf-on imagery and associated DSM are used to perform vegetation and obstruction analysis. Land Info produces the most detailed 3D building models using high-fidelity 15-cm aerial images and DSM from the HxGN Content Program.

"Aerial is always collected close to nadir, meaning looking straight down, which is what gives aerial better visibility than satellites to map all features in urban environments," says Hubing. "In areas of tall buildings, supplemental aerial flight lines are added to provide the best possible mapping in these critical, dense urban areas."

It is also important to have consistent coverage of the area of interest. Satellite data sets are typically produced using multi-view photogrammetry, a process that requires overlapping imagery of the same area. The images may be collected on multiple orbital passes, which occur on different dates spread over months/years and in varying weather and seasonality conditions. In contrast, aerial collection ensures consistency through tighter collection windows of days/weeks for large areas and meets the requirement to deliver cloud free data.

CREATING GEO-INFORMATION

Hexagon employs an aerial collection strategy conducive to telco modelling by offering a library of data that is flown in the same season with the same equipment. The “wall-to-wall” coverage of the conterminous U.S. and most of Western Europe eliminates gaps and captures metro areas at a higher resolution, which is ideal for 5G networks focused on densely populated areas. The HxGN Content Program data is available on demand through a streaming service, and data is delivered ready to use to create a variety of products or be fed into machine learning engines. Fast delivery enables firms like Land Info to deliver on short turnaround deadlines.

Land Info differentiates itself by using proprietary techniques to quickly extract elevation and landcover at scale. High-resolution aerial images and DSMs gives the best edge definition, allowing Land Info to map buildings and trees in 3D with the greatest detail. Buildings are segmented to capture different height levels, including roof top obstructions. 3D tree vectors are contoured to represent the different height levels of trees, and value-added Land Info processing can even map canopies, trunks and the tree understory.

“For 5G mapping there is never too much detail in the imagery,” says Hubing. “We like to work with the highest resolution available, and the HxGN Content Program offers current and consistent coverage.”

The telco industry is heavily invested in introducing extremely high-speed wireless coverage around the world. To meet the demand for detailed 3D maps that support network modelling, geodata providers like Land Info are developing more efficient and effective processes that accurately extract 3D buildings, trees and clutter that leverage high-resolution aerial imagery and DSM.

GREAT INCREASE IN EFFICIENCY FOR SCAFFOLDERS

Case Study

Cornelia Dietz — Project Marketing Manager for Leica Geosystems, based in Switzerland.

With the BLK3D, only a few minutes are needed on-site to gather all the required measurement data, increasing the number of different site visits per day.

Without question, construction sites need scaffolding. Painters, plasterers, window fitters, roofers and many other trades need scaffolding to carry out their work on facades, window installations or roofs effectively. Scaffolders aim to be seen as a useful support to construction workers rather than a disruptive factor.

“We bring you up safely” is the slogan of the scaffolding company Kolb GmbH. Stefano Battaglia took over the traditional scaffolding company with two employees in 2010 and today employs a team of 30 that work within a radius of 150 kilometres around the location of Rimbach in Odenwald, Germany. The company is characterised by providing detailed consultations as well as speed of delivery and competence in its field of work. Safety and compliance with rules and regulation are one of its top priorities.

The daily tasks of Battaglia centre around customer contact and finalising quotes for the work.

Every first contact is recorded in the office, followed by the quotation phase. This means that Battaglia or his site manager drives to each construction site in person. Customer data, photos, information from Google Earth or even measurements from a competitor's quote are not accepted because measurement data needs to be accurate and current.

They used to visit construction sites with a measuring tape and a Leica DISTO™ laser distance meter. In addition, smartphone pictures were used to have a visual record and subsequently provide knowledge about which measurements belong where. This was followed by manually sketching a floor plan and adding lengths, heights, potential bays, gables or roof overhangs.

BRINGING INNOVATION TO BUSINESSES

Many of these areas are often hard to access or difficult to measure, which frequently resulted in guessing the distance rather than measuring. This manual process took a lot of time, usually between 30 and 45 minutes to gather all the needed measurements for a quote. Meaning, a total of around six construction sites could be visited per day.

Using the Leica BLK3D in-picture 3D measurement device, only four minutes are needed on-site to gather all the necessary measurement data — meaning that up to 17 sites can be visited each day. This is an immense increase in efficiency. Even more, sites could be visited, however, traffic in the Rhine-Main area is usually heavy, resulting in travel times of around 30 minutes for each 20 km.

“We try to keep the contact with customers on-site as short as possible, as the conversation usually takes longer than the time we need on-site with the BLK3D,” says Battaglia.

The detailed workflow with the BLK3D is as follows: Position yourself close to the entrance of the building and take the first picture, then continue this process clockwise and take a

picture of each side of the house. If a house is too wide, it is usually divided into two sections or more.

SMART TECHNOLOGY INVESTMENTS GENERATE PROFIT

When you provide around 1,200 quotes to potential customers per year, the process has to be as efficient as possible. This means that during a site visit, only 3D images are taken – no measurements are created on-site. The technician in the office then connects the BLK3D to a computer and downloads the images. All measurements needed for the quote are then created with the BLK3D desktop software. The technician knows exactly which measurements are required to determine the square metres for the quote. This streamlined process allows for next day quotes and images with measurements attached for the customer's reference.

Clear advantages for scaffolders using the BLK3D are:

- Project documentation with measurable images;
- Measurements are digital, and everyone can read them — no more errors due to illegible handwriting;
- The pressure of running a scaffolding business is high, the phone always rings. However, using the BLK3D ensures that even during busy times, measurements aren't missed, and it avoids any transcribing errors;
- The acceptance of a quote can, in some cases, take longer than a year. The BLK3D allows you to open your files at any later point in time to check or create additional in-picture measurements. This is particularly useful when a customer's initial request changes - which can happen around five times per week. For example, after consideration, customers might up their budget, and they now not only would like to redevelop their façade but also the roof or even add a balcony to the house. Previously, this meant re-visiting the construction site. With the BLK3D, all needed data is available, and the additional measurements are created right away. This is much more efficient as another site visit isn't required. Plus, the added benefit for the customer is that no additional costs arise due to a change request;
- The pictures with measurements are handed to employees and used during the installation. This has the great advantage that they already have all measurements they need. They still use a DISTO™ laser distance meter to double-

check, but variations between this and the in-picture measurements are usually less than 1 centimetre. If the process is followed correctly, meaning two images are taken, which are then overlaid, the accuracies are more than satisfactory for a scaffolder. For the final invoice, however, measurements of the actual installations are used.

The BLK3D imager has a calibrated stereo camera that simultaneously captures two images of the same scene from two different perspectives at the same time. This is similar to the human three-dimensional stereo vision, which our left and right eye provide to us. To achieve very high accuracy, Leica Geosystems recommends the Multi-Shot, meaning four images are overlaid, and the accuracy is increased. The distance to the facade should be as low as possible.

LEICA BLK3D IN ACTION

The scaffolding company Kolb put the BLK3D to the test and measured a rather complicated construction site, once with a DISTO™ laser distance metre and once with the BLK3D. It took one hour and 15 minutes with the laser distance metre, but the BLK3D completed the same task in only eight minutes. This increases efficiency more than 10-fold.

Battaglia says he isn't very computer-literate, but in his words, the BLK3D software is "fool-proof" to use. He "only" takes the images, but even the technician figured out everything he needs to know on the BLK3D desktop software in less than two hours.

"In the construction industry, you need technology that is easy to understand and use. Few tools and little add-ons are required, and this is what the BLK3D is about," says Battaglia.

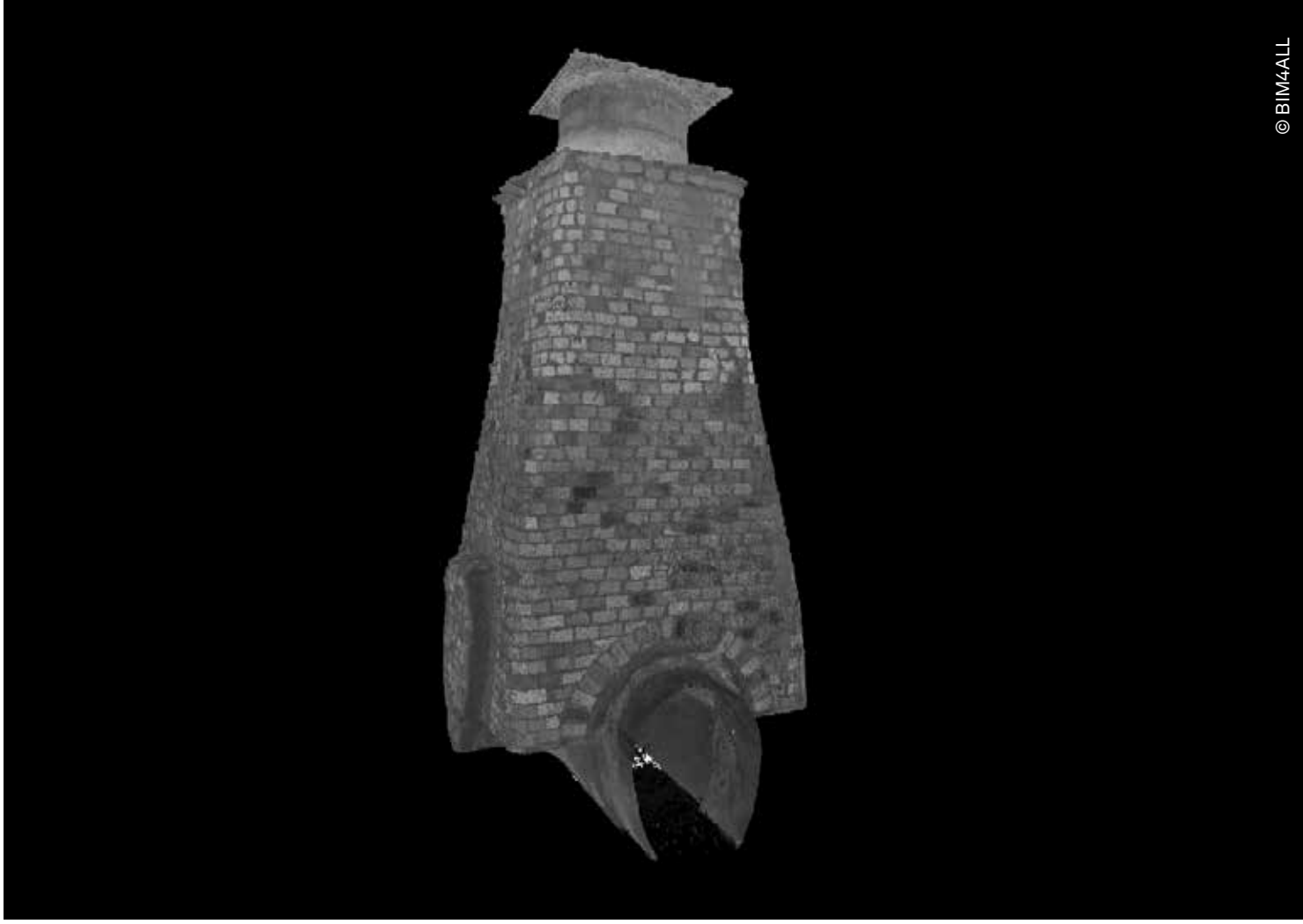
His involvement in the scaffolding industry goes beyond his own company. Battaglia is the regional representation for the scaffolding guild in the state of Hesse, and he also holds a permanent position in the vocational training committee. He is seen as an "innovator" in his trade, which has led to 22 of his colleagues now also using the BLK3D. He believes that the BLK3D will gain momentum in this market.

BRINGING BIM4ALL

Customer Profile

Staff

A BIM firm in the Netherlands brings added values to construction customers.



© BIM4ALL

Building Information Modelling (BIM) has steadily increased in adoption and popularity around the globe. Defined as "a proven process that keeps projects on time and on budget, reducing rework and increasing predictability and profitability" by Leica Geosystems BIM Field Trip, this 3D model-based system is saving AEC industry professionals a significant amount of time and costs.

One firm in the Netherlands fully believes in this concept and has dedicated itself entirely to the endeavour. BIM4ALL, a member of the Brevo Group, is an innovative engineering firm on a mission to share BIM with all areas of the AEC industry. Committed to optimise the processes of building projects, BIM4ALL reduces construction errors and decreases building costs through its knowledge and experience with BIM.

As users of Leica Geosystems 3D laser scanners, total stations and GNSS solutions, BIM4ALL serves more than 200 clients worldwide with an average of 400 BIM projects each year. The company has made a name for itself, landing accounts by leading global companies, while also supporting more local AEC companies.

"As our tag line states, we are committed to 'building value' with our customers and in the industry overall," said Jasper Voortman, 3D laser scanning manager at BIM4ALL. "Our services improve building construction, helping to reduce mistakes in the field by creating precise 3D models in the office."

SERVICES FOR VARIOUS PROJECTS

Though the firm specialises in BIM, there are many facets within that concept. BIM4ALL prides itself on providing a full portfolio to its clients that brings added value and consultation. The services are:

- BIM modelling
- BIM management
- BIM coordination
- 3D laser scanning
- BIM Academy (Partner of Autodesk and Solibri)
- BIM visualisations (in cooperation with Studio X)

These services have been used across the Netherlands and internationally. Some of BIM4ALL's projects include:

- BIM for a new housing development in the Hague
- BIM for new construction of bridges in Denmark
- BIM coordination and management for government buildings in the Netherlands
- BIM coordination with 3D laser scanning and BIM modelling of a new railway station in the Netherlands
- BIM coordination with 3D laser scanning and BIM modelling for renovation of a major department store in Amsterdam

"Our customers call us 'BIM masters', and we're proud of that. We're innovating the building sector. Like the name of our firm, we believe everyone can benefit from BIM, and it's our goal to share this technology and our knowledge, to make everything once thought was impossible, possible," said Voortman.

TAKING LASER SCANNING BELOW GROUND

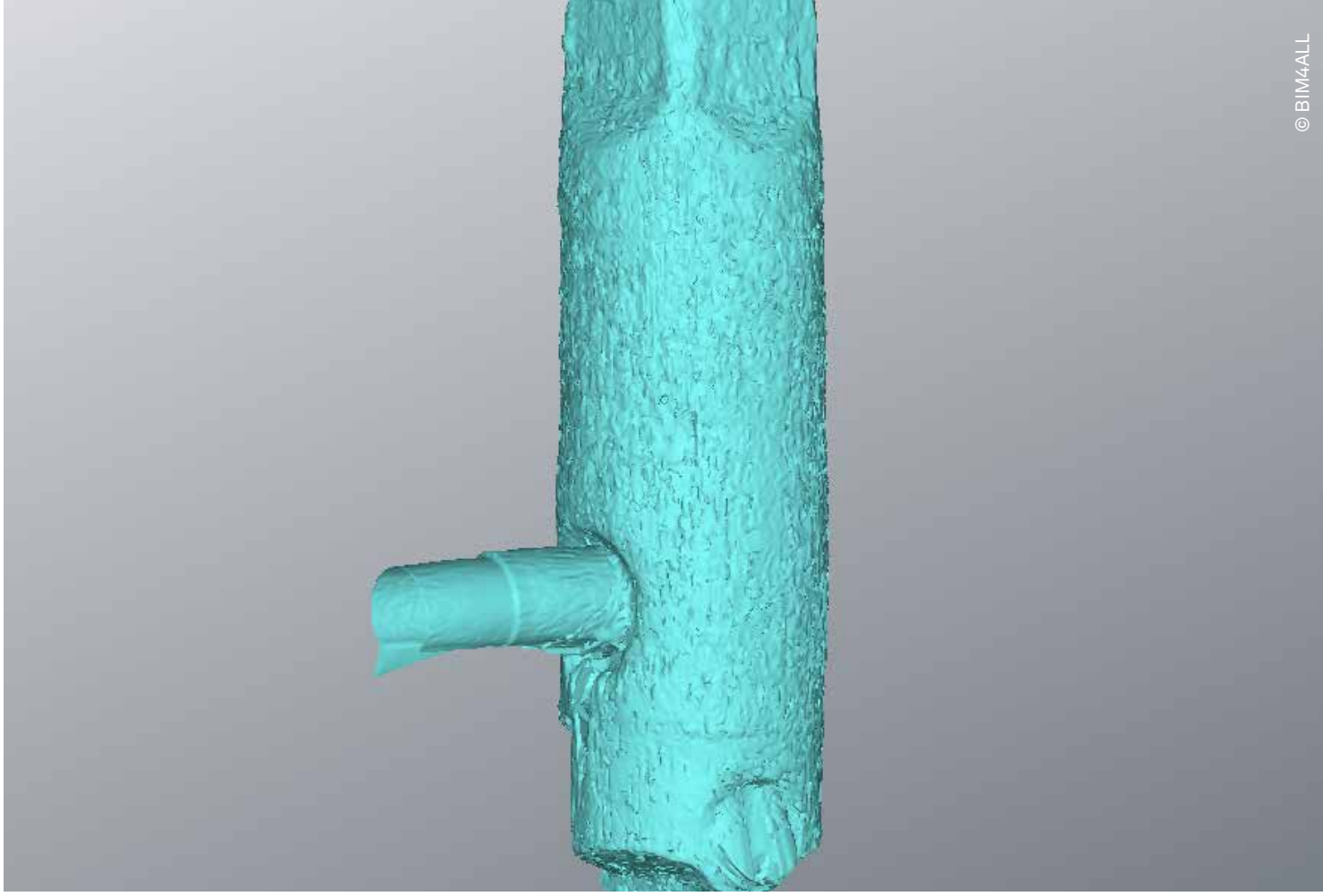
BIM is not only useful for the construction of new buildings but also for the renovations of buildings and objects. To do this, it is a key step to measure the real world and capture it into a 3D model. The best way to do this is by laser scanning. This enables BIM practitioners to accurately capture environments in detail for as-built checks of renovations, retrofits, validation and documentation.

Recently, multiple companies in the Netherlands contacted BIM4ALL to document sewer pits across the whole country. Throughout the nation, there are around 80 million of these sewer pits, and at least 10% of them need to be replaced due to corrosion from hydrogen sulfide gas.

When using the traditional means of excavating the pits, costs would run too high, and it would pose a risk to the environment, not to mention the long duration of such a project. Using laser scanning, however, a composite mould can be made to renovate the corrosive areas in less than a day.

"With our laser scanners, we are able to capture each of these pits in about half an hour. That way we keep personnel out of the pits, which leads to safer operations," said Voortman. "The costs go down, time savings go up, and the environment is significantly less disturbed."

BIM4ALL used the Leica RTC360 3D laser scanner to document 5-metre-deep pits. Capturing 2 million points per second, each pit only took 15 to 30 minutes to complete. In conjunction, the Leica iCON gps 70 T GNSS receiver was used with the Dutch coordinate system to accurately locate and measure the depth of the pits. With an IMU that enables accurate tilt compensation, the staff was able to easily measure hard-to-reach areas of the pit.



The detailed scans were processed in Leica Cyclone point cloud processing software then exported using the Leica CloudWorx for 3D Reshaper plugin to visualise meshes for the client's review. This reduces noise in the point clouds, enabling clients to clearly see the corrosion in the pits and allowing them to precisely create the needed composite moulds.

"We've been working with Leica Geosystems solutions for one year now, and we can assure you that they provide the right tools to optimise our work process even further," said Voortman. "The mix of technologies Leica Geosystems provides helped us create the added value for our customer that we strive to provide in every project."

BIM gains even more and more users worldwide. Even several governments are now requiring BIM for all their construction or renovation projects. Firms like BIM4ALL and specialists like Voortman prove, with their knowledge and various services, the high potential and endless possibilities of the working method and the new technologies for the construction industry.

CREATING VIRTUAL REALITY WITH LASER SCANNING

As part of the Brevo Group, BIM4ALL has direct access to virtual, augmented and mixed reality creations through its sister company, Studio X.

So, it is no surprise, that when the contractor of the sewer pits asked what the possibilities were on behalf of a reality experience, Studio X happily stepped in.

Due to extracting the high-dynamic range images from the RTC360 scans, the team at Studio X was able to create a virtual reality experience, seen through an Oculus VR headset.

"By being able to experience the scans through VR (Virtual Reality), our client was blown away with how clearly they could see the extent of corrosion," said Voortman. "As a member of the Brevo Group, it's great to bring new technologies into the construction industry that can help them to make smarter and more informed choices, by optimising the process and reduce (building) costs."

ICON ROBOTIC TOTAL STATION, BUILD SOFTWARE CONVINCE WITH EASE OF USE

Customer Profile

Staff

Executing construction layout tasks much faster, simpler and more accurately in the United Kingdom.

© Mike Sharp & Son

Resect Engineering Ltd. (Resect) is a Kent-based company providing site engineering and surveying services throughout the United Kingdom and abroad, specialising in piling and groundworks. Involved in the early stages of the HS2 project, a new high-speed rail network connecting northern and southern England, Resect is constantly thriving to improve efficiency and accuracy in its construction projects. In the process of acquiring new layout solutions for construction, Resect decided on Leica Geosystems iCON robotic total stations with iCON field construction software.

Tom Batchelor, senior site layout engineer at Resect Engineering, is responsible for layout tasks as well as in-house layout training for new employees. At the current project in Southend-on-Sea, England, Batchelor is responsible for the correct positioning of drill holes to position the pillars for the basement of a new apartment block.

EASE-OF-USE AND TAILORED APPLICATIONS CONVINCE

Within three months after the first demonstration of the Leica iCON robotic total station by SCCS Survey, a Leica Geosystems authorised distributor and service partner, Resect acquired five new iCON robotic total stations and purchased one Leica iCON GNSS smart antenna, both running on the iCON field construction software.

“We compared several suppliers of course, but the intuitive and construction-tailored iCON field software and the easy-to-use hardware convinced us. It is a great help for everyone on site to work on the same software platform, no matter if we work with the total station or the GNSS rover,” states Batchelor.

At the current project, where the accurate location of the pillars is crucial, Resect uses the Sketching application in iCON field to calculate the centre point of an arch radius after measuring a minimum of three points of a radius.

“The sketching app is just one example of all iCON field applications showing Leica Geosystems developed this software with real construction applications in mind,” says Batchelor.

INCREASING EFFICIENCY

The intuitive software interface and the simple-to-operate apps tailored to the workflows on construction sites are speeding up the stakeout tasks for Resect. Batchelor emphasises the iCON iCR70 can be used by every crew member:

“As senior site layout engineer, I benefit from the easy-to-use and intuitive Leica iCON solution as I can train new engineers on the total station and software on my own.”

Since working with the iCON iCR70 robotic total station, Resect has been able to execute its construction layout tasks faster, simpler and more accurate. Due to the combination of an easy setup, stable prism lock and simple to operate software and hardware, the team’s efficiency on the construction sites has increased.

Another reason for Resect to decide on the iCON solution was the consultancy and support SCCS Survey provided during the entire hiring process.

“A professional, trustworthy consultant and support for us are very important. With SCCS, the process from the first product demonstration, over the sales and after-sales support was completely hassle-free,” concluded Batchelor.

AN INVITATION INTO THE PILING RIG CABIN OF HENRIK BERGMAN

Customer Profile

Arne Forsell is a freelance photojournalist with a great interest in heavy machines, based in Sweden.

Piling rig operator Henrik Bergman describes his working experiences with machine control for piling rigs in Sweden.

A number of pine shaped air fresheners – Wunderbaums — in colours of the American flag hangs from the right corner of the windscreen in Henrik Bergman's piling machine. The Leica MCP80 3D machine control panel from Leica Geosystems is securely mounted in the opposite left corner. It is robust, shock- and waterproof with clear markings and a large touchscreen. It displays the new Leica MC1 software, which is the common platform for all machine control solutions from Leica Geosystems.

Leaning back in the operator seat, in his stocking feet with earmuffs and dark sunglasses to protect against the sunlight, sits Bergman. He is surrounded by the machine's displays and control levers. His wood clogs are neatly placed by the cabin door. The carpet inside the cabin is clean and well-maintained. Bergman's workplace inside the huge piling rig is comfortable and cosy.

"Of course, I want to keep it tidy and make it nice in here," said Bergman with a proud smile. "I actually spend more time in here than I do at home."

MACHINE CONTROL USED FOR PILING MACHINES FOR GROUND STABILISATION

Like a thunderous rhythmic heartbeat from a dinosaur, the piling rig drives the hoisted concrete piles down into the ground. The tower is 22 metres, the ram weighs 5 tonnes and falls from a height of 1.2 m. The concrete piles look almost fragile lying on the ground and giving in to the roughness of the ground surface.

They are taken one by one and hoisted up in the tower of the piling rig, directed into the guide rail by the skilful manoeuvring of the operator. The pile hangs almost apathetically in the machine before it is carefully and accurately hoisted down to the position that is programmed into the machine control solution. The first part of the pile is going easily into the clay-saturated ground, but the friction is gradually intensifying, and then the hammer is taken into use.

Another pile is attached on top of the first pile. The clay soil vibrates, and the piece of cushioning wood plate, that act as a shock absorber between the two piles, catches fire due to the friction. Outside, the noise is almost

painful, but Bergman assures that he is not bothered inside the machine.

"It's actually worse when you are standing at a distance from the pile because the sound is bounced back from the surroundings, and the effect is magnified. Inside the cabin, I hear nothing at all," explained Bergman. The rig operator sits relaxed in the operator seat and monitors the work on the MCP80 panel on the left side of the cabin.

The construction site Bergman is working on is placed in Enköping, north of Stockholm in Sweden, in the residential area of Älvdansen. The municipality is building 700 new apartments, a retirement home and a preschool. The company PEAB Grundläggning is contracted for the ground stabilisation, including piling. This is where Bergman and his piling rig equipped with the Leica iRP3 3D machine control solution enters the scene.

The project comprises 214 concrete piles. The pile pattern, including all information about the work, is programmed into Bergman's machine control solution. Manual stake-out of the pile holes is no longer necessary, and Bergman uses the pile pattern on his display to navigate the machine to the correct position for each pile. The as-built documentation is also logged by the solution. This simplifies the daily work for the operator. Bergman and his machine can work more independently, and the time and costs savings are significant.

A DEDICATED PILING RIG OPERATOR

The bullseye view guides the operator to place the machine's tool point in the correct position.

If you need hands-on advice from someone who worked with machine control for pilers, then Bergman is the right person to ask. He has been working with pilers for 14 years now, thanks to his father-in-law, Tommy, who started him in this business. Bergman used to work as a truck driver, but Tommy asked him to join the piling company he was working for at that time. Unfortunately, the company went out of business, and they both found themselves out of job.

Bergman was then employed by PEAB Grundläggning, and it was his turn to recommend Tommy to his new employer. "And the rest is history," says Bergman with a smile.

In his hometown of Stora Skedvi, Bergman is the owner of a typical Swedish forest farm where he lives with his wife and two children. In his spare time, he enjoys carpentry as well

© PEAB Grundläggning

as spending time in the garage with his two vintage vehicles, a Ford-49 that has won him a prize at the Elmia exhibition, and an A-Ford from 1928. Besides, if you look closely, among the tattoos on Bergman's arm, a Hot Rod car can be found.

SAVING TIME WITH MACHINE CONTROL WHEN PILING UNDERWATER

Two years ago, PEAB Grundläggning was contracted for a project in the harbour of Hudiksvall, Sweden. This was the first project where the piling machine from PEB Grundläggning was equipped with a machine control solution from Leica Geosystems. Since then, Bergman, his team and the Junttan piling machine took part in the pilot project for the development of the machine control solution — a project that Bergman has greatly enjoyed.

"Everybody in the team participated in the project, and Leica Geosystems listened to our opinions. We save a lot of time and costs because we don't need surveyors on the site all the time. To manually stakeout, a pile can take up to 20-30 minutes for every pile. Today, we can do five piles at the same time," explains Bergman.

Bergman describes another big project near Stockholm, connecting the island of Lovön to the mainland with a pipeline for water.

"The project involved 1 kilometre of 88 steel piles in pairs under the water supporting the water pipe. We worked together with divers, and we soon realised how much time we can really save, when working 'blindly' underwater and not having to wait for surveyors for every pile."

After years of experience working with machine control solutions from Leica Geosystems, Bergman has only good experiences.

"You can't really wish for anything better. The system is unrivalled, keeps the costs down, and the software is easy to learn. I haven't had any problems with the solution ever. Leica Geosystems keeps what they promise, and if PEAB Grundläggning buys a new machine in the future, it will certainly be equipped with a Leica iRP3 solution," says Bergman.

DRILLING IN NORWAY WITH 3D RIG SOLUTION

Customer Profile

Arne Forsell is a freelance photojournalist with a great interest in heavy machines, based in Sweden.

3D machine control solution for rig applications enables operators to work more efficiently and from a safe distance in Norway.

Rays of sunlight hit the wooded hillside from the west. The old road seems to lead upwards in an indefinite number of turns. The shadows are long. The water in the mountain lake is sparkling on the other side. The world's highest ski jump slope with the steepest point of 200 metres peaks up from the woods, and snow-covered mountain tops can be seen on the horizon. This is Vikersund, Norway, a few hours drive from Oslo, and the entire scene is glowing in autumn colours.

Fjellsprenger AS is drilling the bedrock for ground preparations to build a fenced construction site, where together with another company, Norsk Fjellsprengning, can store equipment and explosives. The team carries out the drilling work with 3D machine control solutions from Leica Geosystems.

MEETING THE DRILL OPERATOR

A firm handshake from a weathered hand, an impressive moustache, and on top, a hard hat with a miner headlamp – driller operator Odd Are Frydenlund is presenting himself.

Frydenlund has been working with drill rigs for eight years, beginning at the company E. Rolstad AS and now at Fjellsprenger AS. Before that, he worked as an excavator operator.

His machine is a Sandvik Ranger DX800 top hammer drilling rig. It weighs 15 tonnes and stands stable on its track, powered by a strong 225 HP motor from Caterpillar. Frydenlund can drill holes with a diameter of 76 to 127 millimetres with this machine. The drill rig is equipped with a Leica iRD3 machine control solution for drilling applications, which helps Frydenlund to do the job quickly and with absolute accuracy.

Frydenlund changes job sites frequently with his drill rig. Fjellsprenger AS is contracted for many different construction projects, and Frydenlund, as well as many of the company's other machines, is moved between construction sites.

Just a few weeks earlier, Frydenlund was balancing his rig on the edge of a 30-m-tall cliff in a quarry in Maura, Norway. For safety reasons, it was very important to be able to operate the machine remotely from outside of the cabin


© Fjellsprenger AS

and additionally anchor the machine into the supporting soils.

Working over the cliff with the remote support on the machine control solution. Comparing with his previous job site, it is easier here on the plane field in Vikersund.

For some operators, who worked for a long time in the construction industry, inventions like GNSS-assisted machine control might be scary for the first time, but Frydenlund is on the contrary.

“I have experience with Leica Geosystems’ equipment already from my previous job,” says Frydenlund. “It gives me total freedom in my work. If I receive an offset height, I can build my drill pattern in the display. It is so easy! Then, I can do the drilling myself accurately. Every hole is drilled to specification with the right depth and angle. I don’t need a surveyor, everything is fast, and the as-built documentation is easy to export from the system afterwards.”

Frydenlund quickly learned how to operate the drill rig with the new 3D machine control system.

“I have not experienced difficulties with learning the system, and if I had, I would have preferred to call them challenges instead,” said Frydenlund reflecting on his learning experience. “You only need to be a little curious and interested, and then it is just like when you learned to ride a bike — once you have learned it, you don’t forget!”

Frydenlund reflects on the good relationship he has developed with Petter Heyerdahl, product manager for rig solutions at Leica Geosystems and his experience with Leica Geosystems’ personalised support team.

“I am sitting here in my drill rig 40 hours a week — it makes you think and you get new ideas! I have discussed my ideas and wishes with Petter. He listened to me, and I got most of the features that I asked for,” explains Frydenlund.

MEET THE BLAST MANAGER

The blast manager at Fjellsprenger AS, Magnus Hansen, lives close to the construction site, where the drilling is taking place. Close enough for him to take one of the fragmented rocks from the blasting and throw it to his house, if only he had enough strength in his arm.

Hansen obtained the license for rock blasting — a license that must be renewed every

five years. He has worked in the industry for 14 years. The tasks that a blast manager is responsible include the overall responsibility for the work on the site and comprise of:

- safety
- planning
- environmental concerns
- considerations for the surrounding areas
- closing of traffic.

“We have increased productivity and the quality since we have started the cooperation with Leica Geosystem and since the machine control solutions are available,” explains Hansen. “We do not need surveyors on-site to the same degree as before, and that saves us time and costs. Frydenlund can handle everything himself with the drill rig and work totally independently.”

“Once you have tried the solution, you simply can’t go back to the old methods and manual calculations. The drilling today is far more accurate than what we could accomplish before,” refers Hansen on the productivity of machine control solutions.

Back then, there could be a difference of 30 to 40 centimetres in the depth of the holes, and that affects the blast result. With the 3D solution, everything is as plain as a house floor.”

The talking is done now, and it is time for action. The first holes are drilled, controlled and approved. Hansen prepares every hole, handles detonators and wires in such a skilled manner that it looks almost nonchalant, but make no mistake — the blast manager knows what he is doing.

The shell for cushioning and absorbing lateral impact are placed on top of the area to be blasted, then the siren alarm rings.

The blast sounds dampened and controlled — WHOOOOMP!

And the rays of autumn sunshine continue glittering across the blasted earth.

DIRT SIMPLE PAVING – FROM STRING LINES TO COMPLETE 3D MACHINE CONTROL SOLUTION

Case Study

Richard Davies — Regional Marketing Manager for Leica Geosystems, based in the United Arab Emirates.

3D machine control paving solution helps contractor finish a 12-month airfield project within six months in the United Arab Emirates.

Worldwide, the number of journeys taken by air has increased exponentially during the past 70 years. According to Flight 24, in a single day, more than 230,000 commercial flights are flying across the sky. A pre-COVID-19 study by E. Mazareanu estimated the number of passengers travelling on scheduled flights to be more than 4.72 billion in 2020, which is around 137% higher than in 2004.

The United Arab Emirates (UAE) in particular is fast becoming a significant hub for air travel, with both Abu Dhabi and Dubai International Airports competing for a growing connections market. The level of infrastructure needed to support this scale of operation is substantial. It is vital this infrastructure is constructed to the highest standards and that any downtime is limited when maintenance is required.

Al Nisr, a construction company based in the UAE, is a world leader in the construction of airfields and supporting infrastructure. The company is experiencing rapid growth and believes that investing in technology is vital when competing for complex contracts, particularly those that involve the paving of runways or aprons. The company has previously been involved with major UAE projects at Abu Dhabi International Airport, Al Maktoum International Airport, Sharjah International Airport, Al Bateen Executive Airport, Al Fujairah International Airport, and many military airbases across the UAE.

FROM TRADITIONAL STRING LINE METHOD TO COMPLETE 3D PAVING SOLUTION

When paving infrastructure as important as runways and airfield aprons, Al Nisr aims to lay a runway to a tolerance of 5 millimetres, meaning 5 mm or less variation in the thickness, the height of the surface. Traditionally, the firm had used string line methodology to achieve this accuracy in its paving work, using manually laid out strings staked into the ground to guide the thickness and level of the asphalt being laid. This string line methodology can impact the level of accuracy and productivity, as highlighted by Al Nisr's general manager, Eng., Orwa Alward Zaidan:

"We were using string lines – this limited the number of trucks that could come and drop materials. Sometimes people can hit the string lines, and this causes problems. Concrete is laid at night, and the survey of the site is carried out in the morning. So, if the string is hit in the evening, it delays the project until the next morning. A string is also sometimes not accurate and can experience sag — this can have a negative impact on the accuracy of the surface. With string, we could originally only pave 300-metre lengths at a time."


© Al Nisr

With several significant upcoming projects, such as a new airfield operated by Etihad Airways in Abu Dhabi and a military airfield, Al Nisr invested in a Leica iCON pave concrete machine control system from Leica Geosystems, part of Hexagon, to improve its efficiency and accuracy in work. The company was already aware of Leica Geosystems' easy-to-use solutions, as one of their engineers had used the system in the U.K. and was impressed with the performance, understanding that it represented a complete solution for 3D asphalt paving. In addition, Al Nisr had previously used a variety of survey solutions from Leica Geosystems, including Leica TS9 and TPS1200 total stations, along with Leica Viva GS14 GNSS smart antennas. The firm was always happy with the usability and reliability of this survey equipment, so it made sense to invest in Leica Geosystems' machine control solutions.

ACHIEVING HIGH-ACCURACY WITH STRINGLESS PAVING

Machine control systems save time and costs for a variety of heavy construction applications and are used in paving applications to avoid dependency on string lines, making work easier for operators and contractors, while reducing costs. Stringless concrete paving also increases the consistency and quality of the finished surface.

The iCON pave concrete system purchased by Al Nisr consists of the rugged, shock- and waterproof Leica MCP80 control panel, Leica iCR80 or TS16 total stations, and two Leica MPR122 360° prisms for guidance, all supported by Leica MC1 software, the all-in-one software platform for machine control. When using the system, the operators from Al Nir found the graphical interface intuitive and uncluttered, allowing them to focus on the job at hand and complete work quickly with the desired precision. Leica ConX is a cloud-based solution and web interface allowing customers to visualise and validate localised reference models, survey data and constructed data, with powerful analysis tools for monitoring and reporting site productivity. Al Nisr found this feature particularly helpful, as it allowed its chief surveyor to accurately visualise progress on site from the comfort of his office.

Before paving work began, a survey was completed using the GS14 GNSS smart antenna and total station solutions from Leica Geosystems. Autodesk AutoCAD Civil 3D software was used to make a model of the site, before converting into an XML file and then simply uploading it directly to the pavers. Leica iCONstruct Field Simulator was used to ensure everything was correct before work began. Once sections of paving were completed, as-built checks were carried out again using Leica Geosystems GNSS equipment, along with Leica NA2 automatic levels.

Thanks to the easy integration and interoperability of the various software and

hardware solutions the Hexagon portfolio offers, Al Nisr was able to move from traditional workflows toward a more connected, digitised construction site.

ON-GOING ON-SITE SUPPORT AND TRAINING FROM LEICA GEOSYSTEMS

The installation of the system was supported locally by dedicated machine control staff from Leica Geosystems and their local distribution partner, GECO Engineering. Al Nisr staff needed training — Leica Geosystems staff visited and sat with the engineers and all other staff involved with the project to ensure they were comfortable with the system. On-going support was also provided during the project.

Laying runways and aprons using GOMACO GHP2800 and GP2400 pavers, the system has provided a wide variety of benefits to Al Nisr, efficiency being the main one. Originally, a paver had a run of 300 m linear per night but now can do 900 m linear per night or nearly 2,000 cubic metres per night. In addition, with this technology, the role of surveyors is now easier and safer. Pave patterns and models developed in the office can directly be uploaded to the pavers without having to knock in any pins for string lines. Thanks to the increased visibility offered by ConX, all stakeholders can now look at the project and say, with confidence, that it will be completed significantly faster than before.

The benefits of using machine control are clear to chief surveyor, Arshad Mahmood:

“Everything is nice, we really like the system! In UAE, this system helps us to lead the market – we can now look at a project and say it can be completed in a much shorter time. I would say that we see up to three times more productivity than when we use a regular system.”

OVERPERFORMING EXPECTED DEADLINES WITH MACHINE CONTROL

Initial calculations suggested that the Abu Dhabi airfield project could take up to 12 months, yet utilising machine control from Leica Geosystems, it took six months. With large infrastructure projects, such as airfields, contractors want to complete well within deadline as this allows them to avoid significant financial punishments and move onto other jobs.

Leveraging the wide-range of products and brands of Hexagon’s heavy construction portfolio, Al Nisr is proud to be the pioneer of machine control for airfields in the UAE. The approach increases the company’s performance, improves its reputation, and helps the business win more work.

MASTERING THE TRICKY ART OF RESPONSIBLE WASTE PLANNING

Case Study

Corbin Goldsmith — Mine Planning Specialist for Hexagon's Mining division, based in the United States.

Mining increasingly depends on digital solutions and accurate planning to improve the recovery of minerals while reducing the environmental footprint. In the South Pacific islands of New Caledonia, MinePlan Schedule Optimiser and 3D software are being used to manage waste responsibly and help preserve a UNESCO World Heritage Site.

Mines are under increasing pressure to reduce their environmental footprints. Tougher government regulations and increased public scrutiny have elevated responsible reclamation to be a higher priority across the industry. It's especially relevant in the South Pacific island nation of New Caledonia, where mines operate under the added oversight of the United Nations Educational, Scientific and Cultural Organisation (UNESCO).

In 2008, UNESCO added the Lagoons of New Caledonia to the World Heritage Site List, meaning mines are subject to rigorous environmental standards and regulations. One example of these standards is in the restriction of disturbance limits. The disturbance area is restricted to the ultimate pit limits, and all mining activity must stay in this confined area. This imposes a series of limitations and challenges, including a limitation on the space available for waste dumps.

Mines must manage material efficiently and backfill the pit with previously mined waste material. However, opening the space on the pit floor to accommodate the waste can be tricky. In the process of opening the pit floor for backfill, the management and availability of the multiple ore types materials must be considered.

This poses a significant challenge in the mine planning process; the excavation requires a precise schedule to remove the different material types to maintain the grade balance at the mill, while minimising re-handling.

NICKEL IN NEW CALEDONIA

A significant amount of the world's nickel production comes from New Caledonia, one of the top five countries for nickel production. Many of these nickel mines have started producing cobalt with the recent upsurge in renewable energy. The nickel/cobalt mines in New Caledonia (mostly open-pit operations) consist of large nickel laterite deposits, which are typically located close to the surface.

The deposition sequence includes iron oxides (laterites) near the surface and magnesium silicates (saprolites) beneath. Knowing the geology of the deposit is key, and the first step in the long and difficult process of preparing a strategic mine plan.

MEETING GRADE CONSTRAINTS

The restrictions for magnesium and manganese percentages to the mill are rigid and must be met in order to maintain the plant's recovery. Unfortunately, the high-grade nickel and cobalt ore typically come with high amounts of magnesium and manganese as well.

Using Hexagon's MinePlan software - specifically MinePlan Schedule Optimiser (MPSO) - the grade constraints can be applied and altered on a multi-period basis to maximise the mill's processing abilities. This means that the mine plan will try to honour the magnesium and manganese restrictions. In the event the grade balance could not be kept, the schedule would seek other routes, or fail to find an excavation strategy.

This kind of long-range planning tool helps the site verify that they can achieve their mining objectives and provides a schedule for the life of mine. The long-term plan allows the site engineers to simulate different mining scenarios when considering commodity prices and inflation by the input of economic information. The engineering group can optimise the schedule and evaluate multiple possibilities.

OPTIMAL DUMP PLANNING

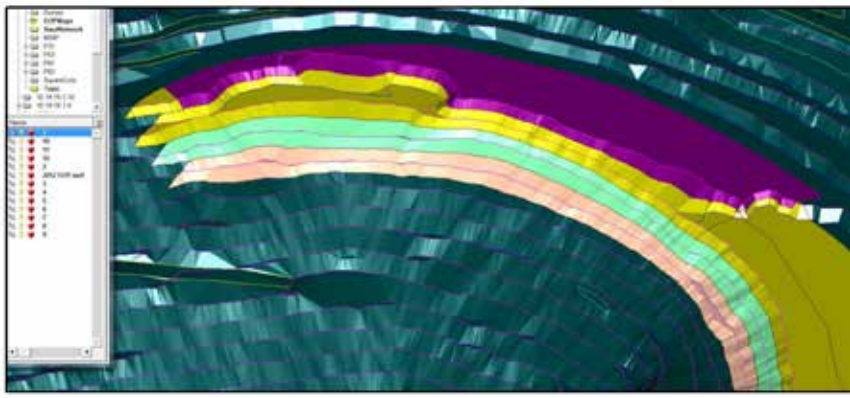
With the stringent mill constraints and the minimal working area, engineers fight an up-hill battle with no summit in sight. All the material must stay within the working area, which only consists of the ultimate pit limits. This means that the first waste dumps will be placed on the future ore zones, requiring the material to be moved later. Using MinePlan 3D software (MP3D) the engineers can create the dump designs with a specific amount of volume or tonnage in mind. This allows the engineers to design waste dumps to be re-handled at a specific time, and they can strategically schedule the start of the final waste dump areas.

CUT PLANNING

Timing the sequencing of all these moving parts requires the expertise of an experienced user and the right tool for the job. MPSO was not only able to manage the need to re-handle waste material, but also strategically schedule the mining cuts. MPSO optimised the sequencing of mining of cuts to maximise net present value while trying to honour all the quality, quantity and blending constraints. The sequence and constraints are performed through multiple iterations of the plan to get the best results.

Plans can be made solely on nickel recovery, or factor in the extraction of cobalt, which will dramatically change the order in which the pit is opened up. The ability to create multiple plans to account for different scenarios the mine may face is one of MPSO's strongest qualities. The long/medium range plans prepared with MPSO are then used as a guideline for short-term plans, which are prepared with MinePlan Activity Scheduler.

Mining increasingly depends on digital solutions and relies more on accurate planning to both improve the recovery of minerals and reduce the disturbance on the environment. The environment and local ecosystems must be protected by using an adequate plan which ensures the mine is meeting or exceeding all regulations set by the local government and company policies. MinePlan empowers mines to do this.



HOW CERREJÓN TACKLES RISKS AND PREVENTS ACCIDENTS

Case Study

Neville Judd — Communications Director for Hexagon's Mining division, based in Canada.

A Hexagon film crew visited Colombia to document Cerrejón's commitment to safety.

Stretching more than 270 square miles (690 square kilometres), Cerrejón in Colombia is the largest open-pit coal mine in Latin America and the 10th biggest in the world. Complete with its railway system and shipping terminal, the mine employs thousands of people operating hundreds of vehicles.

Protecting its people is a priority for Cerrejón, whose zero-harm culture is enshrined in all aspects of the business. The company turned to Hexagon for a comprehensive collision avoidance solution. Hexagon shares Cerrejón's core belief: the most important asset coming out of a mine isn't what's extracted – it's the people who make it possible.

A Hexagon film crew visited Colombia to document Cerrejón's commitment to safety. Staff shared the benefits of Hexagon's MineProtect Collision Avoidance System (CAS), including how the mine puts data to work towards strategic safety objectives. CAS has not only helped the mine to minimise the risk of accidents, it has also addressed other safety challenges.

"We put in place a system of random monitoring and preventive monitoring of compliance with stop signs in the mine and in the company," explained Álvaro Uribe of Cerrejón's Production Safety Committee.

"And this allowed us, from 2014 up to date, to gradually, decrease up to 90% non-compliance of stop signs. This is a great benefit to the safety performance of the company. We are being preventative, and we are identifying and correcting wrong habits in our operation."

Amid heavy traffic, large equipment, poor visibility and blind spots, CAS delivers 360º proximity detection via a non-intrusive cabin display unit. It provides a call to act if an unwanted event is about to occur. It empowers Cerrejón's operators to prevent collisions and avoid accidents.

Operator acceptance was essential to success, said Rafael Mazzilli, Cerrejón's operational integrity coordinator.

"There was a lot of evidence from alarms and as time went by and with training, the alarms were diminishing," said Mazzilli. "Until today, where the reports show the operators respond to the alarms. Operators' acceptance was also very important, because we made surveys, we trained and inquired of everybody; we asked them to express the benefits and the improvement opportunities."

Hexagon's Mining safety portfolio manager Marcos Bayuelo oversaw the CAS deployment at Cerrejón and has been a regular visitor to the mine for the past decade. He credited the company for its proactive approach to safety.

"Like Hexagon, Cerrejón is serious about safety," said Bayuelo. "All the times we had an opportunity to save someone, where the system worked and did its job, that's when we can say we have contributed. For me, as a product manager, it gives me satisfaction that one more person makes it home safe.

"We are sincerely grateful to the busy staff who participated in the video and Cerrejón's communications team, who made it possible."

Hexagon recently broadened the scope of its MineProtect portfolio to include slope monitoring capabilities. By integrating with another Hexagon company, IDS GeoRadar, the MineProtect portfolio now connects systems for safety and radar-based slope stability hazards.

Via real-time equipment visualisation, integration ensures timely alerts about hazardous areas for people and machinery. This additional layer of information means better risk evaluation. It's another way to ensure everyone gets home safely.

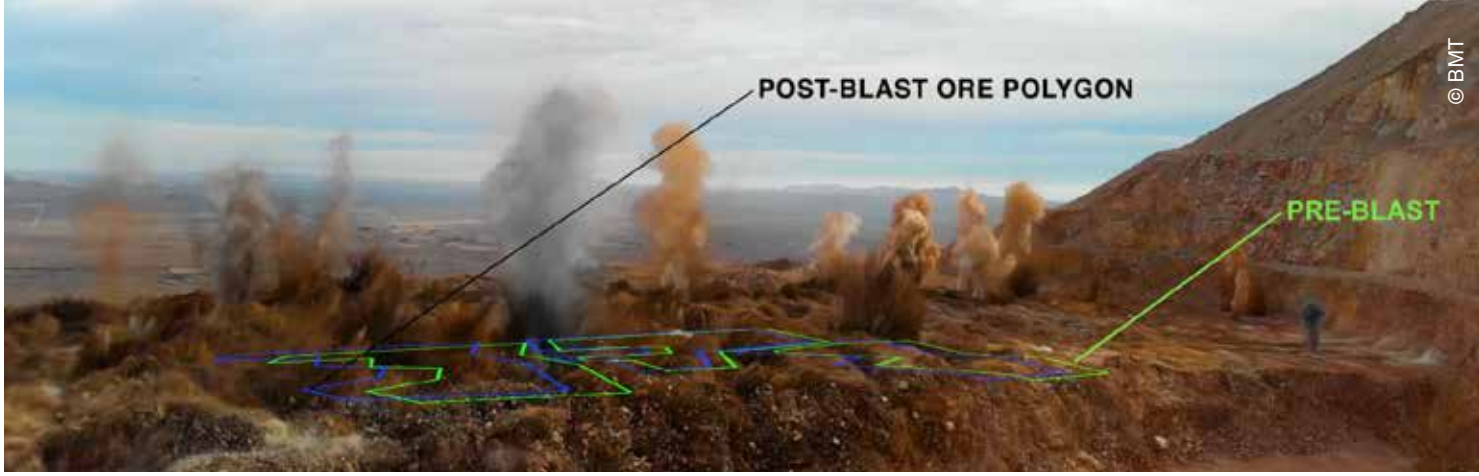
Video available at: https://blog.hexagonmining.com/how-cerrejon-tackles-risks-and-prevents-accidents/

MAXIMISING PROFITS WITH FRAGMENTATION ANALYSIS

Case Study

Ian Leones — Content Marketing Specialist for Hexagon's Mining division, based in the United States.

How fragmentation analysis solution saved one mine in Peru $7.2 million a month.



The goal of any business is to maximise profits by optimising resources, processes and new technology. This is especially true in mining, where the initial extraction processes can drastically impact downstream activities and the overall profitability of an operation.

Open-pit mines often view blasting as separate from other extraction activities. However, results of the blast, such as fragmentation, muck pile profile and displacement, impact downstream activities like mining, crushing and milling.

That's why the complex, multi-layered process of drill and blast is arguably the first and most important step to get right. It can also be the toughest and most expensive.

Two copper mines in Peru recognised the need to create new drilling and blasting designs to improve mining and milling productivity. The mines hoped that changing the designs would allow a better distribution of energy during detonation and ultimately improve the fragmentation.

Fragmentation of rock – making rock small enough and loose enough to be efficiently excavated - is essential to mining and is the preparatory stage in the extraction process. Correct fragmentation means easier digging, reduced shovel cycle times, reduced rework, less oversize causing downtime at the crusher, lower cost crushing, and improved tonnes per hour (TPH) through the processing plant.

The two mines identified four key objectives to accomplish their goal:

- Optimise blast fragmentation
- Improve the shape of the pile material fired
- Improve the efficiency of crushing
- Maximise the processing of the semi-autogenous grinding (SAG) mill by optimising the size of the material

In order to meet these objectives, they needed a way to analyse their fragmentation.

THE SPLIT ADVANTAGE

The mines selected HxGN Split to deliver high-quality fragmentation information. HxGN Split measures particle-size distributions from mine-to-mill to manage blast design, optimise fragmentation, increase mine site productivity and profits, all with automated systems. HxGN Split-ShovelCam, HxGN Split-TruckCam and HxGN Split-ConveyorCam trigger images of fragmentation and transmits them to a Split-server to process particle sizes automatically. This gives a mine a complete picture of what is going on with its fragmentation from the muck pile all the way to the conveyor belt.

HxGN Split-ShovelCam measures Particle Size Distribution (PSD) information as the ore is loaded into the shovel in the pit. By measuring at the muck pile face, the largest rocks are captured early in the process.

HxGN Split-TruckCam measures the PSD of post-blasted rock delivered to the primary crusher. Rock fragmentation from different blast designs can be measured to determine the most effective parameters for oversize reduction and crusher throughput.

HxGN Split-ConveyorCam measures PSD information for any conveyor belt location. This system provides real-time analysis data for measuring particle size distribution, shape and colour.

CLOSING THE DRILL AND BLAST GAP

As a result of using HxGN Split to identify and reduce fragmentation size, the mines saw improvements to equipment efficiency, loading and transportation productivity, tonnage processed, and energy consumption.

Both mines saw a reduction in mill circuit product size (known as P80) of 38%, as well as a 50% increase in fines – smaller particles found in mining.

The first mine saw a 12% increase in SAG mill processing and an increase in profits of $7,182,119 (about 6.3 million Euros). The second mine increased fines by 40%, productivity of excavators by 19% and SAG mill processing by 2%.

The Peruvian mines illustrate the benefits of using fragmentation analysis to inform the drill and blast process, improving profitability from downstream activities like milling. It also helps explain why technology to tailor fragmentation outcomes must be integral to any drill and blast portfolio.

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