

# REPORTER

Geosystems Division  
September 2021

## 100 Years Innovation Heerbrugg

The more we automate,  
the less we waste

How hybrid airborne data  
supports sustainability  
initiatives

Going towards sustainable  
construction

### Why Hexagon places sustainability at the core of its business

Helping the world transition to a greener economy is an opportunity.



**HEXAGON**

# CONTENT

## THOUGHT LEADERSHIP

- 4 **The more we automate, the less we waste**  
*Editorial*
- 6 **Versatile geospatial solutions**  
*Editorial*
- 10 **Why Hexagon places sustainability at the core of its business**  
*Editorial*

## WHAT'S NEW

- 14 **News**  
*Latest Geosystems happenings*

## AROUND THE WORLD

- 18 **Around the World**  
*HEXAGON Geosystems features customers*

## SURVEY SOLUTIONS

- 20 **100 Years innovation Heerbrugg**  
*Editorial*
- 30 **Measuring the point cloud... with a GNSS rover**  
*Case Study*
- 34 **Using 3D laser scanning to detect structural changes in salt and ice caves**  
*Case Study*

## GEOSPATIAL CONTENT

- 40 **How hybrid airborne data supports sustainability initiatives**  
*Editorial*
- 42 **High-density airborne LiDAR sensor ideal for challenging coastal survey of Sylt**  
*Case Study*
- 46 **Colour-infrared images provide a different perspective**  
*Feature*

## MINING

- 50 **A wholeness approach to open pit scheduling and optimisation**  
*Editorial*
- 54 **Minimising mining's operational and maintenance costs**  
*Case Study*
- 56 **Enabling the local community in an autonomous project**  
*Case Study*

## BUILDING SOLUTIONS

- 60 **Going Towards Sustainable Construction**  
*Editorial*
- 64 **Creating the first digital shopping centre in Peru**  
*Case Study*
- 68 **The BLK3D cuts perfect stone for historical facade restoration in New York City**  
*Case Study*

## HEAVY CONSTRUCTION

- 72 **Heavy construction draws on digital capabilities to meet sustainability demands**  
*Editorial*
- 76 **3D or nothing**  
*Case Study*
- 80 **Beyond 3D machine control: An integrated piling solution**  
*Case Study*

**Reporter:** Hexagon's Geosystems division customer magazine **Published by:** Hexagon's Geosystems division

**Editorial office:** Heinrich-Wild-Strasse, 9435 Heerbrugg, Switzerland, Phone +41 71 727 3131, reporter@leica-geosystems.com

**Editor:** Haike Finch-Schattka **Design:** Marino Plečáň, Stephanie Chau

©2021 Hexagon AB and/or its subsidiaries and affiliates. All rights reserved.



### President's Message

Thomas Haring  
President of Hexagon's Geosystems division

Do good, help others do good, talk about it, and let others talk about it. That is how we take responsibility, by accelerating sustainable developments and harmonising the planet, people and prosperity.

Our solutions already contribute to environmental and social sustainability by improving efficiency, quality, and safety in a broad array of industries. We have long been proud enablers of our customers' sustainability journeys — but we didn't talk about it. With this edition of our customer magazine, we're changing that.

2021 is a very special year for us — we are celebrating 100 years of Innovation Heerbrugg and, with it, honour thousands of committed people who have driven innovations worldwide for a century and created many unforgettable moments. Heerbrugg is and will remain one of the largest global locations for Hexagon. The high-performance innovation factory ensures technology leadership for Hexagon. Innovation was important 100 years ago when WILD Heerbrugg was established, and it is essential today. In the historic review by Eugen Voit, who held various senior technology leadership roles over the last decades, you will read that tradition and change do not have to be a contradiction. The continuous striving for innovation is the link between stability and change, and the basis for sustainable developments.

Learning from the past means a better future. The urge to spread innovations and thus technology to solve customer and societal problems is firmly anchored in our corporate culture. Let Burkhard Böckem, CTO Hexagon, take you on a journey into the future. Find out which technological leaps are already possible, which future technology trends we're translating into concrete solutions and how we leverage these opportunities for good by making the technology broadly accessible.

Of course, selected, highly innovative sensing and software solutions will also be featured in this issue, even if, as every time, we have more than fit into this issue. We're telling you how customers use our solutions to solve their business challenges and grow their companies. In addition, we will explain how the project positively affected sustainability or how the featured solutions contribute to crucial research. A professional land surveying company in Singapore expanded its business with the Leica GS18 I GNSS RTK Rover while making work safer for its employees. Optimising mining fleet management with Hexagon solutions means significant cost savings and also a considerable reduction in a mine's environmental footprint. Learn how the Leica Chiroptera 4X helps assess ocean health and how machine automation in heavy construction ensures companies deliver projects as specified, on time, within budget while keeping people safe and lowering emissions.

Beyond enabling others' sustainability journeys, we are also committed to lowering our own impact on the environment and that of our supply and value chain. Driving a culture of sustainability within our company is going to be accelerated. Read the interview with Hexagon's Head of Sustainability Maria Luthström to learn more about Hexagon's pledge to contribute to solving the world's most pressing problems.

By believing in the future, we as innovation enthusiasts will aspire to lead by example and to demonstrate what can be done. I wish you a lot of reading pleasure and let's move on to "do good, help others do good, talk about it, and let others talk about it."

Thomas Haring  
President, Hexagon's Geosystems division



# THE MORE WE AUTOMATE, THE LESS WE WASTE

☰ Editorial



Burkhard Böckem is the Chief Technology Officer of Hexagon.

**We are all increasingly aware of the impact of climate change. And we need to care deeply about the environment if we all want this Earth to be preserved for future generations. I am concerned about the future. At the same time, as Hexagon's Chief Technology Officer, I am also optimistic. I believe in the power of technology and innovation to solve the most pressing problems. Much of the technology that will significantly reduce waste and emissions already exists, and at Hexagon we're determined to make it more inclusive and more broadly available in more seamless workflows.**

**The pandemic crisis has accelerated digitalisation everywhere including in our own company. Because of travel restrictions and safety requirements, we're now collaborating entirely digitally both internally as well as with our partners around the globe. Traditional innovation processes that include different prototypes and real-life testing can use up a lot of resources. Engineers, for example, usually produce and physically test multiple samples. Within digital workflows, however, engineers can use computer simulations to study the performance of different materials and test them virtually. In 2020, we changed our innovation process including testing and production planning to be entirely virtual. A team in one country developed the product and created a virtual prototype which was then tested by a team in another country to check the design was correct.**

Sustainability is a theme throughout the entire process. We always ask how much faster can you do a job? Where can the process be leaner? How can you do it more efficiently? Which elements can you simplify? And usually, sustainability factors are in line with user needs. Energy-efficient tools and devices are not merely environmentally friendly, they are also more convenient for users because you need to recharge or change battery packs less often. Our brand's emphasis on high-quality, durable products ensures long lifecycles which are in the customers' interest and are more eco-friendly. Our training, maintenance and service ensure products stay in good working order and reduce the risk of accuracy issues that could lead to reworking costs, scrap and material or energy waste. Predictive and preventative maintenance avoids unnecessary machine downtime and further drives sustainability. Support staff can solve issues remotely and anticipate the need for site visits. Planning such trips and predicting the need of spare parts — rather than merely reacting to issues — avoids unnecessary journeys while saving the customer time. Consultancy also helps eliminate unnecessary activities and thus unnecessary emissions. So, as we optimise for customer outcomes in the innovation process, we optimise for sustainability.

We empower customers to put data to work to increase efficiency, quality and productivity so that they can use resources more wisely and avoid waste. But it is only when the collection and interpretation of data is easy that it becomes a powerful tool for optimising operations, eliminating unnecessary patterns and developing lean processes. Harnessing the power of data is often complex.

In addition, autonomous systems and processes need to be able to deal with changing situations. In the autonomous future Hexagon is envisioning, work processes and even entire industries will be able to adapt

intelligently and autonomously. Real-time data impels autonomous, fully optimised and sustainable workflows. Hexagon is adeptly positioned to drive this autonomy with its sensors, software and autonomous solutions.

Many people still associate autonomy with cars. It can do so much more — but the example can help demonstrate the impact of autonomous processes. Autonomous cars are more fuel- or energy-efficient than human-driven ones. Self-driving cars reduce congestion and thus engine idling time. In fact, one study showed that even a single car with autonomous speed control can have a noticeable impact on traffic flow. Researchers demonstrated that self-driving cars could reduce the fuel-consumption of vehicles in phantom waves by 40%. Many areas do and will benefit from data-fuelled autonomy. It can make fossil fuels cleaner, renewable energy farms more efficient, mining safer, manufacturing leaner, buildings smarter and cities more liveable. As our products support these autonomous systems, we're helping customers — and societies — to reap the advantages.

We keep pioneering autonomous innovations and we democratise them. Technologies such as the Leica BLK portfolio of solutions and our HxDR platform are easy to use and make the benefits of digitalisation and autonomy accessible and available to a broad set of industries and users.

Envisioning — and witnessing — how pairing fully digitalised processes with artificial intelligence (AI) breaks new ground is exciting. Deep learning can extract new learnings from data and enable solutions and applications we currently can barely imagine. AI has already transformed how we do machine visualisations and image processing. Coupling AI with Simultaneous Localisation and Mapping, and its ability to self-navigate alongside smart sensors with processing at the edge, will boost robotics and unlock additional potential for autonomy.



**BURKHARD BÖCKEM**

Burkhard Böckem is the Chief Technology Officer of Hexagon.



# VERSATILE GEOSPATIAL SOLUTIONS

☰ Editorial



Ken Mooyman is Executive Vice President at Hexagon's Geosystems division and President of the World Geospatial Industry Council (WGIC).

Throughout our long history, a core driver of innovation has been our ambition to create solutions that are easier to use. As a result, precise geospatial tools and the value that they provide are now available to a larger group of people.



**Our user-friendly software solutions help even nonspecialists interpret, analyse and visualise geospatial data. As Hexagon's Geosystems division continues to serve traditional industries such as surveying and construction, we're excited to see new applications for our solutions in other industries, including areas that support sustainability and keep people safe. Consider these examples:**

### MONITORING

Global warming increases the frequency of natural hazards, such as landslides, melting glaciers, avalanches or rockfalls following heavy rainfalls. In addition, in many countries, infrastructure is ageing and becomes vulnerable because of increased stress due to urbanisation and construction activities. For example, 40% of the United States' 600,000 bridges are more than 50 years old; one out of eleven is structurally deficient.

Monitoring is fundamental in understanding the risks related to these phenomena and preventing disastrous consequences. Advanced Monitoring technologies assess the actual risk and indicate where corrections are impactful or protection measures necessary. They can also identify the precursors of structural failure or early indications of natural hazards to allow evacuating people in time. Monitoring, for example, the traffic-induced vibration of a bridge helps engineers identify structural problems and close the traffic for restructuring the bridge in time. Continuously monitoring the movement of a landslide or a glacier helps recognise accelerations, which are often precursors of a collapse. Increasingly intelligent systems automatically trigger alarms and even prompt protection measures.

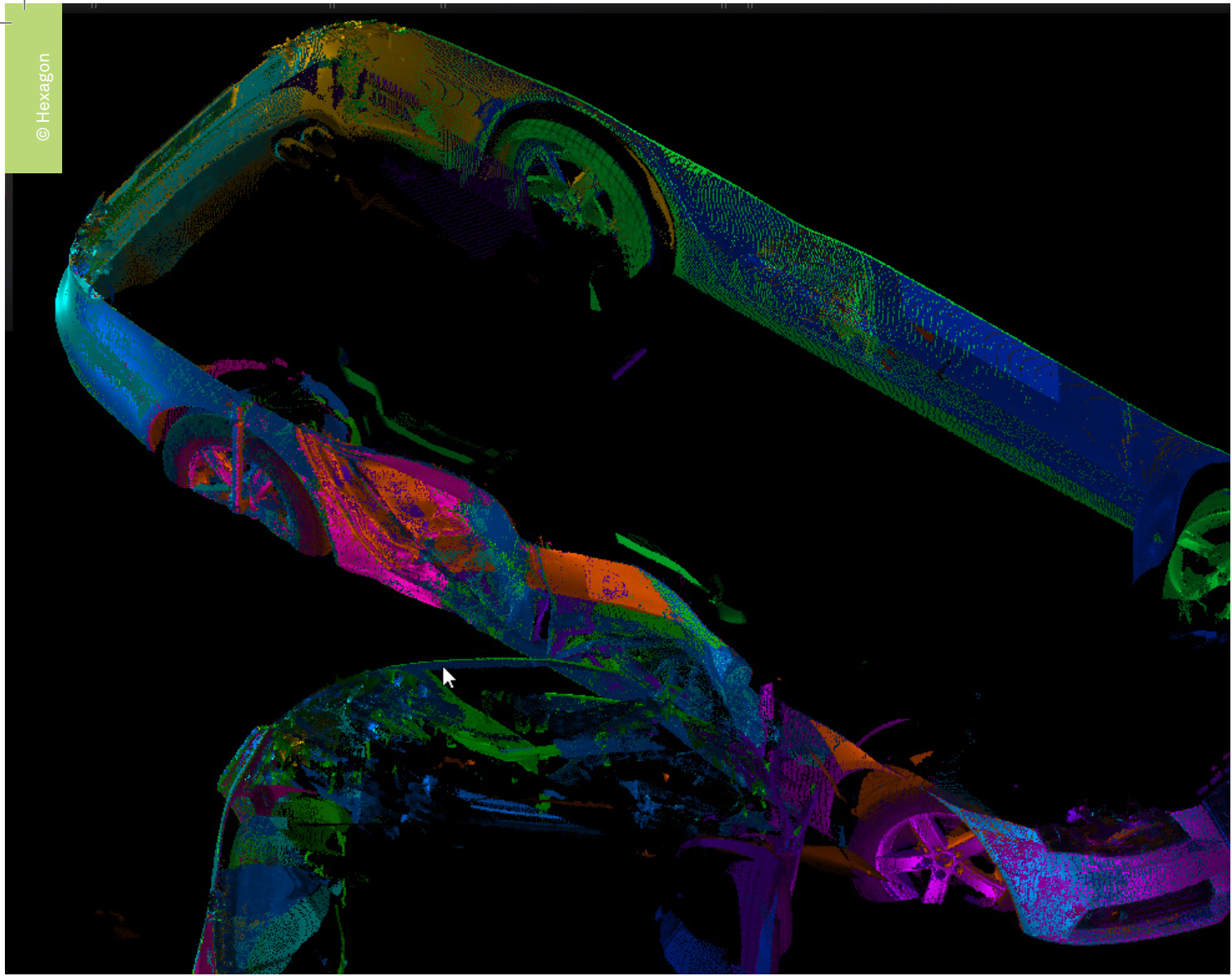
Hexagon owns a unique range of technologies suitable for monitoring and is pursuing the Total Monitoring concept:

It provides advanced, complementary monitoring hardware and software that merges and correlates the data from different sensors and facilitates the interpretation by the user.

### MEDIA AND ENTERTAINMENT

The push to achieve ever-more-stunning visual effects in films and video games creates demand for solutions that help achieve these effects in faster, better and more cost-efficient ways. By capturing real-life environments using Reality Capture solutions and turning them into digital realities, movie makers and game designers can quickly create 3D models. These serve as bases for their fictional worlds, which would be extremely difficult, time-consuming or even impossible to build from scratch. Hexagon solutions are a perfect match for an industry that expects stellar quality and speedy delivery. Easy-to-use laser scanners such as the Leica BLK360 and Leica BLK2GO make it easier for professionals to acquire 3D data capture for movie and game production.

Creative professionals can turn these digital worlds they design into immersive experiences that allow the visitor to enter a scene and to move through it. Such compelling experiences can be emotionally moving. Some people compare their intensity to real-life memories. Environmental organisations are increasingly using the same technology, that is, reality capture and virtual reality, for edutainment: Teaching people about environmental protection in an absorbing and engaging manner. People can virtually experience threatened ecosystems, including coral reefs or old-growth forests, that they couldn't access otherwise. Research shows that such experiences incentivise people to learn and increase their sense of connectedness to the issue.



## PUBLIC SAFETY

Access to accurate information and complete visibility of evidence at an incident scene is essential for public safety professionals. Minute details can contain crucial information. To preserve such information through a virtual copy — the Forensic Digital Twin — public safety professionals use our laser scanning, total stations, UAV, and mobile mapping solutions to instantly capture and visualise crime, crash or fire scenes. In many instances, investigators may not be able to revisit the scene for months or even years. During that period, pertinent information can get lost. Reviewing and analysing the Forensic Digital Twin helps police officers, investigators, prosecutors, judges and others to clarify or understand the course of events.

Apart from evidence gathering on an incident scene, digital twins can help major-event organisers understand crowd behaviour, identify bottlenecks, map escape routes and model scenarios to ensure effective crowd

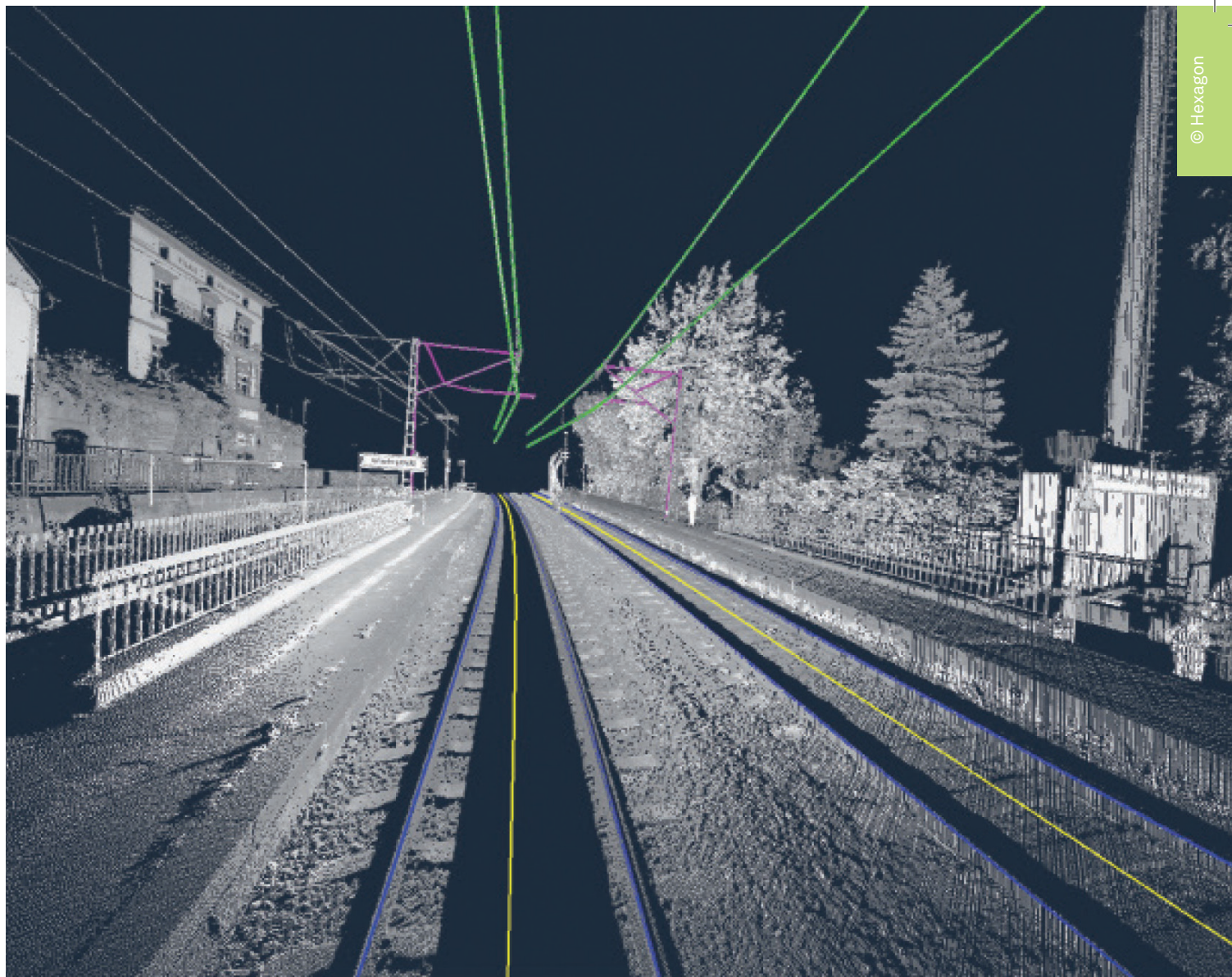
control and protection. Security service companies can use accurate digital models to identify and mitigate threats. Security managers, organisers and first responders can explore a 3D environment, zoom in on details, annotate and prevent threats.

## RAIL

Facilitating rail transport is a crucial step toward reducing global carbon emissions.

Rail is a safety-sensitive, and thus conservative, industry. However, because rail networks and systems are highly complex, digital technologies can have a tremendous impact on efficiency, safety, asset maintenance and asset reliability. For countries with modern railway systems, digitalisation is a must if they are planning to enable high-speed and autonomous rail. The Leica Pegasus:Two offers survey-grade accuracy and high-resolution images for creating digital twins in the rail industry. It can be mounted on a rail-enabled vehicle or a road vehicle to capture data on and off track. The Leica Pegasus:Two





captures rail track geometry, catenary, vegetation, and surrounding infrastructure, which can be used for rail track geometry evaluation, redesign, clearance analysis, autonomous trains, etc. Data capturing is quick and efficient and requires fewer people in potentially hazardous zones. Additionally, the Pegasus:Two can be mounted on a train, reducing the need for rail track downtime.

Digitally enabled process optimisations mean faster transportation of people and freight, safer operations, fewer breakdowns — and increased public trust in these environmentally crucial transport solutions.

### CONCLUSION

These are some of the many examples where I have seen the adoption of geospatial solutions. It's inspiring, and I look forward to seeing our company continue to push the boundaries of geospatial technologies and witnessing how our customers put those technologies to use.



### KEN MOOYMAN

Ken Mooyman is Executive Vice President at Hexagon's Geosystems division and President of the World Geospatial Industry Council (WGIC).

# WHY HEXAGON PLACES SUSTAINABILITY AT THE CORE OF ITS BUSINESS

☰ Editorial



Maria Luthström is Head of Sustainability and Investor Relations at Hexagon.

Earlier in 2021, Hexagon launched a new sustainability programme. Maria Luthström, head of sustainability and investor relations, is responsible for driving the company's environment, social and governance (ESG) agenda.

**As the Head of Sustainability, you're spearheading Hexagon's sustainability efforts. How did your passion for sustainability practices begin?**

After graduating from university nearly 15 years ago, I started as a trainee at a large, family-owned company in Sweden. The owners were very focused on sustainability which shaped my views. I was inspired by the company's head of sustainability, a former politician. Being involved in a lot of sustainability projects at that group — and leading many of them — allowed me to gain valuable experience. I implemented sustainability frameworks such as the Global Reporting Initiative. At the time, that was very new, and nobody at the company had any prior knowledge or experience of the topic. We didn't hire consultants either, so I had to do my own research to implement it. I learned a lot by doing that.

**Earlier this year, Hexagon announced the launch of a new sustainability programme with key environmental, social and governance (ESG) goals centred around carbon emissions, supplier audits and gender diversity. Why is Hexagon making sustainability a core aspect of its strategic focus?**

I think everyone should make sustainability a focus — but corporations have a particular responsibility: They are profit-driven and must abide by market principles, so they have an opportunity to drive real change. That is why our mantra "do well to do good" is so important: Companies must become sustainable while still achieving their business goals. We have to achieve sustainability in a cost-effective way. Otherwise, it won't stick.

**What is Hexagon doing that's unique and different?**

We are in a special position because Hexagon's core business is already an enabler of sustainability: We're focused on improving efficiency, productivity, quality and safety for our customers. And that's also how we're supporting their sustainability journeys. Sustainability is really at the core of what we do, and we are able to pull our client companies in various industries along.

Also, the business venture R-evolution is fantastic and unique. We will invest in green-tech projects where Hexagon's technology can be applied. It's business-driven and shows that helping the world transition to a new greener economy is an opportunity. Sustainable, profit-driven projects can propel society toward that vision. We're currently investigating whether putting solar panels on-site is feasible in some of our larger facilities. An alternative would be to buy power purchase agreements where we'd invest in the build-out of renewable energy, which we can then use to power our facilities.

**How do you cultivate an environment that values and promotes sustainable practices at Hexagon?**

We already know that many employees are passionate about sustainability, and that is crucial. It's important with the bottom-up approach. But we're aware that the support and the commitment must also come from the top. Sustainability must be part of business planning and a recurring topic in strategy sessions and communications.



### Do you establish ESG objectives at the employee or management level?

At the beginning of the year, we defined overarching targets: Our ESG targets include carbon neutrality in our scope 1 and 2 emissions by 2030; carbon neutrality across our entire value chain in scope 1, 2 and 3 emissions by 2050; sustainability supplier audits across 100% of our direct suppliers in risk areas by 2023; and at least 30% of our leadership positions filled by women by 2025. Those targets are very high-level, of course. We are now breaking them down into more granular objectives and activities to help people grasp what they mean for their roles.

### Can you share what measurements the company will implement?

We're increasing energy efficiency across our facilities, reducing carbon emissions from business travel and company fleets. We will also increase our focus on sustainability during the product design phase, implement stronger supplier audit processes and launch initiatives

that build and nurture an inclusive culture while attracting and retaining diverse talent. I'm excited that some divisions are rolling out their own initiatives, for example mentoring programs to increase the percentage of women in leadership. I'm hoping to extend such programs to the rest of the company.

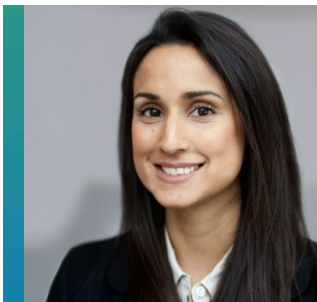
### Where do you see challenges?

Our organisation is decentralised, so the decision to adopt a company approach to sustainability will make a big difference. The divisions will drive their own sustainability agendas, but there is a joint commitment. We've also set up expert groups within operations, procurement, HR and compliance. These groups include members from each division. They develop sustainability initiatives in line with their operational contexts and goals and the progress is reported quarterly to the president and CEO Ola Rollén and Hexagon's board of directors. That's how we ensure that sustainability initiatives across the company align with the overarching goals.



**Is there a company out there that you want to emulate?**

We do look at best practices within other companies. Some companies with a larger environmental footprint have been under pressure from stakeholders to become more sustainable for some time. Those companies' frameworks are usually more advanced. Compared to those companies, we don't have a big carbon footprint. We don't have large production facilities, for example. For tech companies, other challenges may be more obvious. The industry is very male dominant, and that's something we need to break. We're also focusing on our supply chains where human and labour rights can be an issue in some areas. Assessing our suppliers' sustainability is an important step.



**MARIA LUTHSTRÖM**

Maria Luthström is Head of Sustainability and Investor Relations at Hexagon.

# NEWS



## New digital twins of major cities

Hexagon will add 3D digital twins of major cities to the HxGN Content Program, including Munich, Cologne, Vienna, Amsterdam, Stockholm, Tokyo, Dallas and New York. The data will enable city administrations and infrastructure providers to manage and monitor critical assets, anticipate and mitigate risks and visualise projects to create smarter, more sustainable cities. Captured with the Leica CityMapper-2 urban mapping solution, the data stack includes orthophotos, obliques images, LIDAR point clouds, DSM, DTM, 3D building models, 3D meshes and semantic maps. Exceptional data consistency and flexible use terms make this data ideal for machine learning, analytics and automatic feature extraction.



## Hexagon releases HxDR

Hexagon releases HxDR, its cloud-based storage, visualisation, and collaboration platform for reality capture and geospatial data. Users can store, view, and share their reality capture data and purchase data for their own use from the HxGN Content Program through HxDR.

HxDR automatically converts uploads, including E57 files or any scan from a BLK laser scanner, into 3D models. Users can create virtual tours, assign tasks, and add annotations within the platform for seamless collaboration with colleagues and clients around the world.



## GNSS correction at your fingertips

HxGN SmartNet is the world's largest GNSS correction service provider. We process more data, from more reference stations around the world than any other provider. Now, customers can start using high-accuracy GNSS correction services whenever they need them by subscribing to our services on our local SmartNet e-shops. Germany, Italy, Norway, Sweden, Finland, Spain and Denmark are already open for business and we'll continuously add more countries. Choose a subscription that fits your needs, pay online and you are ready to measure.



## 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 MC1 swing boom support

The Leica iCON iXE3 3D excavator machine control solutions will be available for smaller excavators with swing boom, providing an easy-to-use solution on one unified software and hardware platform. Leveraging the Leica MC1 — a unified platform for software and hardware — means compact equipment benefits from flexible dataflows, easy-to-use interfaces and increased productivity so operators can focus on the job.



### 3D reality capture solution for Boston Dynamics robot

Mounting the Leica RTC360 3D laser scanner onto Boston Dynamics Spot robot creates an efficient scanning solution. Rather than a human operator, Spot does the walking and stationing of individual scans. Programming the devices to repeat scanning routes through a location increases productivity and flexibility. Such programmed scanning tasks can benefit professionals in various industries, including construction, public safety and defence. Thanks to the remotely controlled RTC360 and Spot's agility, professionals can cover terrain that may be difficult or hazardous for humans.



### One app for entire terrestrial laser scanning portfolio

The Leica Cyclone FIELD 360 mobile-device app now extends to all Leica Geosystems 3D terrestrial laser scanners for in-field data acquisition and visualisation, enhancing the existing and well-established 3D reality capture workflow. With the simple push of a button from the mobile-device app, all users of Leica Geosystems' laser scanners can operate and capture high-quality 3D data and carry out pre-registration directly in the field with a few simple clicks, saving valuable post-processing time in the office.



### Leica iCON site milling pilot

Our customers can benefit from a new update to our iCON site differential milling pilot application as part of our Leica iCON site field positioning solution for the heavy construction industry. The latest update of the Leica iCON milling pilot application offers an automated entry-level GNSS milling machine guidance solution. The new automatic milling pilot takes away the need to enter the milling values manually, making the repaving process faster and more accurate.





## Hexagon acquires OxBlue for construction visualisation

Hexagon strengthened its capabilities to serve the rapidly evolving architecture, engineering and construction (AEC) ecosystem with the acquisition of OxBlue, a leader in construction visualisation. OxBlue's high definition time-lapse photography and live video streaming services deliver real-time visual documentation of everything that happens on a job site. Combining the latest camera technology, artificial intelligence, and machine learning algorithms, OxBlue's desktop and mobile software platform connects stakeholders to their construction job sites from anywhere, anytime. Keeping everyone informed about project status, critical milestones, and other key information, including weather conditions, ensures projects stay on schedule and under budget.



## Leica Geosystems celebrates 100 years innovation Heerbrugg

100 years of success are an occasion for celebration. On 26 April 1921, the "Heinrich Wild, Werkstätte für Feinmechanik und Optik" was founded in Heerbrugg. Out of that company grew the Leica Geosystems AG which has become an essential building block of the Hexagon technology group. We are proud to recognise these "100 years of innovation in Heerbrugg" in a series of events and publications. On 26 April 2021, the experience centre in Heerbrugg opened its doors to showcase company history through product innovations by WILD, Leica Geosystems and Hexagon.

# HEXAGON'S GEOSYSTEMS DIVISION FEATURES CUSTOMERS

## AROUND THE WORLD. EVERY DAY. ANY APPLICATION.

Doing traditional surveying, monitoring buildings that might collapse, building a digital copy of a dinosaur skeleton — the applications of our solutions are numerous.

At Hexagon's Geosystems division, we are honoured to support our customers 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](mailto:reporter@leica-geosystems.com) to be featured in *Reporter*.



Steven Couwels, founder and director at Real To Desk Asia, scanning with an RTC360 from an elevating platform in Antwerp, Belgium.



Mar Gonzalez is surveying in breathtaking views in Marina Alta, Spain, using Leica GS18 T.



To monitor damaged structures of burned buildings that might collapse, the Polish State Fire Service uses Leica Geosystems TS16 total stations. By Paweł Krótki, Poland.



"I'm a big believer in getting the best kit for the job," says Paul Bradshaw from the UK — which is why he was among the first to purchase a Liebherr crawler excavator with factory-fitted machine control solution from Leica Geosystems.



The light-weight and easy-to-use BLK2GO is making reality capturing child's play. By Kseniia Kirsanova, UK.



Lucas de Ridder and Hugo de Potter capturing the prehistoric iguanodonts at the Natural History Museum in Brussels with a Leica ScanStation C10 scanner.

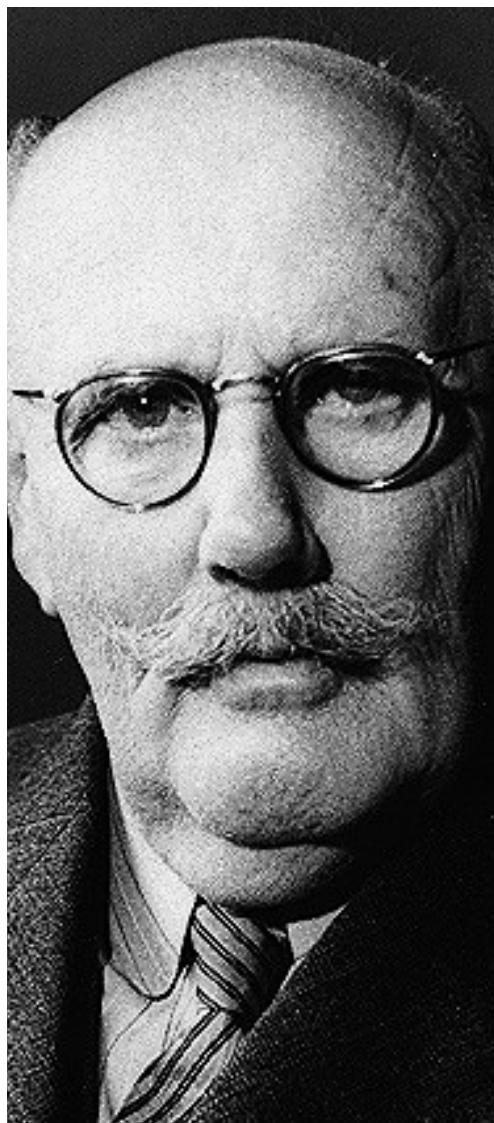
# 100 YEARS INNOVATION HEERBRUGG

☰ Editorial



Eugen Voit is a former Senior R&D Manager at Hexagon and a member of "Historic WILD," a work group dedicated to the preservation of the company's history.

The company "Heinrich Wild, Werkstätte für Feinmechanik und Optik" was founded in Heerbrugg, Switzerland, on April 26, 1921. Over the decades, this company developed into the world-renowned Leica Geosystems AG, an essential component of the Hexagon technology group. Founder and master innovator Heinrich Wild revolutionised surveying with smaller, more practical, yet more accurate instruments.



**Heerbrugg has repeatedly been the source of major innovations, such as the first optoelectronic distance meter in 1968; the first electronic theodolite with digital data recording in 1977; the first surveying system based on GPS signals in 1984; the first digital level in 1990; the first hand-held laser distance meter in 1993; the first digital aerial image sensor in 2000; and the smallest, lightest and most user-friendly laser scanner in 2019. What was the recipe for success in this hundred-year history of innovation?**

#### **A DIFFICULT START**

The structural crisis in the embroidery industry in the early 1920s hit Eastern Switzerland and especially the Rhine Valley so hard that its impact in the region exceeded that of the global economic crisis ten years later. Because the major Rhine-regulation projects were coming to an end at the same time, new work was urgently needed for the people of the Rhine Valley.

After working for the Swiss Federal Topography, Heinrich Wild had built up the geodetic department as chief engineer of the Zeiss-Werke in Jena, Germany. He already had a

reputation as a brilliant inventor in the surveying world. Because of the uncertain future post-war and the constant devaluation of money, he wanted to return to Switzerland with his family. With design plans of geodetic and photogrammetric instruments in mind, he looked for partners in Switzerland to found an optical precision-mechanical experimental workshop. He remembered his fellow officer Dr. Robert Helbling in Flums: The owner of a well-known surveying office would be very good at assessing the market needs. Helbling knew Jacob Schmidheiny, an industrialist from the Rhine Valley, from their time studying together at the ETH. Schmidheiny took a liking to the project. As a successful entrepreneur, he had the right sense of purpose and the necessary money. Heinrich Wild repeatedly pointed out that precision-mechanics specialists would be available in the area of the watch industry in Switzerland's western cantons. But Schmidheiny's guiding principle was clear from the start: He wanted to create jobs for people in the Rhine Valley.

On April 26, 1921, the three signed a contract to found a simple company under the name "Heinrich Wild, Workshop for Precision



Engineering and Optics, Heerbrugg." The production of Heinrich Wild's new level started, but many of his innovative ideas and designs were not yet technically mature in 1921. After a year — even before the first instruments had gone on sale — the company's capital was exhausted. In 1923, the company got an injection of new capital through the foundation of the "Verkaufs-Aktiengesellschaft Heinrich Wilds Geodätische Instrumente Heerbrugg" (Heinrich Wild's Heerbrugg Selling Company for Geodetic Instruments). On a commission basis, this joint stock company provided credit and obtained orders for products. However, because of technical problems in productionisation coupled with a shortage of optical and precision mechanical specialists, Heinrich Wild's vision of a small, compact universal theodolite proved difficult to realise: In 1924, only 27 of the planned 350 T2 theodolites were completed. Not until 1929 was the company on safe ground and paid out a dividend for the first time.

Heinrich Wild's inventions also laid the groundwork for photogrammetry. This made it possible to produce accurate maps economically, such as the then-new Swiss national map. WILD's phototheodolites,

autographs and aerial cameras quickly became reputable worldwide.

### THE TEST WORKSHOP BECOMES A COMPANY

The streamlining of the organisation and the establishment of a worldwide sales network by the new director Dr. Albert Schmidheini brought about a first expansion phase with 250 employees in 1930. The 1930s economic crisis interrupted the expansion, but in 1933, 130 employees remained.

The increasingly threatening political situation in the 1930s triggered a need for military instruments in Switzerland too. In record time, prototypes of telemeters, telescopic sights, omnidirectional telescopes and instruments for artillery units were developed, built and demonstrated in Bern. As a result of this successful activity, WILD became one of the main suppliers of the Swiss Army, and expansion began again in Heerbrugg.

During its second growth phase between 1936 and 1941, the workforce increased to more than 1,000. It remained at that level until 1951 and then continued to rise steeply, exceeding the 3,000-mark in October 1961.



### THE INVENTIVE GENIUS LEAVES THE GROWING COMPANY

Around 1930, Heinrich Wild and his family moved from Heerbrugg to Zurich. He rarely came to the Rhine Valley anymore, and communication became increasingly difficult. In 1933, he left the company and went into business for himself as an inventor and designer. Heerbrugg continued to commission him until 1935, when he signed a contract with Kern & Co in Aarau. He remained loyal to Kern until he passed away in 1951. However, the name “Wild” remained omnipresent in the company name and product names until 1990, when the Leica era began. For many people of the Rhine Valley, “Wild” is still synonymous with the Heerbrugg factory.

### SKILLED WORKERS IN SHORT SUPPLY

Recruiting personnel from the optical centres of the time helped counter the acute shortage of skilled workers in the optical and precision-mechanics sector, but the goal was to recruit and train Rheintalers. As early as 1921, two apprentices selected personally by Heinrich Wild began their apprenticeship in Lustenau. A dedicated school was founded in

1924 to provide even more targeted training. In 1930 this became the Fachschule für Feinmechaniker und Optiker, the Technical School for Precision Mechanics and Opticians.

### THE CULMINATION OF THE PRECISION-ENGINEERING EPOCH

In 1943, WILD drawing instruments were brought onto the market. The impulse for this was not least the Kern DKM1 theodolite, which bore the inscription “Construction Dr. H. Wild” despite protests from Heerbrugg. The T4 astronomical theodolite was the pinnacle of optomechanical precision when it was launched in 1944. This instrument enabled a direct reading of 0.1” with an accuracy of  $\pm 0.3$ ” — still legendary today.

WILD also collaborated with international research partners. In 1952, for example, the BC-4 ballistic camera — developed together with the Ballistic Research Center in the USA — went into production. This camera combined the high angular-measuring accuracy of the T4 with the high-resolution capacity of the special aerial-imaging lenses. The BC-4 camera would later also be used for satellite triangulation and thus for constructing the first global positioning system.



### OPTICAL FLIGHTS OF FANCY

In 1947, WILD continued its pioneering work in the field of microscopy. The first research microscopes produced in series in Switzerland, the M9 and M10, had their market launch. Hans A. Traber — who later became famous for his natural-history programmes on Swiss radio and television — joined Heerbrugg in 1947 and headed the Microscopy Department from 1949 until 1956.

Thanks to management's vision and WILD's reputation as an employer, the company succeeded in attracting top-class specialists to the Rhine Valley. In February 1946, Ludwig Bertele joined Heerbrugg as Head of Optics Development. The former specialist for the design of photo lenses at Zeiss-Ikon in Dresden was probably the most important optics designer of the time. He was entrusted with the development of a new type of high-performance lens for aerial photography. Under his leadership, the optical design office for the first time used an electrical calculation device to design and optimise the lenses. The device they used, the Zuse Z22, was one of the first "computers" to be produced in series. WILD was the first Swiss industrial company to purchase such a system. With this electronic calculator, it was possible to calculate about 3,000 refractive or reflective surfaces per day. Using traditional mechanical calculators,

two experienced employees would have spent 20 working days to complete the same task.

On the night of July 21, 1969, people worldwide sat with bated breath in front of their television sets as the first humans, astronauts Neil Armstrong and Buzz Aldrin, set foot on the moon during the Apollo 11 mission. NASA made use of various instruments from Heerbrugg in its lunar landing programme. The T3 was used in the orientation of the Inertial Guidance System and the T2 for the optical alignment of the LEM lunar module during construction. During the television broadcast of the spectacular moon flight, an astronaut could be seen on screen carrying out positional measurements. WILD had supplied the lens system of the instrument he used.

### THE AGE OF ELECTRONICS BEGINS — WITH A COOPERATION

In 1958, an electronics department was set up in Heerbrugg. At the 10th congress of the «Fédération Internationale des Géomètres» (FIG) 1962 in Vienna, the first microwave distance meter was presented: Developed in cooperation with the electronics company Albiswerk Zurich, the Distomat DI50 was the world's first electronic distance meter with a measuring range of 100 metres to 50 kilometres. Radically new technologies were often brought into the





company via cooperations or acquisitions. In 1963, a Distomat DI50 cost around 40 times the monthly salary of a surveyor. Radically new technologies are often costly initially and therefore only economical for very specialised applications.

### THE NEW PREMIER DISCIPLINE — OPTOELECTRONICS

The first infrared distance meter, the DISTOMAT DI10, was a joint development with the French company Sercel (Société d'Etudes, Recherches et Constructions Electroniques) in Nantes, and was launched in 1968. This first close-range distance meter revolutionised surveying technology. It did not yet use a laser, but instead the infrared radiation of a gallium arsenide diode. It marked the beginning of optoelectronics, which became a core competency in Heerbrugg. At the 14th International FIG Congress in Washington in 1973, there was a great deal of interest in the new DI3 infrared distance meter. It became a geodesy best-seller, and the name DISTOMAT became synonymous with distance meters.

### A VOLKSWAGEN FROM HEERBRUGG

In the 1970s, analogue photogrammetry reached its peak. By 1975, 1,000 A8 Autographs had left the Heerbrugg factory. The A8 was often referred to as the “Volkswagen of photogrammetry.” But technological developments, and digitalisation

in particular, ultimately brought the autograph business to a standstill. Image processing and computer science became the new premier disciplines for the digital photogrammetry that followed.

### INNOVATION REQUIRES TECHNICAL EXCELLENCE IN NEW DISCIPLINES

An intensive exchange with universities was an essential motor for innovation. Dr Hugo Kasper, previously a professor of Geodesy at the Technical University in Brno, joined WILD in 1948 and took over the newly formed Research and Development Department for Photogrammetry. The A7 and A8 autographs and the B8 Aviograph were developed under his leadership. In 1961 he was appointed professor of Geodesy, especially photogrammetry, at the ETH Zurich. He remained in contact with WILD until his retirement in 1973. In 1955, Hans Tiziani completed his apprenticeship in optics and mechanics at WILD. After training as a technician and qualifying as a mechanical engineer, he studied optics at the Sorbonne and the Paris School of Optics. He graduated as an engineer in 1963 and received his doctorate from Imperial College in London in 1967. From 1968 to 1973, he was responsible for establishing and managing the Optics Group in the Department of Technical Physics at the ETH in Zurich. From 1973 to 1978, he was head of WILD's central laboratory.



In 1978 he was appointed to the University of Stuttgart and led the Institute of Technical Optics until his retirement in 2002. To this day, he remains in intensive contact with “his” company in Heerbrugg.

Max Kreis, a graduate in mechanical engineering from the ETH, joined the Heerbrugg design office in 1932. Throughout his professional career, he was a strong advocate of higher education. As president of the executive Board, in 1968, he was a founding member of the Institute of Technology in Buchs (NTB), which today is part of the Eastern Switzerland University of Applied Sciences. Dr. Albert Semadeni, later president of the board, brought about constructing a cantonal school in Heerbrugg by tabling a motion when he was a member of the St. Gallen Cantonal Council. The school opened in 1975.

#### **SURVEYING 4.0 BEGINS IN 1977**

The fully automatic electronic infrared tachymeter TC1 was presented at the 15th international FIG Congress in Stockholm in 1977. Electronics took over the measurement of the distance and the angles as well as the logging of the measured values. A cassette was used for data storage. This marked the beginning of the era of computer science in surveying. In the beginning, however, digitalisation was a bulky and

weighty affair. For the first time ever, in 1980, the GEOMAP system enabled continuous data flow from geodetic field measurement to the finished graphical plan using the interactive graphical workplace-computer Tektronix 4054.

In December 1984, the WM Satellite Survey Company was established as a joint venture with the Magnavox Government and Industrial Electronics Company in Torrance, California. The new GPS surveying system WM101 was presented as early as May of the following year, marking the beginning of the GNSS success story that continues to this day.

#### **WILD HEERBRUGG — WILD-LEITZ — LEICA — LEICA GEOSYSTEMS**

The period between 1988 and 2000 was eventful in terms of company names, composition and ownership. The acquisition of Kern in Aarau brought a bundled load of industrial-measurement technology to Heerbrugg, and this today still represents an important market segment within the Hexagon Group.

#### **CRAZY IDEAS SOMETIMES BECOME SUCCESSFUL PRODUCTS**

In 1990, the NA2000 — the world’s first digital level — attracted a great deal of attention at the most important surveying congress in the USA



in Denver. It was awarded the innovation prize in photonics. The device's real magic is in its associated algorithm: Industrial mathematicians optimised the evaluation algorithm that worked on a PC so that it also delivered good results on a field device in an acceptable time.

The idea of launching a more accurate alternative to the ultrasonic devices and steel measuring tapes available on the market, based on all the experience with the high-quality add-on distance meters, was greeted internally with a tired smile. In the end, however, the DISTO, the world's first hand-held laser distance meter, set new standards. When it was presented in 1993 at the international construction fair BATIMAT in Paris, this new development created a real stir and received a prize for innovation.

### **EVERYTHING IS DIGITAL — WORKFLOW AND STOCK-MARKET LAUNCH**

The first digital aerial camera, the ADS40 — developed jointly with the Institute for Optical Sensor Systems of the DLR (German Aerospace Center) — was presented in 2000. The sensor's success was mainly due to a robust workflow, which required effective, frictionless processing of the massive amounts of data generated during flight operations. Software innovation was the key to this.

Acquiring the Californian company Cyra Technologies in 2000, Leica Geosystems was the first surveying company to invest in laser scanning. This technology was quickly internalised and developed further in Heerbrugg. Under the slogan "High Definition Surveying," the next-generation laser scanner HDS3000 was presented alongside the new Cyclone 5.0 software. In 2006, not only the development but also the production of the scanners was concentrated in Heerbrugg.

### **STRONGER TOGETHER — SENSOR FUSION**

Acquisitions complemented the company's own innovation activities as it expanded its solutions. This trend was further accelerated by the acquisition of Leica Geosystems by the Swedish technology group Hexagon AB in 2005.

In the past ten years, the acquisition of nearly 40 companies strengthened the company's presence in emerging markets and supported its expansion into new markets. In 2013, for example, the acquisition of Italy's Geosoft laid the foundation for the Pegasus mobile mapping product line, which records images and LiDAR data in a GIS-enabled platform while in motion, thus enabling complete capture of the surrounding area. The acquisition of the Berlin company Technet in 2015 added GIS software solutions for railway applications to the Pegasus product line.



Acquiring Italy-based IDS GeoRadar in 2016, the company obtained extremely competitive radar solutions, such as ground-penetrating radar systems that can precisely detect nonvisible underground pipes and cavities. In combination with Pegasus, recorded underground infrastructure can be linked to the spatial data recorded above ground.

CityMapper, the world's first "fused sensor" for aerial photography, with newly developed cameras and laser sensors, was introduced in 2016. It consisted of an RCD30 multispectral camera in the centre, four oblique RCD30 cameras angled at 45° and a Hyperion LiDAR unit. It was specially designed for challenging 3D city views and formed part of the RealCity overall solution for 3D city model creation.

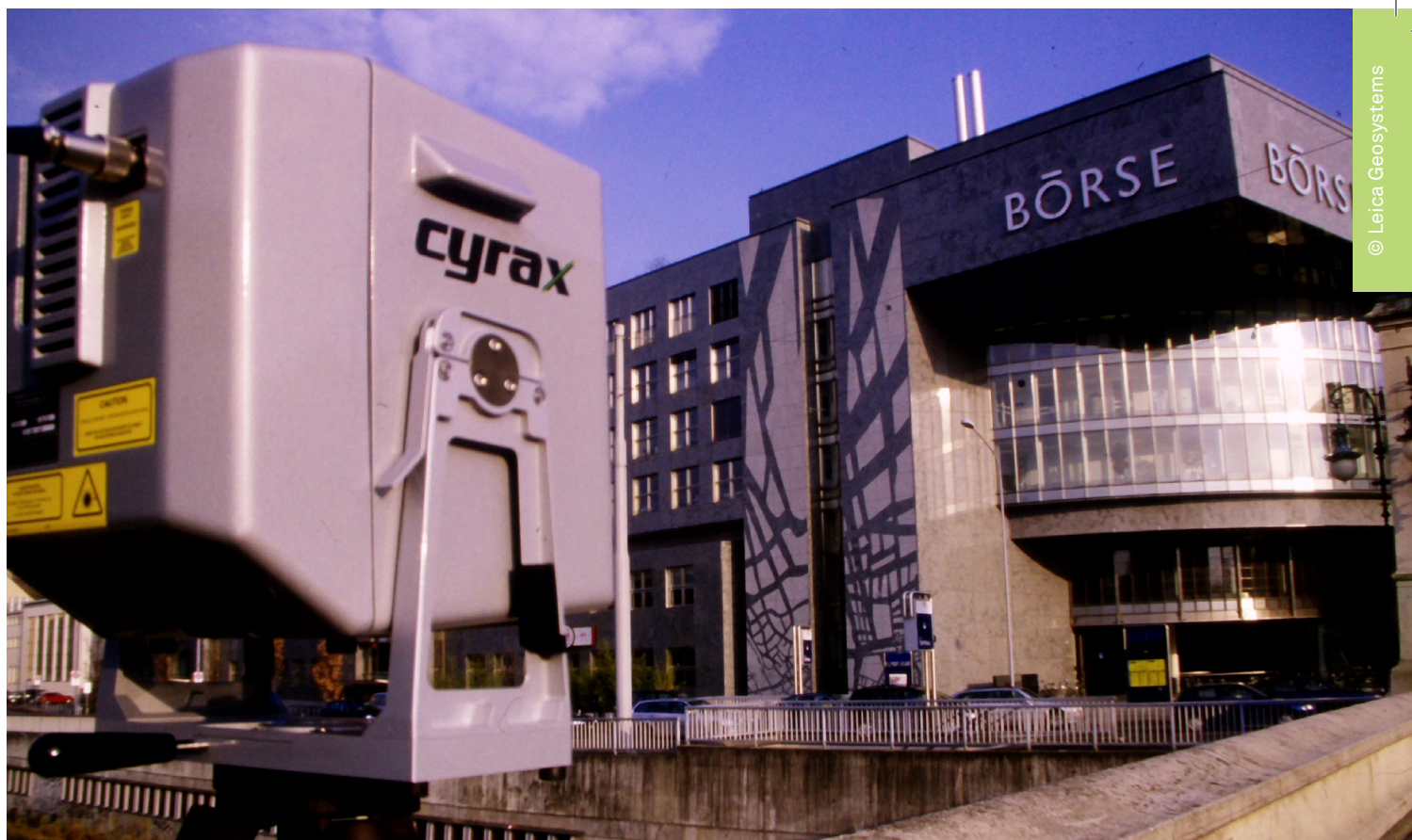
In 2017, the first GNSS with true tilt compensation was introduced. The GS18 T was the world's fastest and easiest-to-use GNSS RTK rover. Now, professionals could measure points more quickly and more easily, as they no longer had to hold the pole vertically. The development of a robust tilt compensator had been an R&D target for decades. The solution was an IMU (Inertial Measurement Unit) integrated into the GNSS antenna. The IMU recorded acceleration and rotation values and offset them against the GNSS position data.

### SMALLER, LIGHTER, SIMPLER AND MOBILE

On November 18 2016, CTO Burkhard Böckem presented the BLK360 to the public at Autodesk University 2016. The timelessly elegant laser scanner with its compact design, weighing only 1.1 kilograms, was the smallest, lightest and most powerful device on the market. The BLK360 won countless design and innovation awards. A dedicated team brought this product to market in a surprisingly short time using the latest development methods.

The first hand-held imaging laser scanner BLK2GO was presented at HxGN LIVE 2019. In real-time, as the user moves, it digitises rooms in 3D using images and point clouds. The integrated SLAM technology (Simultaneous Localisation and Mapping) enables the precise determination of the movement path while simultaneously capturing the space's geometry. And, once again, the spirit of Heinrich Wild beckons — "small, light and mobile" like the T2.

In addition to surveying-related applications, it is also increasingly used in other areas, including forensics, the film industry and archaeology — thus considerably expanding its market.



## 100 YEARS AND STILL RARING TO GO

Hexagon's geosystems division will continue to innovate in its five core industries: surveying, construction, heavy-machine control, mining and geospatial solutions. But the range of possible applications for new and emerging technologies also opens up new markets: Mobile 3D scanning technology and software solutions allow investigators to preserve digital copies of crime or crash scenes but also enable new insights for architectural scientists and archaeologists. Lasers, GNSS receivers and total stations enable media and entertainment professionals to create digital replicas of real-world objects or environments to incorporate into movies and games; urban planners use the same technology to model city development. Easy-to-use monitoring solutions can help professionals screening for natural hazards, facilitate building maintenance or assist in monitoring assets in the railway industry — to name but a few examples.

Hexagon invests between 10% and 12% of its turnover into research and development each year. But successful innovation also requires the necessary corporate culture. Since the company was founded in 1921, it has always remained important to mix the good local conditions with new ideas brought in from outside. The diversity that results from Heerbrugg's multinational employee base — with people hailing from 50 countries — enables and promotes a culture of innovation.

## HEXAGON'S NEXT CHAPTER

For its next chapter, Hexagon is committed to bringing this inventiveness to bear on developing innovative technology that drives sustainability by improving efficiency, increasing safety and reducing waste. By incorporating sustainability aspects in its innovation process, Hexagon seeks to lower carbon dioxide emissions and to combat climate change while helping existing and new customers tackle their challenges more quickly, easily and efficiently.

- This article was first published in Geomatik Schweiz 3-4 / 2021.



### EUGEN VOIT

Eugen Voit is a former Senior R&D Manager at Hexagon and a member of "Historic WILD," a work group dedicated to the preservation of the company's history.

# MEASURING THE POINT CLOUD... WITH A GNSS ROVER

☰ Case Study



Renata Barradas Gutierrez is Communications Manager, Surveying Solutions, at Hexagon's Geosystems division.

“We measure the point cloud.” This is the slogan from JTRS Registered Surveyor, a professional land surveying company in Singapore that provides 3D laser scanning, land survey, aerial mapping and inspection, photogrammetry and imaging services. JTRS is continuously looking for innovative and creative ways to improve the surveying services the company provides.



The company's latest technology leap is being able to measure the georeferenced point cloud and points with its brand-new tech acquisition — the Leica GS18 I GNSS RTK Rover.

“The capability of capturing images at the same time with real-time positioning from a single instrument really changes the way we carry out surveying. It's a reality capture concept,” explains Jimmy Tan, owner at JTRS. “Also, the tilt compensation that comes with it helps in getting RTK observations and recording quickly, which is useful when working at night like we have to do at airport runways or MRT viaducts. I don't need an extra pair of hands to hold the torchlight to shine at the bubble while I level the pole.”

Beyond measuring the point cloud, the GS18 I has empowered JTRS with a powerful RTK rover that combines fast RTK initialisation, tilt-compensated measurements and Visual Positioning. With GS18 I added to their portfolio, JTRS has been able to provide new services and improve the company's current services.

### BULLET-PROOF WORKFLOW

JTRS mostly uses the GS18 I for control surveys and quality checks in utility and construction projects. The tight accuracies needed range from 50mm to 100mm and for most QC projects within 40mm. For each project, the workflow with this versatile RTK GNSS rover is:

- Capturing the data using either the pole tip or Visual Positioning with the GS18 I and Leica Captivate field software

- Data processing with office software Leica Infinity

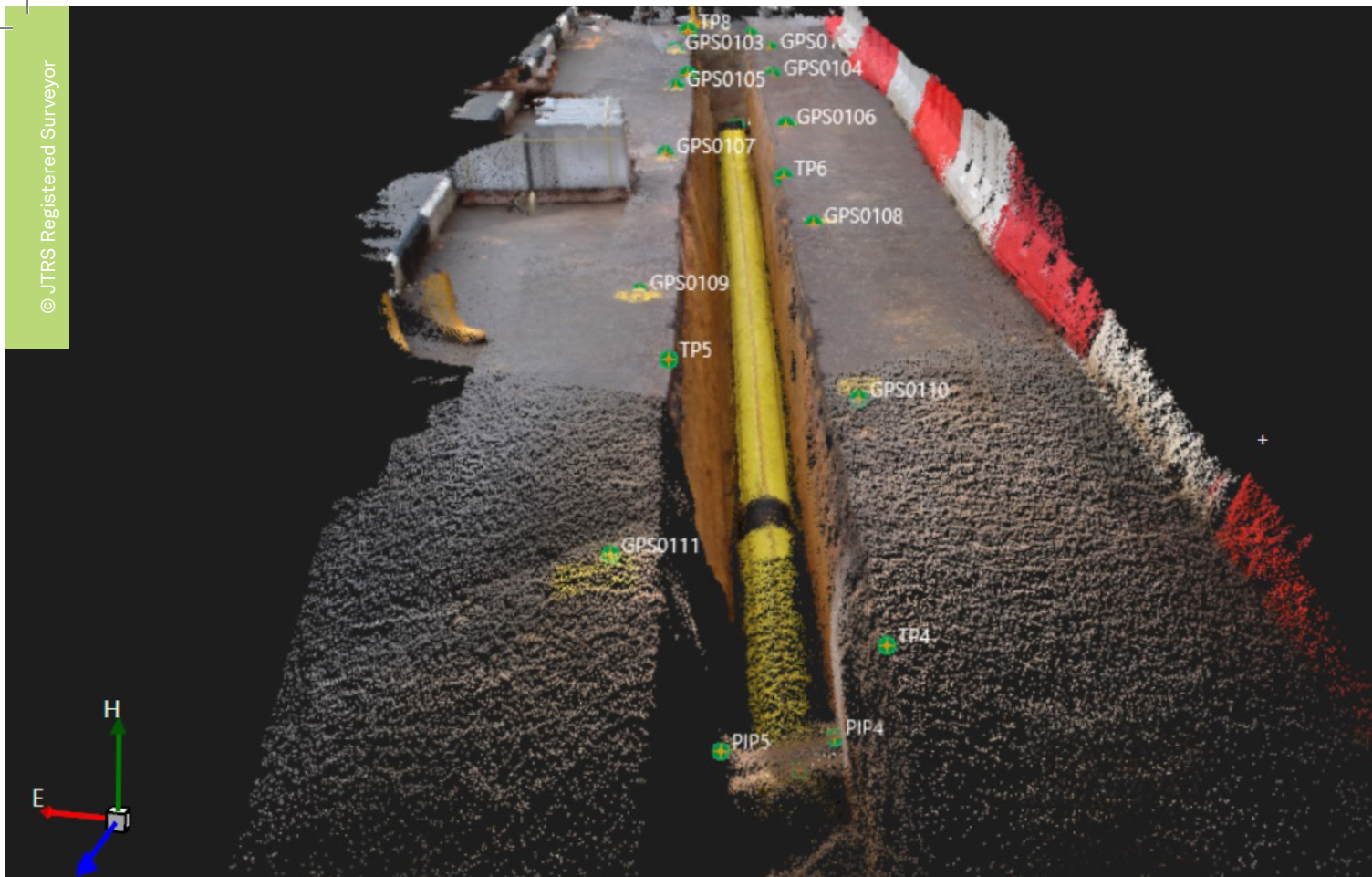
- Creating deliverables with Infinity (to process images to point clouds), Leica JetStream (to publish the point clouds) and 3D Reshaper (to do mesh modelling based on point clouds)

In Tan's words, “With the GS18 I, I just need to point the camera onto the subject that I want to capture while walking. For example, in one of my projects, the time taken to survey the trial pit with the GS18 I was no more than five minutes. The time taken to post-process in the office using Infinity software was 30 minutes. I can produce true colourised point clouds, which I can export to orthophotos and also create digital surface models. It is also possible to create hundreds of topo points from the georeferenced images quickly and efficiently.”

### SAFETY AND SPEED IN A TRIAL PIT AND AS-BUILT TRENCH SURVEY

Carrying out trial pit or as-built trench surveys can be challenging. Surveyors usually need to follow the site contractors' workflow and schedule as the trench needs to be backfilled, and the road lane needs to be reopened as quickly as possible.

Tasked with a utility trench documentation, JTRS saw it as an opportunity to test their GNSS rover. Besides doing an as-built survey of trial pits and the underground utilities, the GS18 I allowed them to create a 3D point cloud and sequence it into a 3D mesh model.



Using both the pole tip and Visual Positioning to measure in the field and a simple workflow for processing in the office pushes the boundary of surveying for JTRS.

“Surveying using GS18 I has never been so exciting. Once you capture the site using the Visual Positioning technology, you are able to validate the coordinates or levels of certain points. I am able to show the client confidently on the reduced levels of the existing pipe trough by selecting the point over the images that were captured in the survey controller — the CS20,” affirms Tan. “Alternatively, I am able to post-process the captured data and generate the topo points list with coordinates and levels. All this is done in the comfort of my office’s air-conditioned environment.”

#### **CONFIDENCE AND ACCURACY IN QUALITY CONTROL CHECK SURVEYS**

For a building and scanning project that included the 3D scanning of 1,200 blocks, JTRS carried the quality check of the georeferenced scanned data with the GS18 I. Again, the tilt and Visual Positioning technologies on the sensor made it possible to access previously unreachable points.

“In one of our projects with HDB (Housing Development Board), I was able to pick up coordinates of points captured during my walk

using Visual Positioning. With the GS18 I, it is convenient and fast to survey and I can get instant results before leaving the site,” Tan describes. When it was not possible to use the pole tip because it was too close to the building’s edge and the RTK signal couldn’t initialise, we used the Visual Positioning method and walked further away from the building where there is RTK signal. Most of the time, we would use both methods if the site condition enabled us to do so.”

#### **SMOOTHER WORKFLOW + HIGHER QUALITY DELIVERABLES = CONFIDENT CLIENTS**

JTRS is now able to work more safely and with lower manpower costs as the GNSS antenna is operated by only one person. To get ready to use the GS18 I on the field, the team needed no training, and just one short introduction on how to process the images in Infinity was required.

“Clients are more confident in the quality of the deliverables. With Infinity, I am able to process the images into true point clouds with accurate georeferencing. With Visual Positioning, I can capture two images per second as I walk, and each image comes with global coordinates from a single source — the GS18 I. It is like flying the drone installed with a GNSS antenna and camera, except we are walking,” sustains Tan.





## OPENING NEW OPPORTUNITIES BY MEASURING THE POINT CLOUD

JTRS specialises in reality capture through 3D laser scanning and photogrammetry. The GS18 I adds to the company's motto of "measuring the point cloud" with an antenna that allows surveyors to capture sites freely and safely, carry QC for almost all its data and create multiple deliverables.

"We can further develop point clouds into a 3D mesh model — that's reality capture and it is very helpful in visualisation — many times better than a single point, single line or a 2D drawing. With Infinity you can also create Digital Surface Models. This is good for engineers or designers who can use this TIN model in their design work and easily extract heights and contours, water flows and more," says Tan.

The GS18 I is not only helping to improve the current services JTRS provides but helping the company to provide new services. Being able to create multiple deliverables faster and with fewer resources has led to more project opportunities.



## Environmental, social and governance impact

### Worker safety

Worker safety can be a major concern for specific surveying tasks. Working in or near trenches, for example, can be hazardous: Risks include falling into the trench, exposure to toxic fumes, contact with buried service lines, being hit by machinery and more. Any technology that requires fewer people and less time on site helps keep workers safe. The GS18 I was designed for surveyors who want to capture an environment quickly. They can decide later which points to measure and do so in the office, thus saving expensive and possibly risky on-site time.


# USING 3D LASER SCANNING TO DETECT STRUCTURAL CHANGES IN SALT AND ICE CAVES

☰ Case Study



Tommaso Santagata is co-founder at VIGEA - Virtual Geographic Agency and member of La Venta Esplorazioni Geografiche, an international research organisation running geographical exploration projects with a focus on underground natural environments.

Cave explorers and researchers increasingly use Terrestrial Laser Scanning (TLS) to map caves. Tommaso Santagata from the virtual geographic agency Vigea recently used Leica Geosystems' laser scanning solutions in two cave surveys: an investigation of the form and structure changes in the Lechuza salt cave in Chile and the natural well ice cave in Italy.



**Santagata explains how detailed scanning at intervals can offer insight into physical changes in cave environments: “Although most processes occurring in caves are relatively slow, some can be fast, such as erosion caused by flooding. These geological changes can be monitored by terrestrial laser scanning surveys and measured by comparing ‘before and after’ 3D models. It’s an interesting tool for making comparisons over time and is therefore increasingly being used in the study of climate change.”**

#### **MEASURING CHANGES CAUSED BY FLOODING IN THE LECHUZA CAVE (CORDILLERA DE LA SAL)**

Close to the Chilean village of San Pedro de Atacama is an important cave, composed of Oligo-Miocene mineral deposit rocks, known as Cordillera de la Sal. Two surveys carried out in 2015 and 2018 allowed Santagata’s team to verify and measure small topographical changes in the cave due to a flood in 2017, which caused the river in the cave to flow and dissolve a measurable amount of halite — commonly known as rock salt.

In 2015, La Venta Esplorazioni Geografiche and the Commissione Grotte Eugenio Boegan of Trieste organised a complete 3D survey of the cave. The team used a Leica HDS7000 phase-based laser scanner to perform about 50 scans. In 2018, the La Venta team, in collaboration with the University of Bologna, used a Leica ScanStation P40 to perform 68 scans, including about 200 metres surveyed in the external canyon upstream of the cave as part of the research project “Reading the salt caves of Atacama” supported by the National Geographic Society.

Researchers subsequently analysed Lechuza data, which they’d obtained in point cloud file format, to identify areas where changes had occurred. Santagata explains, “Since very limited variations were found, it was necessary to recognise points in common and position the point clouds in the same origin and orientation to make comparisons. In at least three areas of the cave, collapses from the ceiling and erosion on the floor were recognised and digitised to obtain detailed sections of these parts of the cave. The comparison between these two surveys



has shown that in this case, it was possible to accurately document the areas where detachments or torrential erosion occurred.”

#### **THE NATURAL WELL ICE-ROCK CAVE MONITORING PROJECT: MEASURING ICE COLLAPSES**

The second study concerns the underground ice deposit in the Cenote Abyss, one of the deepest and most voluminous caves of the Italian Dolomites. The 280-metre-deep ice cave was discovered in 1994 after the entrance opened as a result of the abrupt emptying of a small lake in the Regional Park of Fanes, Sennes and Braies. The cave’s vertical entrance consists of a 130-metre-thick layered ice deposit; at the lower limit of the ice-filled entrance part a shaft opens — ice-free and 165 metres deep — leading into a dome-shaped chamber occupied by a cave rock glacier.

Laser scanning surveys carried out in 2015, 2016 and in 2018 allowed Santagata’s team to estimate variations due to collapses and acquire data for a complete monitoring project. The first expedition in October 2015 included a complete 3D laser scan survey of the final chamber using a HDS7000 phase-based laser scanner. This survey has provided the detailed volume of the chamber (420,000 m<sup>3</sup>) as well as a first record of the position of the ice masses hanging from the ceiling and of the rock glacier at the bottom. During this expedition and in subsequent ones in 2016 and 2018, other parts of the cave were 3D scanned using a ScanStation P40.

Santagata explains, “Due to the ice filling in some passages in the following years, it was not possible to repeat the survey of the final chamber. (This will be a goal for future expeditions). However, the data acquired in



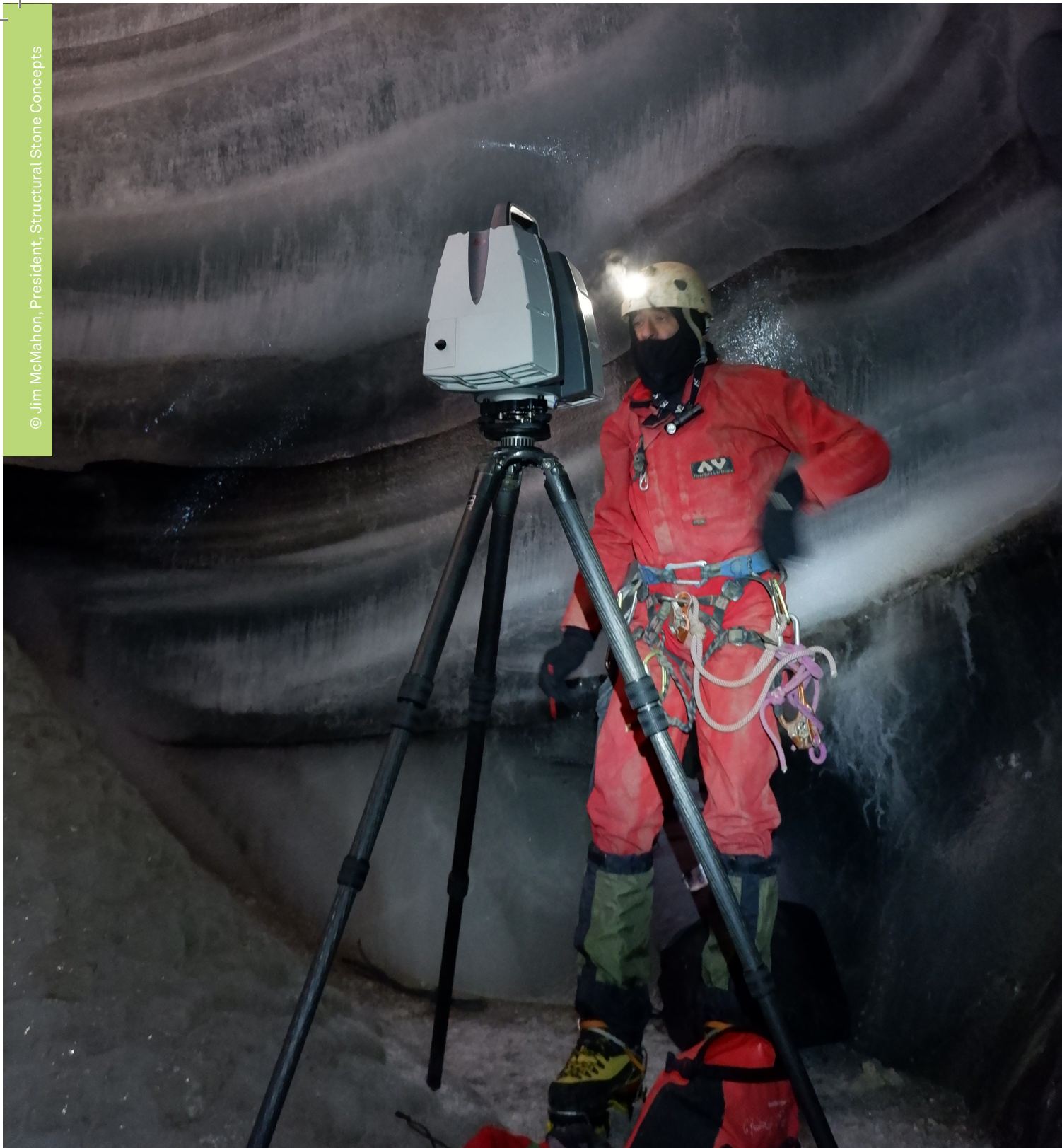
these years in the upper part of the cave has allowed us to study the changes that have taken place in the first two rooms near the entrance. In particular, a collapse was highlighted in one area, which led to the enlargement of a passage occurred after 2016. This area was 3D scanned before and after the collapse and the acquired data allowed us to verify the detachment and quantify the volume of rocks collapsed.”

“Point clouds were compared using two different methods: Firstly we ran a quick comparison between the two datasets to understand where to focus our more detailed analysis. Secondly, we extracted several ‘slices’ of the areas of interest. We exported these areas for a complete digitisation, to have a better estimation of the volume of rock collapsed, about 61m<sup>3</sup>.”

### **ONGOING STUDIES: USING 3D MODELS TO UNDERSTAND GEOLOGICAL PROCESSES**

The studies show that 3D laser scanning is a useful measuring technique for highlighting changes to natural structures. The data obtained can be used to help interpret other geological information, Santagata says, “For example, the variations highlighted by comparing the Lechuza cave studies provided interesting data that can easily be correlated to the rainfall that occurred in this area between the two survey campaigns.”

“In the case of the Cenote Abyss, the collapses probably occurred due to temperature variations, considering that the area is subject to oscillations between surface and cave temperatures recorded by temperature and air pressure sensors



installed in the cave. A detailed environmental monitoring of this area of the cave is ongoing and the repeated 3D models will allow us to understand if these processes are important for the origin and development of ice caves in the Alps.”

Key people involved in the surveys: Tommaso Santagata (Vigea — Virtual Geographic Agency and La Venta Esplorazioni Geografiche), Umberto Del Vecchio (Vigea — Virtual Geographic Agency and La Venta Esplorazioni

Geografiche), Jo De Waele (University of Bologna and La Venta), Francesco Sauro (University of Bologna and La Venta), Stefano Fabbri (University of Bologna/La Venta).

The Lechuza cave expeditions were organised by the Association La Venta Esplorazioni Geografiche with the scientific support of the BIGEA Department of the University of Bologna and with the collaboration of the Commissione Grotte E. Boegan in 2015. The scientific expedition in 2018 received funding



 Environmental, social and governance impact

## Climate research

Terrestrial laser scanning allows measuring distances of up to 1,000 metres with a very high accuracy. Obtaining 3D information of natural objects with such high accuracy and high spatial resolution grants researchers new insights into less explored structures. Scanning at intervals and comparing the data allows them to trace physical changes. As global warming accelerates such processes, TLS provides valuable data for climate researchers in their efforts to address sustainability.

from the National Geographic Society and was realised with the support of CONAF Chile. The Cenote monitoring is a multidisciplinary project organised as part of the Inside the Glaciers project with the collaboration of La Venta, BIGEA and the Regional Park of Fanes Sennes and Braies with the collaboration of Studio GST and Eli Friulia, the Speleo Club Proteo of Vicenza, the Gruppo Grotte Treviso and the Gruppo Speleologico Padovano.

# HOW HYBRID AIRBORNE DATA SUPPORTS SUSTAINABILITY INITIATIVES

☰ Editorial



John Welter is President, Geospatial Content Solutions, at Hexagon's Geosystems division.

Accurate digital representations of our world play an essential role in creating a sustainable future. Rich digital twins and 3D models provide a new level of detail that is ideal for monitoring ecosystems, simulating changes, and making informed choices.



**In the past years, we have learned just how unpredictable the world is. Having current rich digital twins at hand enables us to react to emergencies better and more quickly, and compare the past with the present to predict the future. For the most effective analytical results, digital twins need to be collected regularly and fast. Hexagon's airborne sensors and software support the planning of smarter, greener, liveable cities by providing high-productivity tools to achieve more frequent updates and enabling in-depth analysis with AI and machine learning.**

### WHY HYBRID DATA?

Only accurate digital twins with a high level of detail support reliable planning. Image-based 3D models — even densely matched ones — have data gaps, for example in narrow, occluded areas between buildings, in shadow areas or under trees. Imaging data can also deliver dissatisfying results for smooth surfaces such as water or untextured roads. Introducing a second data source significantly improves the accuracy and quality of 3D models and meshes.

Hexagon developed the Leica CityMapper-2 airborne mapping system to produce high-resolution hybrid data from two complementary technologies: photogrammetry and LiDAR. It is equipped with two nadir cameras (RGB/NIR), four 45-degree oblique cameras (RGB) and a Hyperion 2+ LiDAR sensor. The built-in mechanical forward-motion-compensation, which is unique to Leica Geosystems' airborne sensors, enables sharp images even in low-light conditions and at high flying speeds. The 2 MHz linear mode LiDAR delivers three-centimetre range accuracy and is optimised for data collection in urban environments.

Hybrid data offers the best of both worlds. Optical images have high point accuracy in the X/Y plane, while LiDAR has high accuracy in the Z component. LiDAR adds accuracy to mesh models as it penetrates foliage and detects objects in shadowed areas between buildings. Optical works well for top-surface models, and four-colour images are preferred for interpretation, although building facades, roads, transitions and water appear smoother with the aid of LiDAR. Digital twins based on hybrid data contain greater detail and consistency, which provide ideal training data sources for standardised, accurate, large-volume analytics, feature extraction and machine learning.

### MAPPING WITH HYBRID DATA

The high-performance workflow software, HxMap, is fully integrated with Leica CityMapper-2 for fast, efficient and intuitive data processing. Within one single interface, the HxMap product generator produces a wide variety of deliverables from the image and LiDAR datasets,

including referenced images, orthophotos, colourised point clouds and DSMs. 3D and mesh models come alive with textures added from oblique imagery.

Users can also enhance the 3D model with comprehensive Geographic Information Systems (GIS) data and Building Information Modelling (BIM) data to create a digital twin of the inside and outside of buildings and the surrounding topography. In effect, the real world is converted into an exact digital replica to facilitate analysis, planning and management.

### USING 3D MODELS FOR SUSTAINABLE DEVELOPMENT

One focus of many city governments is to transform their cities into sustainable living spaces. 3D models and meshes can be analysed to compare conditions over time and simulate possible future scenarios. Visualising development plans in 3D helps stakeholders understand the consequences of interventions, comprehend interrelationships and recognise planning errors at a pre-investment stage. Urban planners can work with digital twins to identify suitable areas for green belts or fresh air corridors. The models support the optimal design of critical infrastructure such as energy grids, decreasing the risk of outages and increasing energy efficiency.

Vegetation and green spaces are vital to the health and well-being of city dwellers. In a digital twin, trees are modelled and monitored for health, clearance from power lines, changes in biomass, etc. Early detection of disease prevents the loss of vegetation. Simulations also help prepare for natural disasters, such as floods and fires, by helping to identify risk areas and evacuation routes, uncovering weaknesses in emergency services and detecting vulnerable supply lines for fuel and food.

The myriad applications for digital twins and 3D models are supported by the hybrid oblique imaging and LiDAR solutions made possible by the Leica CityMapper-2, paired with the HxMap processing platform.



**JOHN WELTER**

John Welter is president, Geospatial Content Solutions, at Hexagon's Geosystems division.

# HIGH-DENSITY AIRBORNE LIDAR SENSOR IDEAL FOR CHALLENGING COASTAL SURVEY OF SYLT, GERMANY

☰ Case Study



Linda Duffy is a marketing professional at Apropos Research, focusing on remote sensing and the geospatial industry.

Arctia-Meritaito efficiently produced a seamless digital terrain model of land and water along the shallow coastal areas of the German island of Sylt using a Leica Chiroptera 4X airborne bathymetric sensor.

**Coastal surveys are greatly influenced by the quality of the water, which can be degraded by swirling sand, algae, and seaweed. Difficult conditions in the North Sea compound these issues and increase the importance of fast data collection and reliable operations. Finnish company Arctia-Meritaito Ltd. successfully completed an airborne topographic and bathymetric survey of Sylt using a Leica Chiroptera 4X as its surveying instrument.**

#### THREATS TO THE ISLAND

The German island of Sylt lies on the outer edge of the Schleswig-Holstein Wadden Sea, between 9km to 16km off the mainland. While other islands in the North Sea are surrounded by extensive intertidal sand and mud flats - called wadden - that protect the coastlines, the west coast of Sylt is completely unprotected and exposed to the forces of the water. Harsh weather conditions such as strong currents from tidal ebb and flow, frequent sea storms, and waves up to 10m high continuously reshape the island, despite attempts to reduce erosion along its sandy beaches. Since the 1980s, preservation efforts have focused on pumping sand back onto the beaches every year, rather than constructing unnatural concrete structures.

The Landesbetrieb für Küstenschutz, Nationalpark und Meeresschutz Schleswig-Holstein (National Office for Coastal Protection, National Park and Marine Protection Schleswig-Holstein) is responsible for drawing up coastal protection plans and implementing appropriate measures. In recent decades, the organisation has experimented with different technologies to identify the most effective methods of maintaining the coastlines.

In the past, surveying vessels carried out the bathymetric mapping of the seabed. For profile lines with a total length of approximately 1,100km, about four weeks were required to

allow for the daily varying tide. Mapping was complicated by an underwater reef about 400m to 500m off Sylt's west coast, where the depths rise from about -6m up to 3m. Outside the reef, the depths in the open North Sea fall again to about -10m. This reef has always been an obstacle to measuring the whole area with a vessel due to potential damage to the ship and equipment.

In 2020, Arctia-Meritaito was selected to survey Sylt with a Leica Chiroptera 4X airborne bathymetric scanner. The Chiroptera 4X can typically penetrate down to -25m and has even reached -30m in depth in ideal conditions. The elliptical scan pattern captures a forward and backward view to provide two datasets of the same point, which reduces noise caused by waves and increases depth penetration. In addition, the oblique view of the laser beam captures data of vertical objects. Despite the turbidity and waves around Sylt, the Chiroptera 4X successfully penetrated -10m to reach the seabed, meeting all project requirements.

“Bathymetric laser surveying from the air is a more suitable method to capture the coastal area of Sylt,” says Lutz Christiansen, head of surveying, topography, morphology at the National Office for Coastal Protection, National Park and Marine Protection Schleswig-Holstein. “By conducting the survey under favourable weather conditions at low tide, Arctia-Meritaito successfully met the required depth and accuracy with an airplane rather than risking running aground with a ship. Based on these results, the measurements will be performed every three years in the future using airborne bathymetry.”

#### LIMITED WINDOW OF OPPORTUNITY

The most notable challenge of collecting airborne bathymetric data is timing. Perfect timing produces a clean dataset that is fast to



process, while bad timing results in a noisy dataset that does not fulfil the specification, or even no data at all. In the area around Sylt, there are multiple issues. Too much wind makes white water and waves, while algae floating on the surface blocks the laser and fine sand stirred up from the seabed interferes with data collection.

“Being ready at the right time and making the best of the good weather window requires dedication and effort,” explains Mikko Ojala, head of airborne LiDAR bathymetry, Arctia-Meritaito. “The weather and water conditions can change very rapidly. We cannot perform topographic surveys when it is raining, and airborne bathymetric surveys are impacted by inflows of water from the land that increase turbidity. When conditions are finally right, the equipment needs to be functioning and ready to go.”

Seabed material consisting of fine sand is always moving and causing turbidity. As the seabed is frequently changing, overlapping data collected many days apart will not match and will take longer to process. It is crucial to cover the whole project area as quickly as possible to maximise consistency. To capture topographic and bathymetric data of Sylt’s west coast and south and north ends, Arctia-Meritaito targeted June 2020. In two days and a total of five flight hours, the team collected 70 square kilometres.

“We flew the whole area with only two flights, with one day between, and still the seabed topography had changed between the flights,” says Ojala. “This created a processing challenge because there were two seabeds in some places where the data from the previous flight overlapped.”

In addition to Terrasolid for point cloud processing and the QPS hydrographic software suite, Arctia-Meritaito used Leica LiDAR Survey Studio (LSS) to process all waveform and position data and incorporate four-band camera data from the Chiroptera 4X. Arctia has a LiDAR-specific processing setup based on recommendations from Leica Geosystems.

### **SURVEY RESULTS SUPPORT ANALYSIS**

To ensure high-quality results that guide preservation decisions for the future, the surveying contract stipulated that measurements should only be carried out under favourable conditions (easterly winds). Deliverables included point clouds with classifications (one-metre and ten-metre grid) and orthophotos. The height accuracy had to be better than 20 centimetres and the positional accuracy better than 50 centimetres. Processing was completely done by Arctia-Meritaito, with results delivered about eight weeks after data collection.

“We achieved a minimum point density of 5 points per square metre in the water, thus demonstrating the Chiroptera 4X fulfils general industry requirements in shallow water,” says Ojala. “In addition, simultaneous collection of the bathymetric and topographic point cloud along with aerial imagery is highly efficient and produces a seamless dataset from the land to sea bottom.”

The dataset confirms the status of the coastline and allows for further analysis. When compared with previous measurements, the 2020 survey indicates that the sand deposits added to the beach have contributed to the protection of the coast since the 1980s. Lutz Christiansen intends to continue monitoring of Sylt with periodic bathymetry measurements.

“I am very satisfied with the results. The Chiroptera 4X reached the necessary depth,” says Christiansen. “The data density, accuracy and type of processing met all of our requirements. It was an excellent project that provides an up-to-date status of the west coast and shore area. Now we have a digital terrain model (DTM) from the steep coast of +20m down to -10m water depth.”

## DEVELOPMENT OF BATHYMETRIC MAPPING

Arctia-Meritaito specializes in hydrographic mapping, fairway maintenance and maritime navigation, carried out with a fleet of ice-breaking ships and surveying vessels. Traditionally, Arctia-Meritaito surveyed shallower depths with vessels equipped with a single beam echosounder that resulted in depth profiles at defined interval distances rather than complete coverage. This approach left significant data gaps between the survey lines in a single beam dataset.

More recently, the multibeam echosounder addressed the data gap issue; however, a multibeam echosounder is not always efficient in shallow waters. The survey swath gets narrower as the seabed rises toward the sensor. Other disadvantages include an increased risk of equipment damage or loss in shallow water if the vessel collides with an uncharted shoal, and the echosounder cannot produce seamless data from water to land.

In 2015, a pilot project was conducted by the Finnish Hydrographic Office that compared the

performance of several airborne bathymetric sensors. This project proved that airborne LiDAR surveys could meet required mapping standards in shallow water. A subsequent project in 2016 favourably compared airborne LiDAR results to single beam and multibeam echosounders. To adapt to changing industry demand and remain technologically up to date, Arctia-Meritaito replaced its single beam echosounder service with airborne bathymetric LiDAR.

“There were other sensors in the 2015 pilot project, but we saw that the Leica Chiroptera 4X provided the most promising results,” says Ojala. “By replacing single beam vessels with airborne LiDAR, we get full coverage in shallow waters with depth penetration down to -25m depending on the conditions, while minimising the risk of losing sensors. Now we collect land and water in one effort, instead of executing a separate survey for the land portion.”

Thanks to improvements in laser technology and more sophisticated algorithms, today it is possible to reach depths of -25m or more with a shallow-water sensor, such as the Chiroptera 4X, previously attainable only with a deep-sea sensor or echosounder.



Environmental, social and governance impact

## Environmental research, sustainable harvesting

Global warming leads to rising sea levels, which pose a risk for humanity. Mapping shorelines with Hexagon’s airborne solutions allows coastal managers and communities to plan for a changing climate. Researchers also use Hexagon’s bathymetric data to detect and analyse underwater vegetation to measure ocean health. In one region where locals use rockweed as fertiliser, the same method allows researchers to develop sustainable harvesting methods that avoid depleting more rockweed than regrows.

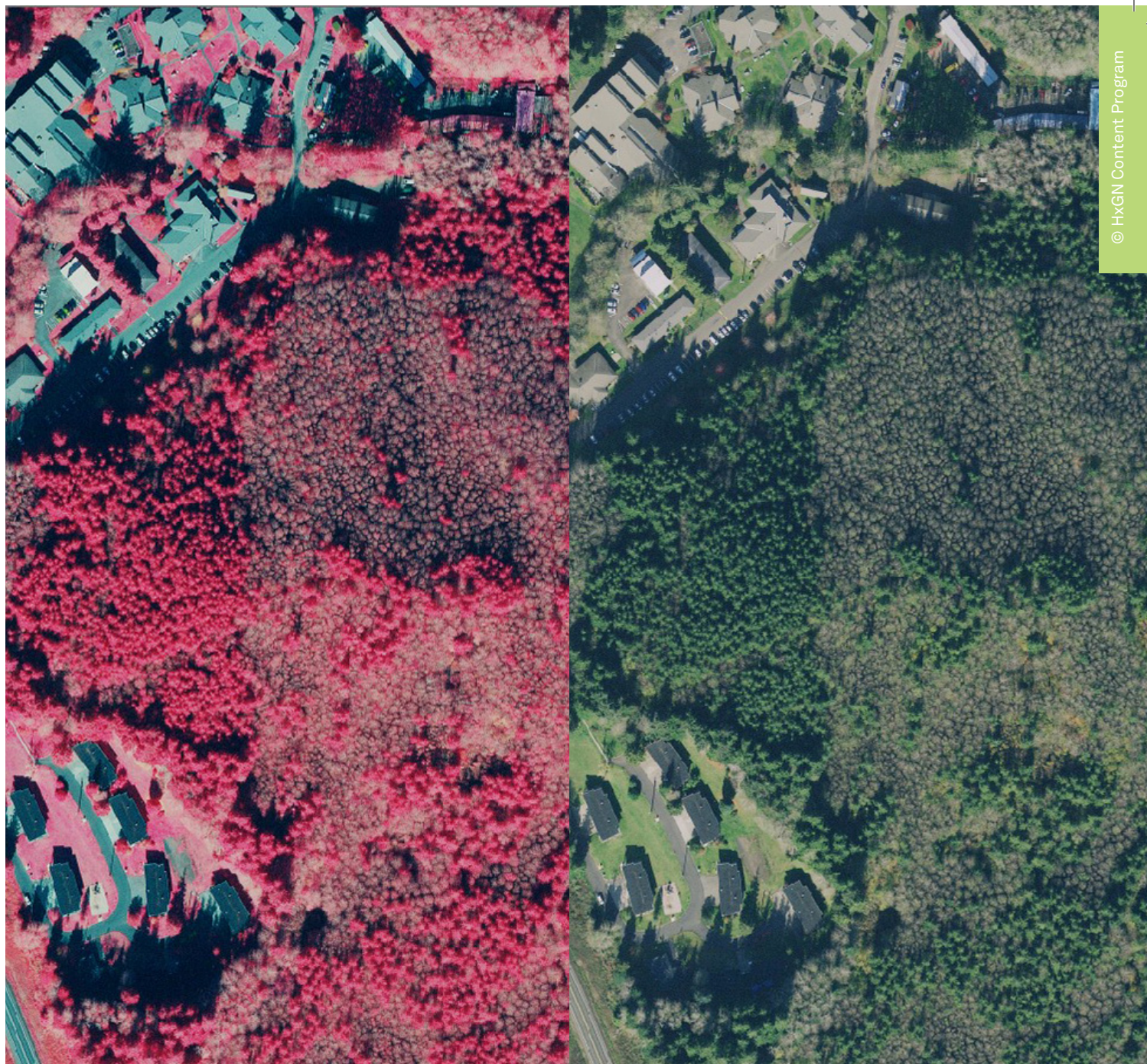
# COLOUR-INFRARED IMAGES PROVIDE A DIFFERENT PERSPECTIVE

☰ Feature



Linda Duffy is a marketing professional at Apropos Research, focusing on remote sensing and the geospatial industry.

The fourth band in an aerial imagery product provides a wealth of information for many applications — particularly those involving vegetation and wetlands.



**The fourth band refers to the near-infrared (NIR) wavelength in the electromagnetic spectrum. Invisible to the human eye, it's a valuable tool for image analysis and change detection. A colour-infrared (CIR), or false colour image, is composed of NIR, red and green bands, while a true colour image displays the visible red, green and blue bands. By displaying the NIR band as a visible band, the NIR reflectance values can be "seen" and analysed.**

In a CIR image, the internal cell structure of vegetation strongly reflects the NIR wavelength, providing a more robust indicator of plant health than the visible green wavelength reflection of chlorophyll in the leaves. On your computer, the NIR band is typically displayed as red for easy identification. Different shades of red colour show varying levels of plant health and vigour. A

healthy plant is bright red, while dead, dormant or unhealthy plants are lighter shades of red or blue-green.

Water absorbs the NIR wavelength so it appears black in a CIR image. CIR images can therefore provide information about the turbidity, or quality, of water. Sediment and suspended particles in water are detected by the NIR wavelength and show up as shades of blue instead of black.

#### **WHAT TO LOOK FOR IN CIR PHOTOGRAPHS**

Since vegetation absorbs the red and NIR wavelengths at a higher percentage than blue and green wavelengths, the human eye and computer recognition technology can distinguish variations in vegetation more easily in a CIR image, which makes them ideal for analysis.



The above CIR image on the left clearly shows different shades of red for dense canopy and other vegetation species, while structures and roads appear blue-green. The above RGB image on the right shows shades of green that are more subtle and the structures are less distinct.

### AERIAL COLOUR-INFRARED PHOTOGRAPHY SERVES BROAD RANGE OF APPLICATIONS

CIR film has been around since World War II when it was used to identify camouflaged military vehicles. In CIR images, green vegetation would appear red, while equipment painted green or covered with cut vegetation would appear blue-green.

But CIR is a valuable tool in many industries: For any application that involves quantifying vegetation, assessing vegetation health, identifying individual species of vegetation, and estimating water turbidity and soil moisture, CIR images provide invaluable insights.

- **Forestry:** The forestry industry benefits from aerial mapping as an efficient and cost-effective method of collecting data over large, hard-to-reach areas. Analysing CIR images of forests is more accurate than

acquiring samples on the ground for forest management and mapping, assessing forest and tree health, classifying trees as well as monitoring forest fire regrowth and deforestation.

- **Agriculture:** Some sectors of the agriculture industry use CIR aerial imagery on a global scale to estimate the amount of land planted with specific crops and predict food availability. Individual farmers use the technology to assess vegetation health, address issues and increase yields.
- **City Management:** CIR aerial imagery provides valuable insights for vegetation management, urban forest analysis, land use studies, parks and recreation management, and analysis of pervious versus impervious surfaces.
- **Utilities:** Utilities use CIR imagery to monitor and manage vegetation encroachment along powerlines and pipelines. Detecting unhealthy trees early can avoid outages and damage to crucial infrastructure.
- **Environmental Science:** Environmental studies rely on CIR imagery for wetland delineation, stream and river erosion delineation, invasive species monitoring, vegetation classification, and land use/land cover mapping.





### HEXAGON PROVIDES COLOUR-INFRARED PHOTOGRAPHS WITH EVERY ORDER

The HxGN Content Program is the world's largest library of aerial orthophotos, digital surface models (DSMs) and stereo images across the United States and Europe. As the premier data provider to a diverse range of global customers, we recognize the unique value of CIR imagery data which is why we include it with every orthophoto purchased.

Under the HxGN Content Program, whether you stream or download pixels, your imagery data includes access to two 3-band layers (RGB and CIR). With our CIR-focused customers in mind, we also offer a custom 4-band pixel download option to help reduce data volume and improve usability for CIR-specific activities.



Environmental, social and governance impact

### Research, sustainable forestry, agriculture and city management

Colour infrared (CIR) aerial photography offers valuable vegetation data for mapping and monitoring in environmental and biodiversity surveys. Environmental studies rely on CIR imagery for wetland delineation, stream and river erosion delineation, invasive species monitoring, vegetation classification, and land use/land cover mapping. CIR aerial photography can help assess forest and tree health, classifying trees as well as monitoring forest fire regrowth. In the agriculture industry, CIR aerial imagery can help estimate the amount of land planted with specific crops and predict food availability. For individual farmers, CIR is particularly valuable for assessing field conditions when crop canopy is minimal: Detecting early-season issues enables growers to respond before they impact yield.

# A WHOLENESS APPROACH TO OPEN PIT SCHEDULING AND OPTIMISATION

☰ Editorial



Ernesto Vivas is Principal MinePlan Advisor at Hexagon's Mining division.

**A wholeness approach to open pit scheduling and optimisation requires the integration of mine plans across multiple planning horizons. Principal MinePlan Advisor Ernesto Vivas shows how aligning plans and monitoring execution ensures mines stay on track to achieve business objectives while lowering their environmental footprints.**

The global mining industry reports hundreds of billions of dollars in revenue every year. Most of this value is forecast ahead of time and reported in the life-of-mine and budget plans.

Mine planners evaluate and update several mine plans on a regular basis. Traditionally, multiple teams and departments prepare bits and pieces of long-, medium- and short-range plans, often using differing software solutions.

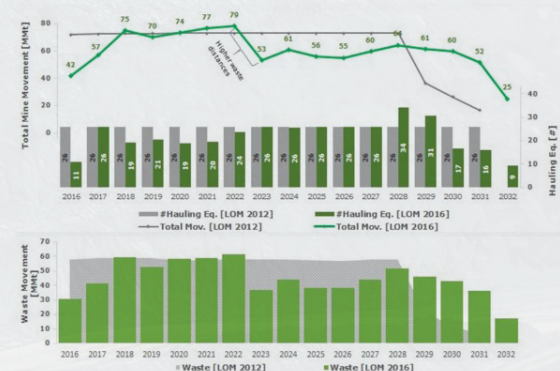
A wholeness approach requires integrating mine plans across multiple planning horizons as well as merging the extraction plan, the haul plan and the dump plan so mine planners can formulate and solve them as one problem. Ultimately, mine plans must be aligned with mine operations with the aim to reduce the variance between planning and execution and thus to achieve important project milestones.

For every cut that is mined, hauled and dumped, there is an associated cost, revenue and a direct impact on project value. Planners must examine the value of the plan: Is it the best plan? Where are we excavating? Is the shovel in the right location? Where are we dumping in each period and how does that affect truck requirements over time? How is the material routed from the excavation source to the dumping destination? What are the haulage costs and distances associated with the material movement? Answers to these questions help understand the mine plan and its value. Every time mine planners create new iterations of the mine plan, they add additional information and details.

Some mines can move more than one million tons of material per day. Assuming an average mining cost of \$1 per ton, the value of just moving material can be worth more than \$1 million per day for large operations. So, if the

value of a mine plan can be worth hundreds of millions of dollars — in some cases billions of dollars — mine planners increase fortunes every time they improve the mine plan. Improvement can be measured and compared against alternative plans for trade-off analysis and to help with the decision-making process.

#### LOM 2012 vs LOM 2016



The image above shows a comparison between some haulage aspects of the Life of Mine (LOM) from 2012 and 2016 for a mining project. The 2016 LOM shows an optimised discharge plan for the waste dumps which results in lower capital and operating costs for trucks and shovels. This optimisation was not the result of trial and error in which the shovel, haul and dump plans are solved separately and manually through endless iterations. Instead, this is the result of an optimisation where all parameters are integrated and solved together as one optimisation problem.

There are several implications downstream as the results of mine planning studies are used in support of public company filings related to the disclosure of resources, reserves, and financial data with organisations such as the Securities and Exchange Commission. Similarly, mine



planning studies support the investment of hundreds of millions of dollars in assets such as trucks, shovels and drills. Thus, optimising the haulage aspect of the schedule has a significant impact on project value. Extending and maximising the life and use of the mine assets can be done with the assistance and implementation of mining software for both planning and operations.

Mine planning studies support and guide important capital investment projects such as mill expansions. Over the past decades, we have become accustomed to the term “mine to mill.” It is a simple term to describe a complex multi-layered process in the mining cycle. For example, what happens when you have multiple mills, each one with a different throughput? This presents a challenge for both mine planners and operators. Suppose a project has two different-size mills, each with different throughputs. In addition to that, ore materials have a variable tonne-per-hour milling rate for each mill, which depends on several factors such as the mineral type, rock type, rock hardness and fragmentation. So, the mill hours associated with processing ore blocks at the big mill and the small mill are set up as variables in the orebody model.

Mill throughput depends, among other things, on rock fragmentation. Image recognition analysis from Hexagon allows us to monitor and measure the rock fragmentation from post blast product to belt conveyors all the way to the mill feed. A network of cameras and intelligent image recognition software is used to monitor crushing, conveying and grinding circuits. Oversized rock can be quickly screened out to prevent disruptions in production. Drill and blast patterns and designs can be adjusted to improve fragmentation, reduce mill energy consumption, and increase plant throughput, all of which have a direct impact on revenue.

In addition to monitoring fragmentation, there are many other aspects of the mine that must be supervised. Control rooms allow the mines to oversee the operation and keep track of production KPIs in real time. Fleet management systems are used to monitor the operation, operators and plan compliance.

Reduced planning variance — minimising the discrepancy between your plan and what actually happens in the pit — doesn't merely save costs, it also has a direct impact on the sustainability of a mine's operation. Optimising fragmentation can reduce the energy the



mill consumes. Using Hexagon solutions to monitor crushing, conveying and grinding leads to better rock screening and helps prevent production disruption, which results in a reduction of idling trucks that burn fuel unnecessarily. Improved planning also means better fleet management which reduces a mine's environmental impact by lowering the number of trucks and heavy equipment in use, reducing the necessity of refuelling trips and extending the life cycle of trucks through reduced wear and tear.

Implementing mine planning software and mine monitoring systems has resulted in significant increases in production and revenue while lowering operational and capital costs — and decreasing the mine's environmental footprint.

Generating the best possible mine plan requires a wholeness approach and monitoring its execution is key to making sure the operation stays on track and that business objectives are achieved. Aligning mine planning with mine operations is critical to realise maximum project value. At hundreds of mines throughout the world, both planning and operation solutions from Hexagon are used to this end.



#### **ERNESTO VIVAS**

Ernesto Vivas is Principal MinePlan Advisor at Hexagon's Mining division.

# MINIMISING MINING'S OPERATIONAL AND MAINTENANCE COSTS

☰ Case Study



Ian Leones is Content Marketing Specialist at Hexagon's Mining division.

Minimising operational and maintenance costs is a key business driver in mining. The challenge is doing this in a stressful, ever-changing environment. At the front line are dispatchers responsible for scheduling and assigning work orders to operators and equipment. Their decision-making keeps a fleet running efficiently.



**The multitude of fleet management systems available on the market shows that mines are hungry to improve their operational efficiency.**

OP Pro is Hexagon’s flagship solution for fleet management. It combines hardware and software for unparalleled insight into production. The latest version, OP Pro 3.0 introduces an all new user interface and experience, as well as peer-to-peer communications to ensure that there are no gaps in network coverage.

In May 2020, Hexagon conducted a three-month trial with dispatchers from Adaro’s PT Saptaindra Sejati mine contractors using the newest advancements in OP Pro, in particular the Optimizer tool.

OP Pro Optimizer is a real-time production optimisation tool that helps keep trucks on target. The tool takes a wide range of user- and system-defined parameters to calculate optimal assignments. This includes shovel and material priorities, capacities, road networks, restrictions, queue times and more.

OP Pro 3.0 brings even more functionality including an enhanced module to manage breaks, detailed logs to show what parameters were considered in calculations and other ease-of-use improvements.

Over the course of the three-month trial, Adaro reduced the number of haul trucks per fleet by two, increased productivity from 91.88% to 103.44%

of the plan and reduced loader hangtime from 12 minutes per hour to seven.

While many factors affect efficiency, including operational conditions, infrastructure and dispatcher skill, the data collected in this trial shows some of the real benefits of implementing Optimizer. Production optimisation is a differentiating factor from other FMS products.



**Environmental, social and governance impact**

**Reducing emissions**

Mining is a carbon-intensive industry, but the transition to a greener economy depends on it: Clean energy technologies require metals and rare earth elements. Policymakers and the public will likely increase pressure on the sector to shift to more sustainable operations. Increasing fleet performance with OP Pro — Hexagon’s flagship solution for fleet management — lowers greenhouse gas emissions by lowering the number of trucks in the fleet, decreasing the number of refuelling trips and reducing engine idle time through reduced loader hang time.

# ENABLING THE LOCAL COMMUNITY IN AN AUTONOMOUS PROJECT

☰ Case Study



Neville Judd is Communications Director at Hexagon's Mining division.

**Adding autonomy and other technology to a mine can cause significant concerns within the local community. Improving efficiency can be directly perceived as reducing the need for local labour. Likewise, skilled labour might be drawn from the talent pool further afield, leaving the surrounding community with fewer jobs.**





**In 2017, Kumba Iron Ore committed to the local community by setting a new target enabling R500 million (US\$30 million) of its procurement spend to be directed to, and invested in, local business.**

The company has since evaluated and increased this target annually. Implementation created a challenge for Kumba, existing suppliers and global OEMs: namely, how to support meaningful local community engagement while deploying the leading safety system on the world's largest haul trucks? Beginning in 2010, SAFEmine (now part of Hexagon) began a comprehensive safety journey with Trysome Auto Electrical Engineering (Pty) Ltd to enable collision awareness at the Kumba Iron Ore mines in the Northern Cape. This system utilise then state-of-the-art technology to create additional awareness of equipment operating around large, trackless equipment throughout the mine. Trysome's technicians equipped more than 2,500 pieces of equipment operating in the mine. In 2016, Kumba Iron Ore started a program to upgrade capabilities on its large haul trucks. This program not only enabled operators to be aware of the dangers around them, it also created a true "auto-braking" capability. This was a revolutionary upgrade to the existing system, making Kumba Iron Ore the first mine in South Africa to comply with the country's Department of Mining Resources' Trackless Mining Machinery requirements for full vehicle intervention on vehicle to vehicle, object, and persons in defined risk scenarios. This development resulted in Anglo American and Hexagon's Mining division being jointly named Safety Innovators of the Year by Mining Magazine in 2017.

## THE CHALLENGE

Hexagon, Anglo American and Trysome faced a significant hurdle. On one hand, they were deploying the world's leading safety system on the world's largest haul trucks. On the other hand, all parties were mindful of Kumba's commitment to the local community. The challenge lay in successfully deploying the system while supporting local community engagement. "We tried a few different options and configurations between Hexagon, Trysome, and other local parties that, quite frankly, didn't work," recalled Andrew Crose, Vice President, Autonomous, Hexagon's Mining division. "There were significant challenges getting alignment on roles and responsibilities, amplified by the fact that this is a critical safety system." This challenge was also felt by Trysome. "We had difficulty knowing where the responsibility stopped between parties," said Gunter Haacke, Trysome COO. "An L9 Vehicle Intervention System is only as good as every piece of L7- L8 equipment interacting with the L9 Haul Truck."

## FINDING A SOLUTION

In working through the challenges, a solution was found to meet all objectives. In 2019, Trysome co-founded DeNovo Mining Resources, a company based in Kathu (the iron ore capital of the Northern Cape Province) with majority ownership in the local community. "We were pleased with the new company," said Crose. "It helped us support our localised procurement objectives while transferring skills and mentoring the new local company to success."

DeNovo Managing Director Jake Masisi led the new business. "Starting a new business in the



Northern Cape is not without challenges,” he said. “Having the support of Hexagon and Trysome is definitely a help.”

Not that developing a new relationship was without challenges. Creating a clear understanding of roles and responsibilities was crucial. High-technology products in a mining environment require many layers of support: coordination between those layers is critical. Whether it is ground-zero support to replace failed components, remote support to diagnose and provide component repair and replacement, or product development support to develop new functionality and improve the existing system, coordination is key. Each level has its respective place. Just as new software and firmware code should not be written while sitting in a haul truck, it is equally impractical for software developers to be installing hardware in the field. To overcome this, Hexagon, Trysome and DeNovo worked closely together to create a strong working relationship.

### TRAINING

Hexagon and Trysome first worked with DeNovo to provide training to new local staff. This included both technical training needed to maintain the system and business training to help them stay successful.

### COMMUNICATION

Maintaining regular communication through multiple channels was critical and enabled the parties to ensure issues were continually identified and improved. This occurred at many levels:

- **On-site support** — Hexagon embedded critical staff into the DeNovo team to ensure the L9 auto-braking system commissioning was performed to the highest standard and knowledge transfer occurred to enable the on-site support role after commissioning
- **Remote support** — DeNovo and Trysome staff have access to Hexagon’s case management tool to communicate issues to Hexagon remote support services, which is available to customers under a Hexagon maintenance contract
- **Supply chain** — Hexagon enabled DeNovo and Trysome staff to directly access a new supplier portal to enable supply chain forecasting for aftermarket parts, reducing lead times from older manual order methods



The result is a best-of-breed support model with local support from DeNovo in the community backed by regional and global support by the Hexagon team. By working through the processes this relationship enables a local company to perform services locally (on-site technicians) while backed by regional and global support for the activities best performed by the technology developer.

#### CONCLUSION

Many would draw the conclusion that there are trade-offs in providing support via the local community or via the technology developer. Some might assume that local support would lack the skills and capabilities to provide a comprehensive service while support from the technology provider would cause jobs to be lost locally during an autonomous implementation. This case study challenges those assumptions. By combining support from both local service providers and global technology developers, a best-of-breed solution can emerge through training, close communication and aligned processes.



## Environmental, social and governance impact

### Providing training and jobs, safety

Local communities may worry if mine management implements autonomy and other efficiency-enhancing technologies. People may fear that it'll reduce the need for local labour. If skilled labour is drawn from the talent pool further afield, it leaves the surrounding community with fewer jobs and causes a brain drain in the larger area. In addition, insufficiently trained staff may not be aware of mining hazards. Acknowledging these issues, Hexagon and partners provided training to newly hired local staff. This included both technical training needed to maintain the system and business training to help them stay successful. Additional on-site support ensured continuous knowledge transfer and proper functioning of the auto-braking safety system while remote support ensured on-site technicians receive the necessary backing for activities best performed by the technology developer.

# GOING TOWARDS SUSTAINABLE CONSTRUCTION

☰ Editorial



Fabio Ponzio is Vice President, Building Solutions, at Hexagon's Geosystems division.

**Sustainability is one of the most discussed terms, but many don't realise its full potential. A practical definition could be any action or process we perform that causes little or no harm to the natural world. It's all about finding ways to meet the demands of present generations without compromising the needs of future ones. For example, businesses should create wealth to fight poverty without harming the environment. In this way, businesses help our world today and ensure that future generations can also prosper.**



## GETTING ON THE PATH TO SUSTAINABILITY

Our world is rapidly changing, and our customers are increasingly concerned about the environmental impact of their choices. As a result, the construction industry is looking to adopt technologies that increase productivity while mitigating the impact of growing housing needs on the climate crisis.

At Hexagon, we move step by step towards sustainability, progressively increasing and expanding our activities. Sustainability involves innovative procedures of collaboration and new thinking about the economy. As an organisation, we believe that our sustainability journey is determined both by the role products and solutions play in the market, as well as our processes and actions.

Hexagon's wide-ranging solutions are built with sustainability as a priority. We deliver scalable innovations across a vast array of industries, including construction. Our solutions help our customers to optimise the use of raw materials and components, to improve energy efficiency and productivity, to extend product life, and to predict and prevent harm.

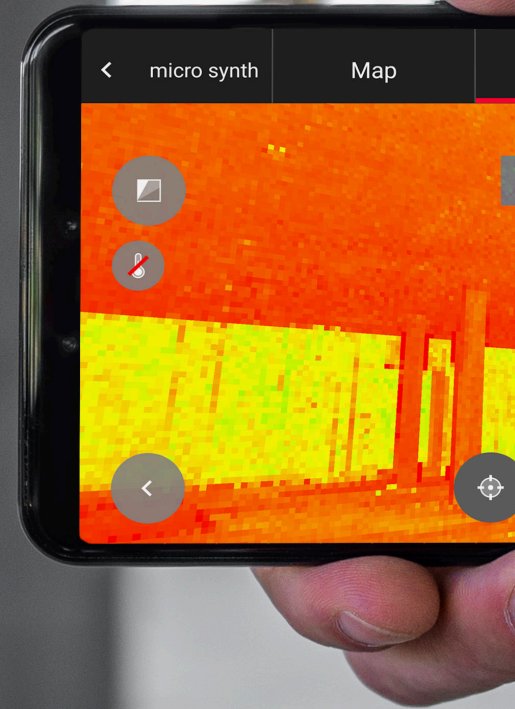
## EFFICIENT BUILDINGS — SUSTAINABLE FUTURE OF CONSTRUCTION

Traditional building construction and building operations belong to the past. Architects, engineers and building owners are searching for ways to expand a building's life cycle, contributing to green building goals as well as providing better solutions for energy efficient operations and occupant well-being.

During this journey, it is crucial to use renewable and recyclable resources, reduce energy consumption and waste, utilise sustainable materials, employ energy efficiency principles, create a healthy environment, utilise green technology and protect surrounding ecosystems. Having the right tools and solutions can help architects, engineers, contractors and other industry experts to achieve all of the above.

Technology providers talk a lot about offering smart building technology that can make buildings more energy-efficient and sustainable during operations, contributing to a better housing experience for occupants and positive outcomes for building owners.

Besides the above-mentioned, customers can achieve sustainability during the design and construction phases. The correct design and construction solutions reduce rework, meaning less wastage, cost savings, less effort and less time. For instance, Hexagon's Geosystems division has designed inclusive hardware and software solutions such as the RTC360, Leica BLK360, or Leica BLK2GO laser scanners to capture existing conditions quickly, enabling users to make informed decisions during the design phase, and keep their site moving efficiently during construction. When renovating existing buildings or designing new ones, architects and engineers can use these captured, existing conditions in their Building Information Modelling (BIM) design process and accurately plan and visualise their designs before the construction phase. BIM, like BricsCAD BIM, reduces design errors and rework. It allows teams to collaborate more efficiently, update



designs in real time and execute those plans accordingly, reducing surprises later on in the process.

When it comes to constructing a building, contractors need to invest in technology that saves time and materials, leading to higher profitability and less waste. The Leica iCON build workflow responds to today's digital construction industry demands for efficiency and quick decision making. It enables field crews to stay on track and it reduces the need for rework. Layout, as-built and verification tasks on projects are completed faster, with higher accuracy.

The iCB50 and iCB70 manual total stations simplify the transition from tapes and strings to digital construction, enabling all relevant layout and as-built tasks to be carried out easily and efficiently, even for complex designs. The iCR70 and iCR80 robotic total stations tie neatly into established building construction workflows and rapidly speed up installation preparation and other construction tasks.

Fast and accurate verification in building construction is a top concern for our

customers. Our iCON field verification app allows contractors to extend their possibilities, using multiple integrated sensors, allowing for easier, more complete, and real-time verification on site.

### **HIGH PERFORMING BUILDINGS — SUSTAINABLE FACILITY MANAGEMENT**

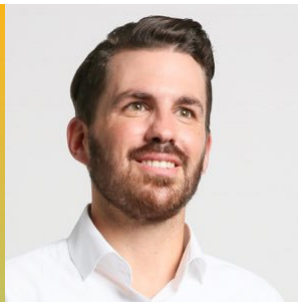
Undoubtedly, the AEC industry is embracing sustainable processes and techniques for the construction of new buildings, but we shouldn't forget existing facilities. Facility and property managers face several challenges when trying to operate buildings efficiently since most of these properties weren't built with sustainability in mind.

It is vital to implement the right tools to monitor and improve day-to-day operations in energy consumption, utilities, and asset management. Our technology helps building owners and property managers to create digital twins of their existing building portfolio and integrate those with leading CAFM/IWMS software. Having a digital twin combined with a CAFM/IWMS software enables stakeholders to manage day-to-day operations with more



transparency, efficiency, and insights into a building's performance, resulting in reduced asset and building-system breakdowns. Furthermore, using an accurate 3D digital twin for managing the operations enables new ways of collaborating more intuitively thanks to functionalities like indoor navigation or geolocation-based asset tracking; allowing different stakeholders to manage their tasks remotely.

In summary, our technology helps building owners to create digital twins of their building portfolio, enabling indoor navigation, remote location-based services, prolonging the life of mission-critical assets, and giving management cockpits more meaning through accurate and reliable geolocation information. These capabilities lead to more effective and efficient building performance, reduce waste, lower the need for traveling, and thus have a positive impact towards sustainability.



**FABIO PONZIO**

Vice President Building Solutions at Hexagon's Geosystems division.

cinépolis

smart fit

# DIGITAL TWIN TO IMPROVE SHOPPING CENTRE OPERATIONS IN PERU

☰ Case Study



Penny Boviatsou is a Marketing Manager, Building Solutions, at Hexagon's Geosystems division.

Plaza Santa Catalina shopping centre is located on Carlos Villaran avenue near the intersection of Javier Prado with Paseo de la República in Lima, Peru. With an area of 11,000 square metres and more than 9,000 square meters of leasable space distributed on three levels, it opened its doors to visitors in April 2019.



**Dormeson SA, a subsidiary of Grupo Mulder, started developing this project in 2018, with an investment of approximately \$9 million. Plaza Santa Catalina has a wide range of movie theatres, pharmacies, restaurants, stores, a sports centre, and a 200 parking spaces area.**

The proper maintenance of a large building can be very complicated. Dormeson understands that the facilities management industry is undergoing a digital transformation and wanted to invest in innovation that enables effective, timely decisions; increases transparency; and reduces operating costs while delivering an excellent visitor experience.

The facility manager oversees many different systems and needs reliable data to manage and track maintenance activities and resolve other incidents. To increase efficiency, avoid costly and time-consuming complications and enable remote management, all data — including 3D data - must be gathered in one system. Renzo Salas, property manager at Dormeson, was looking for the most efficient and effective way to overcome these challenges.

“A 3D digital twin helps us to reduce the complexity of large buildings. The combination of a 3D digital twin and web-based facilities management software for portfolio management, location-based asset tracking, and preventive and corrective maintenance management increases transparency and productivity and saves costs,” said Salas. “For the operation and maintenance of Plaza Santa Catalina, we need accurate digital records of the building in one system; that’s one of the biggest facility management challenges. We need to ensure that we have access to the data remotely from anywhere, which helps us to increase productivity with our daily tasks related to our tenants, facility, and operations management.”

#### **INTELLIGENT DATA CAPTURE AND PROCESSING**

For the creation of the digital twin, Leica Geosystems reality capture and imaging technology captured 11,000m<sup>2</sup> in two days. Dormeson’s main requirement was to use fast and reliable technology that could scan the different areas of the building without



interrupting the operation of the shopping centre. The scanned zones included surrounding areas, the parking lot, water installation in the basement, electric room, roof top, the area that houses the air conditioning machine, all stairways and publicly accessible areas of Plaza Santa Catalina. The team used different solutions:

- 90% of the building was captured with the Leica RTC360 3D laser scanner
- Limited-space areas such as part of the control room were captured with the Leica BLK360 imaging laser scanner
- Also, Leica DISTO laser distance meter was used to take single distance measurements to verify existing conditions directly in the field
- The team used Leica BLK3D to take images of critical assets such as the air conditioning machine areas and plant room

“Intelligent building management is a priority for Dormeson’s real estate business,” said Salas. “We need smart data and insights for the management of large building structures and digital workflows that facilitate processes.”

## FACILITY AND ASSET MANAGEMENT TRANSFORMATION

Geomap, a cloud and GIS-based Integrated Workplace Management System (IWMS), supported the digitalisation of the shopping centre’s facilities and asset support services. Geomap’s IWMS platform imported data of Leica Geosystems scanners enabling a visual 3D management via CAD support.

Geomap has created checklists for the machineries and assets, allowing technicians to be always informed on the building’s maintenance that has to be performed; also, building and facility managers keep track of the operations and performances. Work order management, energy consumptions, budget management, and building documents are now centralised in just one platform making the management of the shopping centre much more efficient.

Digitising Plaza Santa Catalina in the Geomap IWMS software solution resulted in significant benefits on asset and maintenance tracking and cost savings.



### MAKING A BUILDING SMARTER

The accurate 3D digital twin combined with IWMS gives the facility manager complete remote control of the physical asset. An assets register has been created thanks to the use of the Geomap Survey App on-site. The assets have been labelled with QR Code, and technical data of each asset such as brand, model, last maintenances, location, etc., are digitised and available to the building managers.

All this turns into numerous advantages for the operation and management of the building, including:

- More transparency and efficiency for operations and maintenance
- The facility manager has more insights into the building's performance, resulting in reduced assets and building systems breakdown
- Remote assets creation and management are possible thanks to accurate 3D data
- Digital reality data for space management
- Provide a better customer visit experience by having reliable and continuously monitored facilities

“The digital twin brings new ways of thinking; it reduces the complexity of the building and

helps me assess decisions for its operation remotely from the office. Accurate 2D and 3D data allows me to understand better and resolve incidents and share this information with other internal and external stakeholders. This makes it easier to make the right decision for the management of Plaza Santa Catalina,” said Salas.



### Environmental, social and governance impact

#### Reducing energy consumption

Hexagon's reality capture solutions help create digital twins of buildings and facilities, including underlying networks and infrastructure. Digital twins enable smart 3D facility management by equipping facility managers and operators with the tools to optimise performance and reduce energy consumption, and enable remote asset and facility maintenance to avoid unnecessary travel. Accurate location-based asset management and real-time data retrieved from sensors and smart IoT devices help them get more insights, anticipate risks and visualise future changes with unprecedented accuracy.

13 in

13 in

# THE BLK3D CUTS PERFECT STONE FOR HISTORICAL FACADE RESTORATION IN NEW YORK CITY

☰ Case Study



Christopher Dollard is a copywriter with the Agile Marketing team at Hexagon's Geosystems division.

Jim McMahon, President of Structural Stone Concepts, didn't hesitate at all when asked why the BLK3D helps him so much in his work. "This thing lets me sleep at night."

**Jim is a stone supplier that specialises in historic stone facade preservation, and Structural Stone Concepts is the largest supplier that sources, measures and provides stone to masons who restore historic buildings in New York City. He works with the New York Historic Preservation Office to replace limestone and granite facades on historic schools and other buildings throughout the city.**

These facade renovations, with their decorative elements, must exactly match the originals and the measurements must always be right to preserve the buildings as they were originally built. Jim's projects are very expensive to complete, and one measurement error can cause a lot of problems down the line. He used to rely on manual measurement methods, like tape measures, cameras, and a pen and paper. Then he switched to the BLK3D.

#### **BUT WHY DOES THE BLK3D LET JIM SLEEP AT NIGHT?**

"With the BLK3D, that process will take a few days," he said. "Now I can take a picture and send measurements from the BLK3D directly to my CAD guy and he has the drafts in my inbox the very next day so we can get to work."

While Jim's work is unique, he doesn't just work within his field of matching and

producing stone for restoration. He often has to collaborate with other contractors on the job site. "Restoration guys, masons, builders, they need the BLK3D just as much as I do." And he's convinced that other trades can benefit by quickly capturing site conditions and documenting field data in the same way that he does with the BLK3D.

#### **SERIOUS STONEMWORK WHERE THE BLK3D DOES THE HEAVY LIFTING**

The BLK3D is designed to make measuring easier, faster and more precise. It has taken the precision of Structural Stone Concept's work to a higher level, helped Jim to save time and money and enabled him to stand out as a truly unique contractor that is dedicated to excellence in historical stonework.

But when Jim talks about his work being serious, it's not just how seriously he takes it. The city and state invest a great deal of time and money in precise historic preservation, and the BLK3D helps him be even more precise. "This is a historic landmark," Jim said about one recent project. "I have tolerances for some aspects of what we do, but I have certain things I can't do at all. The profile of the new stone has to exactly match the existing stone, and if that profile doesn't match, I have to eat \$150,000. But this machine makes sure I match that profile."



Now Jim doesn't have to eat costly mistakes. "Whoever said a picture is worth a thousand words is wrong; this picture from the BLK3D is worth \$5,000," Jim said. "And every time you're wrong in this business, you remember it — the \$50,000 mistakes, those stick with you. But this machine prevents those expensive mistakes from happening."

That's what helps Jim win contracts and provide some of the best facade restoration that New York City can get. And it offers a degree of flexibility for him, too. "I need to travel to go check out the stone myself, before it's cut from the quarry, to make sure it's right. That means I'm off site and out of the office. But I can train one of my guys to use the BLK3D and let him take over measuring while I'm out finding the stone. And I still know the measurements are right."

Another benefit for Jim and his team is when the BLK3D picks up on measurements that he may not think he needs to get in the moment but end up being very important down the line. "Sometimes I'm only looking for wall width, but my CAD guy, because of the other measurements in the photos, he picks up the stone profiles! You need that to match existing stonework. I'm talking about radius, negative returns, draft, all sorts of stone stuff," he said.

### **BLK3D CAN SPEED UP AND IMPROVE WORK AT BUSY URBAN CONSTRUCTION SITES**

For one project that Jim is working on, there could be 15 different trades on site, and they

all need to take precise measurements. "I'm not even the most important guy on the site," he said, "but I know the plumbing guy needs it, the steelwork guy needs it, the guy doing the windows definitely needs it!" He explains how other contractors will continue with manual measurements, make mistakes and have to double back to fix them. As builders and contractors know, that costs a lot of money and time.

Before he had a BLK3D, Jim ran across those problems himself, or he'd be so busy that he'd have to hire someone else to document existing conditions. "You could be paying someone \$50 per hour for weeks to get it done," he said. "And they can make mistakes, too."

Or, like Jim, you can just go take a picture yourself with the BLK3D, pretty much anywhere you need to. And when safety or space is a concern, the BLK3D really shines.

"Any building project in any borough should have a BLK3D on site," Jim said. "Think about the guy working on, say, filling grout on the side of a bridge. He has to get good measurements, but he can't stop traffic to do it." Any of us who have been stuck in New York City traffic due to construction lane closures knows how much of a pain it can be, and Jim sees this as a solution both for safety and for accurate measurements.

"So," Jim said, "That bridge guy takes one picture without blocking a lane, without risking safety. Boom! The picture goes to his office,



they check out the measurements and send it to CAD.”

Jim also notes that sometimes it’s just not possible to get into some spaces to measure if they’re too high up or too complex. “Say I need to take measurements of second story windows but there’s no space for scaffolding, there’s no way to get up there,” Jim said. “What do I do? Take a picture. Honestly, this thing is almost like taking a selfie. It’s that easy.”

The process is almost as easy as taking a selfie, or taking any other photo with a smartphone, but the BLK3D is way more than that. “I mean, it’s a mini computer,” Jim said. “For cross sections, details, dimensions, profile, gets it all. It’s perfect.”

The BLK3D also connects well to file transfer services and existing industry apps. In the shuffle of his work, manual measurements and drawings can be hard to track down. But the pictures aren’t. “I can send these pictures with measurements to Google Drive, to Gmail, to OneDrive,” Jim added, “and it can do a lot more than I’m doing with it!”

Jim also explained how BLK3D can roll with the punches of heavy construction. “It’s really durable, a tremendous piece of equipment. I trust it on site. I’m working in tight spaces, on ladders and scaffolds. It keeps up with the hard work we do, and other people do too,” Jim said, referring to construction work happening all over the city.

“Tunnel guys, bridge guys, civil engineers, they need this thing. It can really help pretty much anyone that needs to take accurate measurements and needs to do it fast,” Jim said. “And it’s instant! I need to know these measurements now, and with the BLK3D, it only takes one time to do it right and it’s done.”



## Environmental, social and governance impact

### Lower emissions, less waste

Reality capture technology like the BLK3D helps build complex jobs smarter and more efficiently. Construction teams can share captured data with project collaborators — including clients, architects, and trade and consultant entities — on cloud-enabled collaboration platforms. Capture once and different stakeholders can measure as needed in the office or the field. This avoids frequent trips, thus saving fuel. On sites where safety is a concern, the rapid and safe data capture lowers the risks of harm to workers. Precise measurements ensure accurate planning of construction material, thus avoiding waste.

# HEAVY CONSTRUCTION DRAWS ON DIGITAL CAPABILITIES TO MEET SUSTAINABILITY DEMANDS

☰ Editorial



Christian Luttenberger is Vice President of Business Development and Strategy, Heavy Construction Solutions, at Hexagon's Geosystems division.

Digitalisation underpins the future sustainability of the construction industry. Today's technology is ready for companies to build their own digital foundations for efficiency gains and reduced environmental impact.





**Traditional processes in the global heavy construction industry have similarities to super tankers: To change direction, you need foresight, planning and patience. However, the mantra “this is how we’ve always done it” is giving way to new technologies, new practices and new people. The next decade promises to deliver a paradigm shift in priorities and, indeed, the way things are done.**

The industry is slowly beginning to adopt new digitally connected technology, but it’s years behind the curve. One only has to take a look at mining to see how a similar heavyweight industry is already reaping significant productivity gains from digitalisation, remote capabilities and data-driven operations. (Granted: the mining industry’s standardised processes may lend themselves more easily to digitisation.) On the flip side, the heavy construction industry can leverage recent advances in digitalisation and travel a long way up the technological scale in a short period of time.

Technology can play a significant role in optimising resource utilisation on the job site, but it is important to choose the right technology partner. According to a recent Dodge study, 54% of contractors say their field staff is lacking training how to gather data; 49% say data gathering is time-consuming or too difficult; and 31% have concerns about productivity impacts. As such it is important to choose the right digital

solutions that allow contractors to get job done efficiently, effectively and dirt simple.

### **TECHNOLOGY HELPS TO BE ON TIME, ON SPECS, ON BUDGET, ON SAFETY AND SUSTAINABLE**

Crucial metrics for any heavy construction project are accuracy (built to specification), time, budget and safety. Add sustainability to that list — as pressure to reduce environmental impact will increase.

Luckily, these metrics are aligned: Maintaining tight control over your processes and closely monitoring physical operations leads to greater efficiency and tighter cost control. Greater efficiency also means less waste and fewer emissions. Hexagon’s Heavy Construction solutions offer several tools, including the Leica iXE3 machine control solution, that increase the productivity of an excavator by automating vital functions. For instance, using the semi-automatic excavator functionality helps perform complex excavation tasks such as slope creation and trenching faster and more accurately, thereby saving costs, time and fuel.

Another digital solution our customers value is Leica ConX. It facilitates a remote, cloud connection between crews and machines on and off-site for data and design exchange, productivity analysis and reporting of project progress.



### BETTER PLANNING LEADS TO SUCCESS

From a project perspective, if you have a more concise picture of your site you can more accurately prioritise and streamline assets, plan work more precisely and reduce site movement by digging, moving and replacing only what needs to be dug, moved and replaced.

“Our turnover has increased by 25%, plant onsite has reduced by 66% and labour by 45% to do the same work as before using machine control,” says Richard Baker, groundwork contractor. Utilising digital technologies has follow-on effects too. Better planning and less rework mean fewer or smaller vehicles, which reduces the need for people onsite and lowers a project’s emissions. In summary: Quicker completion, less pollution, lower costs and greater safety.

Creating point-cloud-generated digital twins will unlock the potential for far greater use of digitisation, making processes more accurate,

more sustainable, safer and less susceptible to human error. Semi-automated processes already exist, but autonomous solutions face legislative hurdles and, as a result, are further down the road. Autonomy will likely start with slower-moving machines, such as pavers, and then migrate to other parts of the project as the industry and operators become more confident in the technology.

### IMPLEMENTING SUSTAINABLE PRACTICES

To help achieve climate goals, governments increasingly use environmentally responsible procurement as an instrument to influence the sustainability of contractors. In fact, sustainability aspects are no longer nice to have, but become a core part of tenders. Being able to explain your sustainability practices and demonstrating your ability to reduce your impact on the environment will likely be crucial to business success. Some countries already introduced regulations demanding boosts in plant and machine efficiencies.



Across Hexagon, we have the advantage to combine industry knowledge, experts, research and development from various divisions to offer “Dirt Simple Solutions.” Enabling better planning, efficient execution, precise machine control systems, and automated workflows, our customers can benefit from easy-to-use technologies. And this, we back up by comprehensive solution portfolios, service and support.



### **CHRISTIAN LUTTENBERGER**

Christian Luttenberger is Vice President of Business Development and Strategy, Heavy Construction Solutions, at Hexagon's Geosystems division.


# 3D OR NOTHING

☰ Case Study



Daniel Milam is a Marketing Coordinator at Power Curbers & Power Pavers.

3D or stringless control systems for concrete slipforming equipment are becoming more popular by the season. Labour shortages, competitive bidding and scheduling flexibility are some of the most common reasons companies choose to go stringless.

A photograph showing two construction workers in safety gear (hard hats and high-visibility vests) operating a large, white slipform machine. The machine has a tall mast with a light and a yellow container on top. The background consists of green trees under a clear blue sky. The machine has the words "ER CUR" and "PER" visible on its side.

**Elliot Jones, president at W. Gardner, LLC and managing partner of 3D Concrete Solutions, has a different perspective: “I looked at it as training wheels. It kind of keeps us in the rails. I feel a lot better with having this control.”**

An opportunity arose in the Jacksonville, Florida construction market, and Jones took advantage by establishing concrete company 3D Concrete Solutions. His earthwork company W. Gardner, LLC had difficulty with local concrete contractors running out of time, which revealed a gap in the market.

Diverging from his earthmoving business was a big move for Jones since he had no prior hand forming or slipforming experience. From the beginning, Jones wanted the concrete company to be different by being the first in the region running a stringless slipform machine.

#### **A NEW LEVEL OF RESPONSIVENESS, SIMPLICITY AND PRECISION**

Jones worked with machine control on earthmoving equipment for the past ten years and had seen operators successfully trained on dozers or motor graders using 3D systems. He was confident that a slipform operator could be trained similarly and felt good about plunging into stringless slipforming, describing it as a “no-brainer”.

Jones and Rusty Grimes, vice president of project management at W. Gardner, LLC, visited the Power Curbers manufacturing facility to learn more about the slipform machines. Jones revealed, “that visit to Power Curbers in Salisbury sealed the deal”. Grimes agreed, “I would highly recommend that anybody interested in even looking to purchase a slipform machine take a tour of Power Curbers’ plant because that was impressive.”



To complement their new 5700-D concrete slipform machine, the team at 3D Concrete Solutions, selected the Leica iCON machine control system for 3D concrete paving because of the precision it delivers on W. Gardner, LLC's owned earthmoving equipment.

#### **AVOID STRINGLINES WITH 3D MACHINE CONTROL SOLUTION FOR CURB AND GUTTER JOBS**

One of the primary reasons Jones insisted upon starting with 3D controls was avoiding stringline limitations. He stated, "you are saving at least a day on a small job, a half-day to set up and a half-day to break down or anywhere from two days or more for a larger job. You only have so many linear feet of pins, and you have to leapfrog them. That is your bottleneck."

However, with stringless controls, Jones pointed out, "your bottleneck isn't how many pins, it becomes, control is here, total stations are here, we can keep leapfrogging those bad boys until the concrete plant shuts us down. There are no limits now."

Grimes reinforced, "it saves costs with the survey and guys putting out stringline and pins. We can roll in there, localise everything in an hour or two, and we are off and running. We've done as much as 4,000 linear feet or more, and that's only because we ran out of mud." Not only is the Leica 3D machine control system for concrete paving seeing time and money savings, but their quality is outstanding. They've verified vertical tolerances as small as 0.02".



### EASY TO USE AND EASY TO ADOPT 3D MACHINE CONTROL SOLUTION TO YOUR CURB MACHINE

Jones reported that “it’s better than stringline. The stringline gets manipulated by people on the job site. There is room for human error. If you follow the model, it is perfectly to the engineer’s plan.”

After getting settled in with the machine, Jones expressed that the 5700-D concrete slipform machine with machine control solution from Leica Geosystems has “been good, we love it. The guys in the field love it. It works great.” Grimes observed that their slipform crew “adapted to stringless controls really well, they jumped right in and have embraced it.”



## Environmental, social and governance impact

### Less waste, more safety, lower emissions

For concrete paving projects, machine control solutions increase productivity, improve site safety and overall shorten the timeline that’s necessary to complete the work. More efficient processes and shorter overall project times reduce the number of machines on-site and lower emissions. Stringless solutions improve accuracy and efficiency by paving to a 3D model instead of relying on the string line which is prone to human error. Doing away with the string line improves jobsite safety because you require less people onsite. It allows you to optimise trucking logistics thus lowering emissions. Because Hexagon’s Geosystems division offers remote training, support and maintenance, it opens up opportunities in remote areas with fewer jobs.

# BEYOND 3D MACHINE CONTROL: AN INTEGRATED PILING SOLUTION

☰ Case Study



Reka Vasszi is a Communications Manager, Heavy Construction Solutions, at Hexagon's Geosystems division.

The use of pile dwellings and deep foundation techniques to construct houses around the Alps date back to 5000 BC. Today, the seamless integration of machine control technology, precise location data, a flexible GPS rover, and easy collaboration with the office crews through the cloud makes the piling job quicker and more productive.



**Since prehistory, the technology has evolved, tools and machines for piling became larger and more efficient thanks to automation and positioning technology. Deep foundations are vital in many construction projects to strengthen the soil that will support the weight load of the building erected on top of it. When ground conditions are wet, or the project is planned above water, driven piles are crucial for the foundation of a new building.**

This is when the piling expertise of Swiss construction company, Birchmeier Spezialtiefbau AG, comes in handy when working on the foundation of a new building for the water police on the shores of Lake Zurich.

### **CONVERTING A BOATHOUSE TO A WATER PROTECTION POLICE STATION**

The water police of Zurich ensure the 24-hour rescue service in the area, look for people and objects underwater, protect the water from oils and chemicals, manage ship stands and maintain the harbour. The existing building and boathouse built 60 years ago will give way to a contemporary new building in 2022, where the water police and the environmental crime specialist group can work together.

The new water police station is located on a prominent lakeside with neighbouring protected historic buildings from the 1930s. Therefore,

the municipality initiated an architecture competition to find the best design that matches the neighbouring historical buildings, is sustainable and fits the functional requirements.

The jury was impressed by the project called "Coray" with its very clear and compact structure, including a boathouse, offices and a helicopter landing pad on top of the building. Due to the wet ground and weight load of the planned building, Birchmeier Spezialtiefbau AG was contracted to secure the deep foundation of the site.

### **INTEGRATED TECHNOLOGY IS KEY TO PREPARE FOR THE JOB**

Choosing pile foundations were ideal in the case of the new water police station. The waterside building is constructed to allow water underneath for easy access to the boats. To start the construction project, more than 150 piles were required to stabilise the ground.

Andreas Gassmann as foremen and Michael Fuchs as pile operator from Birchmeier Spezialtiefbau AG ensured that each pile was at the right location, at the right time.

Fuchs has been working as pile operator at Birchmeier Spezialtiefbau AG for 3 years now. He is very fortunate to work on this project as he has the most comfortable seat and the best view over the lake of Zurich from his Liebherr



355 piling rig. Each morning together with Gassmann, they start with a site inspection and an overview of the daily tasks.

Once Fuchs aligns with the team, he turns on his Liebherr piler installed with the latest Leica iCON iRP3 3D machine control solution. For accurate positioning, he checks the connection to the correction service is on as always. The corrections are needed for precise location and are handled by the machine control panel for the entire system. After the connection is checked, he loads the latest 3D model directly from the office to the machine control panel via the cloud solution, Leica ConX.

The seamless integration of machine control technology, precise location data and easy collaboration with the office crews through the cloud makes the daily job of the on-site team easier, quicker and more efficient.

### SAVING 5 MINUTES PER PILE WITH 3D MACHINE CONTROL

While the operator finishes his coffee in the cab, the 3D plan is loaded to the machine control solution, location data is secured, and the piler machine is ready to go. Since Fuchs is working with 3D machine control technology, he does not need an additional team member

on-site to stake out and check the exact location of the piles.

"Before using machine control, we worked with a surveying firm to locate where the piles need to be driven into the ground," says Fuchs. "If the markings on the site were removed or disappeared, we had to wait again to recreate those points. With machine control, we always have an updated 3D plan on the panel that automatically guides me to the right location with centimetre accuracy."

With the use of 3D machine control, not only the location of the piles is accurate, but there is no need for rework or wait for stakeouts. Thus, Birchmeier Spezialtiefbau AG can save the costs of one person on site.

"With the 3D system, I can save at least 5 minutes per pile, which takes a lot at the end of the day with 20 piles," reports Fuchs. "But it also became more comfortable, easier and safer with machine control. Safety of the people around is very important when working with such a large machine and heavy piles. Now that I can trust in the machine control's accuracy to guide the piler to the right location, I can focus more on other aspects, such as safety with less stress."



© Reka Vasszi

## MEASURE, CHECK AND VERIFY WITH GNSS SMART ANTENNA

Swiss precision means: measure, check and verify. In the meantime, Fuchs is working with the piling machine; Gassmann double checks if each pile is in the right location with his Leica iCON gps 70 GNSS Smart Antenna according to the plans hanging on the wall in his small field office.

"My favourite product is the GPS rover," says the foreman. "I have the same 3D plan on the GPS controller that Fuchs has on his machine control panel. I check and verify each pile in the ground and cross the ones that are ready on the plan."

In his previous role working in building construction, he used the Leica iCON gps rovers for quick and precise stakeouts. Since the team is working with 3D machine control technology, Gassmann does not need to stake out the location of the piles for the operator anymore; they can trust in the 3D system's accuracy.

"Working with machine control means time savings and accuracy, which automatically leads to costs savings," says Gassmann. "I love both products: the GPS and machine control; it helps us to get the job done right the first time."



## Environmental, social and governance impact

### Less waste, more safety, lower emissions

Easy-to-use solutions for machine control technology that use precise location data make construction teams' tasks easier and faster. Efficiency and productivity gains result in less people on-site around heavy machines which increases the overall safety of the project. Also, trusting the machine control's accuracy allows operators to pay more attention to matters that affect safety. Meanwhile doing the same job within a shorter time frame reduces machine hours and therefore carbon emissions. Increased accuracy leads to less rework and less waste by ensuring the right amount of material ends up exactly where it is supposed to go.

# IMAGINE

## Imaging Power

### Leica GS18 I

Mapping just got simpler, safer and more efficient than ever before. Meet the Leica GS18 I GNSS RTK rover with Visual Positioning. With it you can effortlessly measure points you couldn't reach before. Capture the site with GS18 I and map points from images. A GNSS RTK rover so innovative, that you can accurately measure facades and corners without needing to switch tools.

Once you capture the site, you can measure every detail whenever you want to.

Swiss Technology  
by Leica Geosystems



Leica Geosystems AG  
part of Hexagon  
leica-geosystems.com



©2021 Hexagon AB and/or its subsidiaries and affiliates.  
Leica Geosystems is part of Hexagon. All rights reserved.

