REPORTER

HEXAGON
GEOSYSTEMS

CONTENT

30 The not-so-surprising secret to running a successful surveying firm

After being in business for nearly 50 years, Titcomb Associates continues to raise the bar on what it means to provide quality surveying services in the United States

President's Message

When we understand the big picture, when we can see all the elements that contribute to the entirety of a situation, then we can make the best-informed decisions. When the potential of data is fully harnessed, we can extract the most opportunities. This happens when we converge the physical with the digital, creating smart digital realities and going even beyond reality to the next platform of machine-readable algorithms.

How do we get to this advanced state, though? Through data acquisition and visualisation, by bringing reality capture into entire business ecosystems to increase connectivity and autonomy among operations. In this edition of Reporter, we discover the infinite possibilities of how projects can be made more efficient and productive when visualised data is used to create plans, track progress and evaluate outcomes. Unleashing the potential of fully-developed ecosystems, new ideas that were unimaginable before become mainstream.

Major demolition and construction projects consist of many players. Understanding the contributions of each is vital to a successful outcome. When the project management firm Darden & Company was contracted to oversee the implosion of the Georgia Dome and the development of The Home Depot Backyard in Atlanta, USA, it turned to Multivista to provide visuals and video of the more than 44,000-square-metre site and surrounding structures. Bringing together five partner firms, the project was managed and shared with multiple stakeholders for timely progress updates and cost-efficient deliverables.

When constructing the second largest tower in London, UK, having constant visualisation of reference points is critical for safe monitoring of the structure. Using the innovative jump form system, combining GNSS solutions and monitoring software with HxGN SmartNet, the world's largest reference station network, Careys Civil Engineering firm was able to efficiently and safely build the 62 storeys of 22 Bishopsgate in the heart of the city's financial district. Delivering the most accurate coordinates, the team was able to pour 58,000 cubic metres of concrete and place 7,500 tonnes of reinforcement with clear guidance and trusted precision.

In utility detection, visualisation is key in protecting assets. Seeing what is underground not only increases safety but it can prevent costly utility strikes that can range anywhere from 1,000 to 100,000 euros. We're introducing our latest ground penetrating radar innovation, the Leica DSX, democratising this technology for all to use. No longer do users have to interpret complex raw data but digital utility maps are post-processed within minutes directly in the field.

Data visualisation and algorithms powered by reality capture are the stepping stones to working in extended reality – the sum of virtual, augmented and mixed reality. Working together in one unique, combined way for the most benefit, Geosystems is researching, creating and delivering solutions every day to help businesses and industries discover their utmost potential to go beyond reality.

Enjoy your read.

Juergen Dold
President, Hexagon's Geosystems division

© HxGN Content Program

EXCEEDING EXPECTATIONS

Monica Miller Rodgers

Geospatial Content

Case Study

Providing complete imagery coverage at 30-centimetre resolution and 4-band of Pitkin County in the United States

When Pitkin County Geospatial Technical Lead Mary Lackner put out a Request for Proposal (RFP) for aerial imagery of the entire county, she got more than she bargained for – about 1,000 square miles (approximately 2,690 square kilometres) coverage and a confirmed accuracy report that easily exceeded the advertised specifications.

CompassData Vice President Hayden Howard wasn't surprised, though. With a cost-effective method to provide the imagery, the firm used the HxGN Content Program not only to meet the needs of the county but also to surpass the RFP's requirements.

MAPPING IN THE MOUNTAINS

Pitkin County, located in Colorado, USA, is known for its skiing resorts being the home of Aspen. Covering 980 mi^2 (2,538 km^2), the county is in the heart of the White River National Forest, surrounded by the central Rocky Mountains.

With the changing nature of the landscape, Pitkin County aims to update its aerial imagery reserves every four years. The data is then used across county management for various purposes, such as:

- Geographic Information Systems (GIS) base maps
- Public safety dispatch routes
- Property assessments
- Insurance inspections
- Irrigational land development

With approximately 85 per cent of the county used for public purposes and the other 15 per cent privately owned, flying the entire county was cost prohibitive. The RFP encouraged creative suggestions to overcome this challenge.

GETTING MORE FOR LESS

In his proposal response, that's exactly what Howard and CompassData offered. Introducing Lackner and the county to the HxGN Content Program, the two organisations teamed to provide a means for a more affordable data set at a cost savings of approximately 64,000 USD. Collected in the fall, the HxGN Content Program had complete coverage of Pitkin County at the required 1-foot (30-centimetre) resolution and provided 4-band above the requested 3-band imagery.

"Due to the HxGN Content Program's affordability, we were able to receive more coverage than we were expecting and save money on the project," said Lackner. "CompassData offered some unique methods, and especially since this is our first time working with the firm for imagery, we are really pleased with the results."

CompassData is an expert supplier of geospatial products and services specialising in high precision and accurate GNSS-based data collection, ground control surveys, mobile mapping, aerial photography, processing and verification, unmanned aerial vehicle (UAV) technologies, and GIS integration. Also located in Colorado, the firm is quite familiar with Pitkin County, and as an imagery reseller and the ground

control point provider for the HxGN Content Program in the United States and Europe, CompassData is well versed in the possible applications of the imagery collected with Leica Geosystems airborne sensors.

“Over the years many wide area imagery programs have come and gone, but Hexagon has stated what it will do, what it will provide, and it’s stuck to it,” said Howard. “When we see the right opportunity, we encourage our clients to use the HxGN Content Program, especially for the accuracy of the imagery.”

SURPASSING THE STANDARD

The American Society for Photogrammetry and Remote Sensing (ASPRS) Class 1 accuracy standard calls for 1-ft (30-cm) resolution data to have a root mean square error (RMSE) of 60 cm (2 pixels). The RFP required Class 1 accuracy standards and no less.

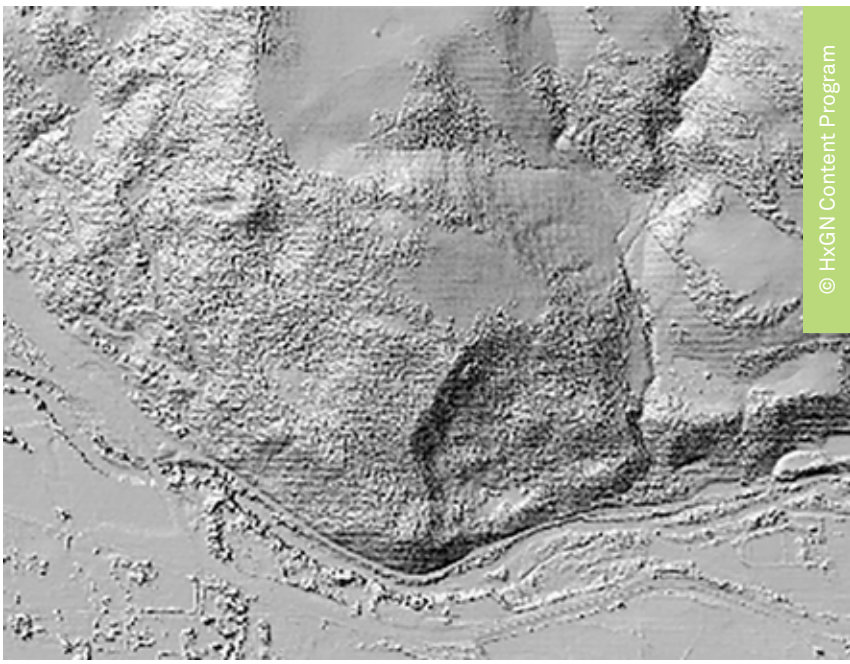
The HxGN Content Program imagery of Pitkin County surpassed the Class 1 standard at 1.36 pixels RMSE, well under the 2 pixel accuracy requirement. CompassData performed its own quality assurance on the data. Surveying 50 new ground control points to ensure the accuracy, the firm verified the accuracy surpassing the ASPRS standard.

“Using 5 cm, or better, accurate grounds control points, we were able to verify the higher accuracy of the HxGN Content Program imagery we provided to Pitkin County,” said Howard. “With the higher accuracy in the imagery, base maps, inspections and all applications the imagery will be able to give our clients a better understanding of what they actually have.”

Getting more than you bargain for usually doesn’t end positively. In this case, though, not only was it a good experience, but it also opened other possibilities for airborne imagery. According to Howard, without the RFP’s open

concept, this different way of operating wouldn't have been possible.

"For CompassData to come forward with such a solution to save this much, with this level of accuracy, and being current data, has been eye-opening," said Lackner "The HxGN Content Program is really a new way to conduct business."



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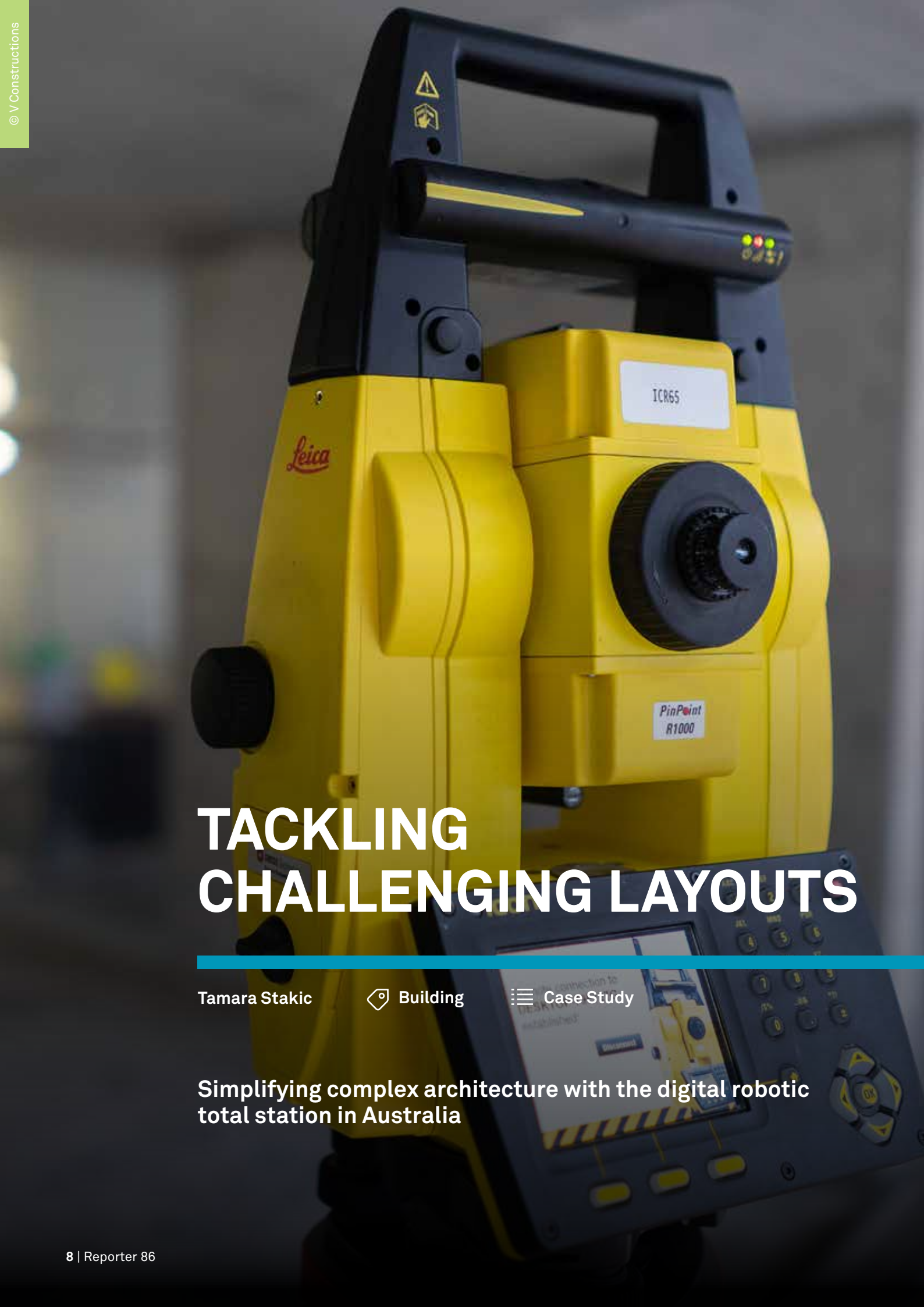


© V Constructions

TACKLING CHALLENGING LAYOUTS

Tamara Stakic

Building

Case Study

Simplifying complex architecture with the digital robotic total station in Australia

© V Constructions

Today, more than ever, new technologies are released with the promise to increase productivity and efficiency. One of the many industries embracing digitisation is the construction industry. For this industry, costs are one of the most important criteria in determining the success of a project throughout its lifecycle. It's no surprise, then, construction companies continually seek more efficient ways to do their work.

The construction industry is embracing digital robotic total stations for the layout of building elements and internal fit out due to proven financial and time benefits– replacing the laborious tape measure and stringline approach.

Traditionally, the layout of building services on site involved working based on the provided paper drawings. These drawings were used in combination with tape measures, levels and grids to identify location points for elements, such as penetrations, pipework and cable trays. This is all changing now.

DIGITISING BUILDING CONSTRUCTION LAYOUT

Based in Melbourne, Australia, V Constructions specialises in both high residential and commercial construction. Many of their recent projects feature complex designs with curved walls and buildings with prefabricated materials and non-orthogonal spaces. Seeking to improve efficiency, ensure accuracy and provide quality control, V Constructions purchased the Leica iCON robotic total station after being appointed as main contractors for the Holme apartments development; a 14-floor mixed-use development comprising of continuously curved slabs, glazed curtain walls and balconies.

V Constructions, a long-term customer of C.R. Kennedy, Leica Geosystems distributor in Australia, understood the need to adopt a digital workflow to work with complex shapes and move forward with the project faster than traditional methods. The company had little time to switch to a digital workflow after finding out it won the project.

"We needed a solution that was easy to adopt, user-friendly and required minimal onboarding time," said Douglas Thirkell, senior surveyor at V Constructions. Switching to a digital workflow and adopting the instrument was easy thanks to C.R. Kennedy who provided technical support on site as the team implemented the iCON robotic total station from day one of the project. "The product was easy to pick up and use straight away by the team," said Thirkell.

Designed by award-winning John Wardle Architects (JWA), the sculptured design includes 154 apartments, commercial and retail spaces above ground, and a 160-car park within three basement levels. The building façade is a standout feature of the development with the original 1920s Art Deco façade being retained on the lower floor frontages and alongside a new suspended brickwork façade.


© V Constructions

With the help of the iCON robotic total station, V Constructions is providing the accurate positioning of building structure, steel reinforcement, concrete layout and the finished levels. The complex nature of the building design would have made it near impossible for the V Constructions team to layout using traditional methods.

MAKING THE SWITCH TO A DIGITAL WORKFLOW

V Constructions traditionally used Leica Geosystems total stations (Leica TCR407 and Leica Builder) for previous building construction projects. The complexity of the Holme apartments project made it necessary for the team to invest in a layout instrument in order be more efficient on the site.

Due to the complex nature of the building, each apartment is unique – there are 42 different sizes of wet areas and not many repetitions of the apartments on each floor. This sophisticated structure involved a greater amount of work for V Constructions surveyors Thirkell and Brian McLoughlin as they had to layout each individual piece. The iCON robotic total station allowed the team to layout metal sections and fabricated concrete curves with simplicity and efficiency.

"What was key for us when evaluating the technology investment is that the instrument had to be robotic and a one-person operation," said Thirkell.

TACKLING COMPLEX LAYOUT CHALLENGES

The team at V Constructions set up multiple survey control points on site for instrument orientation purposes at any location around the curved structure. This technique meant they did not need to use grids for orientation when completing layout tasks. By adopting a digital workflow, V Constructions was able to ensure the setup of the instrument was completed quickly and accurately and all plan data was immediately available on the controller. This ensured quick and accurate layout processes were followed and there was no need to worry about some of the variables and the inaccuracies that come with using traditional methods involving stringlines, tape measures and spirit levels.

Every small mistake can lead to potentially serious consequences. Being a few degrees out on an angle can cause pre-fabricated systems not to fit when the time comes to install them. Similarly, incorrect layout can result in clashes with other building elements or services, thereby

disrupting the construction schedule, generating unnecessary works and wasting materials, time and money.

On the Holme site, the windows of the building contained curves and the glaziers relied on the accuracy of the placement of the concrete hobs to place windows – the concrete hobs are premade and fixed to the form work. There was no room for error for the V Constructions team and only a digital method could provide the team the confidence in accuracy needed – there was not a tape measure or stringline to be seen on the site.

"The traditional approach [to layout] is laborious and time-consuming, and any delays can affect the work of other teams. Adopting digitisation and the Leica iCON robotic total station is really the way of future for us," said Thirkell.

SPEEDING UP AS-BUILT PLANS

One of the key stages of the project that had tremendous efficiency gains was the as-built plans.

Thirkell and McLoughlin were required to complete an as-built survey for every slab. Traditionally, they would set up a laser level and take a reading, manually creating a plan of the completed slab in the office. With the iCON robotic total station, the team can record the data and within an hour upload it into CAD where it would be cleaned up and used to prepare the as-built plan.

Quantifying the productivity improvements, adopting an iCON robotic total station has saved V Constructions one person per day. These are the considerable time savings that may ultimately reduce the number of operatives required on the project and reduce labour costs.

EXPANDING PRODUCTIVITY GAINS

V Constructions realised the productivity gained by implementing a digital workflow during the Holme project and invested in its second iCON robotic total station for a new project – a chancellery building at Monash University. Located at the Clayton campus, the 10,000-square-metre building will comprise of a single basement level for car parking, ground level public spaces, two levels of office space and a third level to house the University executive. The building includes a feature steel sunshade screen that wraps all elevations of the thermally-enhanced façade.

DESIGNING WITH ACCURATE MEASUREMENTS

Cornelia Dietz

Building

Case Study

Visualising data in an easier way with 3D measurements using DISTO™ S910 in Austria

Great design starts with the designer's inspiration and accurate measurements. Falk Flöther, leader of CADFish and partner of Vectorworks, knows this. Flöther worked as a CAD specialist dealer for Vectorworks, a CAD and BIM software provider, and founded his own company, CADfish, to distribute Vectorworks' solutions in the region of Graz, Linz and Western Austria.

Flöther develops entire workflows for his clients providing CAD services for the architecture, landscape and event industries with integrated, complete solutions from the initial on-site measurements to the finished plan. This is where the Leica DISTO™ S910 comes into the picture.

Flöther initially tried the DISTO™ S910 with the tripod adapter FTA360-S and the tripod TRI70 to carry out distance measurements while working on his company building. The precision surveying laser distance metre provided the consistent workflow with multiple precise measurements in 3D he was looking for.

CAPTURING MULTIPLE MEASUREMENTS IN 3D

Flöther usually measures challenging dry construction and facades with different room heights, several slopes and joints. The DISTO™ S910 radically improved the efficiency of his common measuring tasks. Flöther enjoys the simplicity of the device; he can measure from one single location and operate the laser distance metre without studying manuals or videos.

"Once the device had been positioned centrally in the room, it was aligned horizontally and rotated three times by 90° to level the device 'mathematically'. Then, with the help of the micro-adjustable stand adapter and Leica DISTO™ Point to Point function, measuring started by pointing to the selected surfaces in the building," explained Flöther. "Once the last point had been recorded, the 3D point cloud was saved on the device as a Drawing Exchange Format (DXF) file. Pictures of the surveyed points were automatically saved alongside, making it easy to control the quality and check the surveyed data later."

The DISTO™ S910 connects to compatible mobile apps with Bluetooth and exports the DXF files over WiFi, allowing to start post-processing immediately after measuring to visualise and manage data.

FROM THE FIELD TO THE OFFICE

Connecting the Leica DISTO™S910 to the computer and moving the DXF file straight into Vectorworks, a 2D and 3D CAD and BIM software, using the drag-and-drop function enabled Flöther to adjust the working planes of the imported 3D points, create tables with construction elements and more.

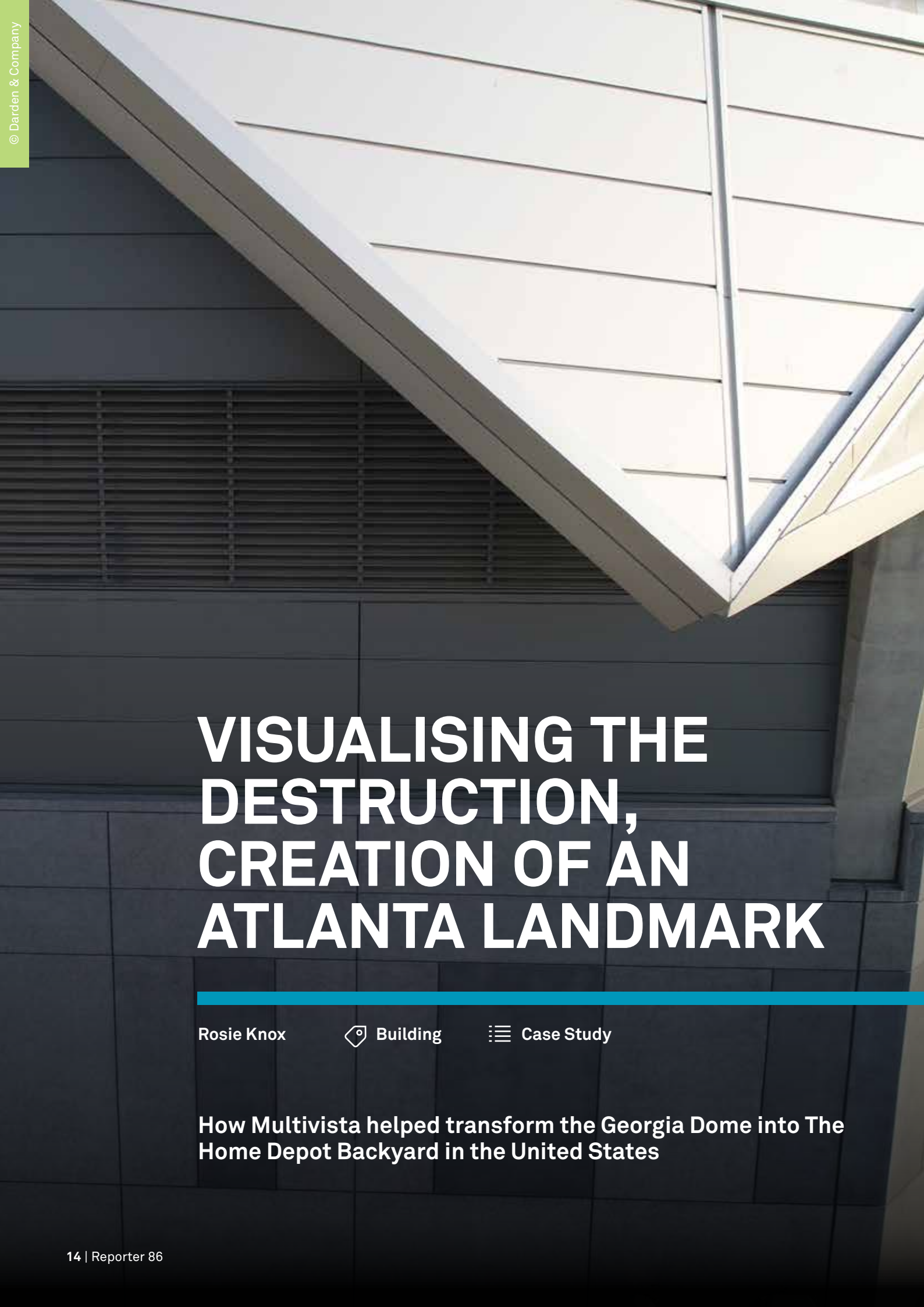
“You can adjust the working planes of the imported 3D points with three clicks, and then a simple rectangle or polygon can be plotted on the selected surfaces,” said Flöther. “To update tables, all I have to do is right click on the table that I have created for the dry construction elements and it updates. With one click I have all the dimensions, and they are always up to date. All of this works equally well with distance measurement units, for example, in corner profiles.”

To visualise data in an easier way, the CAD expert plots different surfaces or panelling with different classes of a polygon. For instance, Flöther plotted the dry construction surfaces in green and in grey.

Using DISTO™ S910, Flöther collects precise 3D data from simple or complex surfaces and transfers easily any measurement into Vectorworks with 3D points available in DXF format. Precision surveying tools, just like DISTO™ S910, can provide an efficient solution also for CAD software users who need accurate measurements visualised in a smart way for designing.

© CADfish

© Darden & Company



VISUALISING THE DESTRUCTION, CREATION OF AN ATLANTA LANDMARK

Rosie Knox

Building

Case Study

How Multivista helped transform the Georgia Dome into The Home Depot Backyard in the United States

The team at Darden & Company has been managing largescale construction projects in the Atlanta, Georgia, USA, area since 1999. Its portfolio includes the training facility of Major League Soccer team Atlanta United, the Arthur M. Blank Family Office Building, and several other large hotel, condominium, office and mixed-use buildings.

The biggest project to date was the construction of the Mercedes-Benz Stadium, the associated demolition of the Georgia Dome, and the construction of The Home Depot Backyard. That such an immense project was entrusted to a local firm is a testament to the confidence the Atlanta community has in Darden & Company.

DOCUMENTING ONE OF THE LARGEST COVERED STADIUMS

After the completion of Mercedes-Benz Stadium in Atlanta, Darden & Company was tasked with managing the implosion of the Georgia Dome — one of the largest covered stadiums ever built — and the subsequent construction of the recreation space that took its place. The firm discovered that Unmanned Aerial Vehicle (UAV) imagery and mapping services were just what was needed to keep the project on schedule and communicate with stakeholders from top to bottom.

The Georgia Dome was a 70,000-seat stadium in Atlanta. When it was built, it was the largest covered stadium in the world. The Dome was the home of the NFL's Atlanta Falcons for 24 seasons, and in its time, it hosted more than 1,400 events attended by more than 37 million spectators. It was demolished in November 2017, after the completion of the Mercedes-Benz Stadium just 83 feet (approximately 25 metres) away.

The Home Depot Backyard is a 44,515-square metre greenspace located on the former Georgia Dome site. It's the perfect spot to tailgate before a Falcons game, see an outdoor movie, or attend a community festival.

The story of how the Georgia Dome became The Home Depot Backyard is the story of 5,000 pounds (about 2,268 kilograms) of explosives, tons of debris, and nearly a year of hard work — and Multivista was there to document all of it.

Data generated included:

- 33,085 Images captured
- 70 Aerial flyover videos produced
- 535 Gigabytes amount of data processed

FIRST CHALLENGE – PROTECTING THE NEIGHBOURS

The Georgia Dome was bordered by the Georgia World Congress Center to the north and the new Mercedes-Benz Stadium to the south. One of the major considerations of the demolition was verifying these buildings weren't damaged by the implosion.


© Darden & Company

Project management firm Darden & Company was contracted to coordinate and oversee the many players contributing to the demolition of the Georgia Dome and the construction of The Home Depot Backyard. The team at Darden & Company hired Multivista to capture detailed imagery of the neighbouring structures and the Dome itself immediately before and after demolition.

“The implosion was meticulously planned to avoid damage, but we wanted to make sure we had a lot of images of the World Congress Center and the new stadium to use as a resource in case anything unexpected happened,” says Jason Hughes, senior vice president at Darden & Company.

Multivista used ground-based imagery and UAVs to visually document all three buildings just before and immediately following the implosion. Darden & Company shared access to all captured visual documentation with five partner firms for review and verification.

SECOND CHALLENGE – TRACKING MATERIAL REMOVAL

When you destroy a 70,000-seat stadium, you get a lot of debris. Removing all that rubble and bringing in new materials for The Home Depot Backyard was a monumental challenge — but Darden & Company, with its unparalleled largescale project management experience, was more than ready.

Darden & Company used Multivista to document the project site using UAV mapping. Once a week, Multivista pilots would fly UAVs over the site, collecting visual data. That data was processed through an advanced photogrammetry engine to produce a map that could be accessed from within the Multivista platform. Project stakeholders were able to annotate the map, use it to measure distance, volume, area and elevation, and export the captured data to create 3D models.

“We’d take last week’s aerial map, compare it side-by-side to this week’s map so we could tell the volume, size and scale of what had been removed in the past week,” says Hughes.

“In the past, we may have said ‘Wow, it doesn’t look like that rubble pile’s moving.’ But that’s a subjective opinion and this was not. We took that out of the equation, which allowed us to be more proactive and knowledgeable about the project.”

THIRD CHALLENGE - COMMUNICATING WITH STAKEHOLDERS

Multivista’s aerial images and orthomosaic maps were invaluable for communicating with

project stakeholders who wanted to keep tabs on progress without having to visit the site. Hughes describes weekly principal's meetings where project stakeholders would review the latest UAV map and discuss next steps.

"We were able to communicate progress internally and externally using aerial data. 'Yes, we're on top of it,' 'Yes we're managing it,' 'Yes, they hit their dates - and here is how we can tell,'" said Hughes.

In addition, the aerial imagery turned out to be a great way to send updates to Arthur Blank, co-founder of The Home Depot and owner of the Atlanta Falcons.

"Mr. Blank loved seeing the aerial pictures with our weekly updates," says Hughes. "We used them to communicate progress so he could ask questions. There's no better tool for communication than these aerial images."

VISUALISATION TAKES MANY FORMS

Darden & Company used Multivista for a wide range of services on the Georgia Dome implosion and The Home Depot Backyard, as well as the construction and facilities management of Mercedes-Benz Stadium.

These services spanned over four years and included site surveys, interior and exterior progressions, pre-slab, underground utilities, and MEP Exact-Built® documentation, owner training videos, and live-streaming webcams. Deliverables to document this four-year transformation included:

- UAV images
- UAV flyover videos
- Aerial mapping
- Photo
- Video
- Live-stream webcam
- Webcam time lapse

"Originally, we were talking about putting up a webcam for the Falcons to use on the PR [Public Relations] side, just to give fans the latest and greatest," says Hughes. "But because we were working on multiple projects, we knew we could use Multivista to manage the day-to-day activities. It was a pretty easy decision on the front end and we've definitely gotten our value out of it."

The Home Depot Backyard opened to the public, on time, in September 2018.

BUILDING ROADS IN BELGIUM WITH 3D STRINGLESS PAVING

Karina Lumholt | Heavy Construction | Case Study

3D stringless paving for building a road ramp up to a bridge in Belgium

© Aclagro

Aclagro in Belgium is a company specialised in infrastructure projects and currently employs 350 people in Belgium and France. Aclagro decided to automate its concrete slipform paving machine and chose Leica Geosystems solutions as the company has been trusting the brand for many years.

"We were a bit concerned if our workers could learn to work with the new system," explains Yves De Backer, foreman at Aclagro. "But, after a few weeks, our people were quite familiar with the new system. The machine is now so easy to set up and operate, and the possibilities are almost unlimited."

The company's Wirtgen SP15 curb and gutter machine was equipped with the Leica iCON pave solution with the new innovative 1UP configuration for a road ramp building project in a suburban area in Aalter located between Bruges and Ghent in Belgium. The workflow from earthworks to curb and gutter paving went seamlessly. The paving machine came into work just after the excavator had finished the earthworks, and, after data upload, it was ready for the job. This was particularly important because the street residents had no access to their houses during the construction works, and the 3D paving solution from Leica Geosystems helped to reduce project time.

LEICA ICON PAVE WITH 1UP – THE BEST OF TWO WORLDS

The 1UP configuration combines the dual GNSS system with a total station and prism system. The GNSS system controls the heading of the machine whereas the prism/total station system controls the slope and elevation of the machine's mould with millimetre precision. This configuration, combining the high precision of the total station and the prism configuration, is paramount for paving jobs with GNSS controlling the direction of the machine and allowed the customer to:

- Simplify the installation
- Reduce the setup time
- Save costs because fewer total stations are needed, and the RTK corrections of the GNSS system are not required.

"The most important question for us was: 'How flexible is the system?'," says De Backer. "Because of this, we decided to go for a GPS and TPS combination. When

working in a tunnel, we use two total stations, but when we are just driving in the open field, we use GPS for the direction and total station for the height."

3D stringless paving was invented more than 20 years ago by Leica Geosystems. Avoiding the physical stringlines increases safety on site because people are no longer stumbling over stringlines and fewer workers are required on site.

DESIGNED FOR EVEN THE HARSHEST OF ENVIRONMENTS

The solution included the new rugged MCP80 panel certified with IP66 and IP67 ratings, meaning it is protected against dust and water penetration. This is especially important for a solution for curb and gutter machines that does not have a cabin and where the panel is mounted on the machine, subject to the elements like the dusty environment typical for paving jobs. The large colour touchscreen is designed for easy navigation and can be used even in direct sunlight.

LEICA MC1 FOR PAVING SOLUTIONS

The machine control solution for Aclagro's curb and gutter machine was delivered with the new Leica MC1 software, the new generation on-machine control platform from Leica Geosystems. MC1 is the one-for-all software solution to guide and automate all iCON solutions leading to a simplified workflow. MC1 software has now been released for the entire iCON road segment, including soil compactors, concrete pavers, asphalt pavers and milling machines. The new software has an uncluttered

and user-friendly interface with the most important functions put forward.

For the curb and gutter machine, the quick access keys in the panel allow the operator to change height offset easily with the touch of a finger and without leaving the run screen that has been set up with the exact preference for the operator.

The integration with Leica ConX, the cloud-based data sharing tool, allows for easy data transfer to and from the machine in real time and gives the customer the opportunity of remote support.

“The machine can be checked remotely, which is a big benefit for us. We won’t have to lose a lot of time when we have problems on a job site,” concludes De Backer.

Building on more than 20 years of experience with 3D stringless paving solutions, technological developments like the automatic leap frog, the 1UP configuration and the new MC1 software platform prove that Leica Geosystems continues leading 3D solutions for the paving industry.

SNOW GROOMING FOR WORLD CUPS

Karina Lumholt | Heavy Construction | Case Study

Creating the piste for the World Cup in ski cross and speed skiing in Idre Fjäll, Sweden using Leica iCON alpine snow management solution

© Idre Fjäll

The Idre Fjäll resort in central Sweden recently hosted for the fourth time the Ski Cross World Cup arranged by the International Ski Federation, FIS. Ski cross is a fast-paced ski sport with rapid turns and high jumps where more than one skier racing down the course ski simultaneously. The sport is well-known for being public-friendly and fun to watch.

BUILDING THE SKI CROSS COURSE

The iCON alpine snow management solution from Leica Geosystems was used to prepare the ski cross course and measure the exact heights of the jumps and turns to ensure a safe and fair competition. The design model of the course is read by the machine control solution installed on the snow groomer. Based on the bare terrain measurements taken during the summer, the exact snow heights can be calculated to build the course.

"We even used the iCON alpine solution to measure the heights of the saved snow piles, and we also used UAVs [Unmanned Aerial Vehicles] to calculate exactly how much saved snow we had and how much technical snow we needed to produce," explains Jonas Pålsson, snow groomer operator at Idre Fjäll.

Pålsson has worked with the iCON alpine solution for several years now – Idre Fjäll was the first ski resort in Scandinavia to adopt the 3D snow depth measurement and snow management solution from Leica Geosystems.

"I use the iCON alpine solution all the time on the regular slopes and trails. I use the solution to measure depths and plan early on if an area needs to have more snow allocated. This saves not only valuable time but also costs because the need for snow production can be calculated more exactly," explains Pålsson.

Idre Fjäll started with a local GNSS base station placed at the very top. To ensure continuous connectivity and precise measurements for the machines, the resort now subscribes to HxGN SmartNet, the world's largest reference station network, as part of the Leica iCON alpine solution.


© Idre Fjäll

IMPLEMENTING ENVIRONMENTALLY-FRIENDLY TECHNOLOGY ON IDRE FJÄLL

The planning of a ski cross competition starts long before the tournament takes place. Every year, Idre Fjäll saves snow from one season to another under a 2-3 millimetre double-layered felt carpet.

“This year we have saved a total of 260,000 cubic metres of snow,” explains Lars Fagrell, operations manager at Idre Fjäll. “We saved the snow from last year’s ski cross course, and even though 2018 was a record warm summer, we still had snow to build the course with less use of technical snow.”

Idre Fjäll is adopting different technological solutions, such as the iCON alpine solution, to stay environmentally-friendly and be a snow-sure destination.

“We produce a total of 1,500,000 cubic metres of technical snow every season,” says Fagrell. “If we can save 10 to 20 per cent of snow from the previous year, it means a very big cost reduction for us. The Leica iCON alpine solution helps us to have control over the snow volumes, so we can place the exact snow heights of technical and saved snow.”

EFFICIENT SNOW MANAGEMENT

Idre Fjäll also hosted the Speed Ski World Cup this year and created the steepest prepared track ‘Chocken’, or ‘shock’, for this purpose. Speed skiers can reach a speed of more than 200 kilometres per hour – this requires a 100 per cent build and groomed slope. To create the steepest groomed ski slope in Scandinavia, Idre Fjäll is using the iCON alpine solution.

Efficient snow management is required for hosting large competitions and helps to extend the skiing season for the entire resort. Geared with iCON alpine solution, Idre Fjäll was ready to open the cross-country ski trails and alpine slopes already in early autumn and the winter season will run until one week after Easter when summer activities take over.

© Idre Fjäll

BUILDING A FAST TRACK BETWEEN GERMANY, DENMARK

Karina Lumholt Heavy Construction Case Study

Preparing the way for one of the world's largest tunnels with machine control solutions

The Fehmarn Belt Fixed Link is a planned immersed tunnel proposed to connect Germany and Denmark, allowing travellers to go by train between countries in only seven to 10 minutes or drive through a four-lane motorway. Upon completion, this 18-kilometre-long tunnel will be the world's largest tunnel of its kind and is expected to employ up to 3,000 people. The Fehmarn Belt Fixed Link is a user-financed 7 billion euro project, expected to be completed in nearly nine years, that would connect Puttgarden on the German island of Fehmarn and Rødby on the Danish island of Lolland. Along with the Øresund fixed link between Copenhagen and Malmö, the Fehmarn Belt Fixed Link will bring Scandinavia and Central Europe closer through the named North-South corridor.

PREPARING FOR THE TUNNEL

Holbøll A/S, a Danish construction company carrying out quality work in the fields of soil, concrete, sewerage and coating for both private and public builders, plays an important role on this project with the earthworks for 56 bridges on the Ringsted-Rødby line, the main route crossing Denmark leading where the tunnel would start. Holbøll's undertakings for this European mega project includes drainage work for the new bridges as well as building the ramps to the bridges. With a total of three years, expected to be finished soon, this is the biggest project the company has ever undertaken.

The company's success is based on adapting to the new challenges and changes that the market constantly creates. This approach enabled the company to win the sub contract to support the railway network works between Ringsted and Rødby. With approximately 130 employees and a machine park of 22 machines equipped with machine control from Leica Geosystems, Holbøll's delivers innovative and sustainable solutions on time and at the agreed price.

At one of the bridges in Vordingborg, operator Flemming Ove Nielsen uses Leica iCON GD4 3D system on the 61PX Komatsu dozer to do the first rough work for building the slopes.

"The dozer is very efficient for this sort of work because it can move so much dirt and, with machine control, hold the correct angle of the blade," explains Carl-Ole Holbøll, co-owner and managing director of Holbøll. "Flemming uses machine control for creating the slope and then the excavator takes over for the final grading work." The dual GNSS solution for dozer is an advantage because the slope is so steep, and to achieve an accurate cross-slope, dual GNSS is required.

Further down the rail track by 5 km, another bridge ramp is under construction. The excavator uses Leica iCON iXE3 3D system for the finishing layer of the ramp slope. The operator has used the solution to document the height of the different dirt layers by simply placing the bucket and letting iXE3 register the height for the as-built documentation and payment release. This saves a lot of time because the operator doesn't have to wait for a surveyor to do the as-built documentation for each layer.

BUILDING A GREENER CORRIDOR

Along with the tunnel, the upgrade and expansion of the rail link between Ringsted and Lübeck will deliver a shorter and faster connection. The Fehmarn Belt Fixed Link is part of the European TEN-T network whose objective is to enhance the efficiency of the infrastructure and reduce the environmental impact. The objective of TEN-T is to transfer more freight from roads to rail, reduce energy consumption and ease road congestion. The infrastructure for rail freight will be significantly improved because freight between Scandinavia and the rest of Europe would no longer need to drive across Storebælt in Denmark, and the rail freight will be shortened by 10 km.

PAVING THE NEXT STEPS

The responsible company, Femern A/S, has taken the next steps developing the area where the factory for the tunnel elements will be built. Continued archaeological surveys, preparatory supply infrastructure and drainage has been financed at 55 million euros. Geared with Leica Geosystems, Holbøll A/S has prequalified for several of the derived projects, including the draining and moving of eight hectares in Strandholm Lake in Denmark.

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THE FUTURE OF MINING – END-TO-END INTEGRATION

Neville Judd | Mining | Q&A

Rob Daw discusses Hexagon's Mining division's portfolio and current and future state of the mining industry

Rob Daw
Chief technology officer at Hexagon's Mining division

Hexagon is helping mining companies adopt a unified digital strategy to improve their business decision making. Leading this drive to digital transformation for customers is the division's new chief technology officer (CTO), Rob Daw. End-to-end life-of-mine integration is at the heart of this transformation, explains Daw, who was cofounder of MiPlan, acquired by Hexagon in 2017. He brings more than 15 years' experience in both open-pit and underground operations.

In a recent HxGN Spotlight interview, Daw elaborated on his background, the current and future state of the mining industry and his expectations for the CTO position.

- **You were recently appointed chief technology officer. What are your expectations, and what are your business priorities as CTO?**

We are delivering world-class technologies to the mining industry. We want to continue to focus on our customers and how we can deliver more value through our products, as well as assisting with the services of those products. It's about looking at ourselves and making sure that we practice what we preach; delivering to our people internally; and improving in our day-to-day jobs.

- **You travel a lot, visiting mines, talking to miners. What are the most common challenges you're hearing about from them?**

Increasing productivity, improving safety and reducing costs are as relevant today as they have been over the last five years, or 10 years. I think the big challenge that I'm starting to identify, as a lot of these new technologies are adopted and the industry looks at autonomous and other areas, is the social change coming into the mines; social licensing, if you want to call it that; how we adapt our workforce; how we bring our workforce along with us on the technology journey - that is definitely something that will be a challenge for a lot of the industry and something that I think we need to have a strong focus on.

- **Give us a snapshot of Hexagon's Mining division's portfolio.**

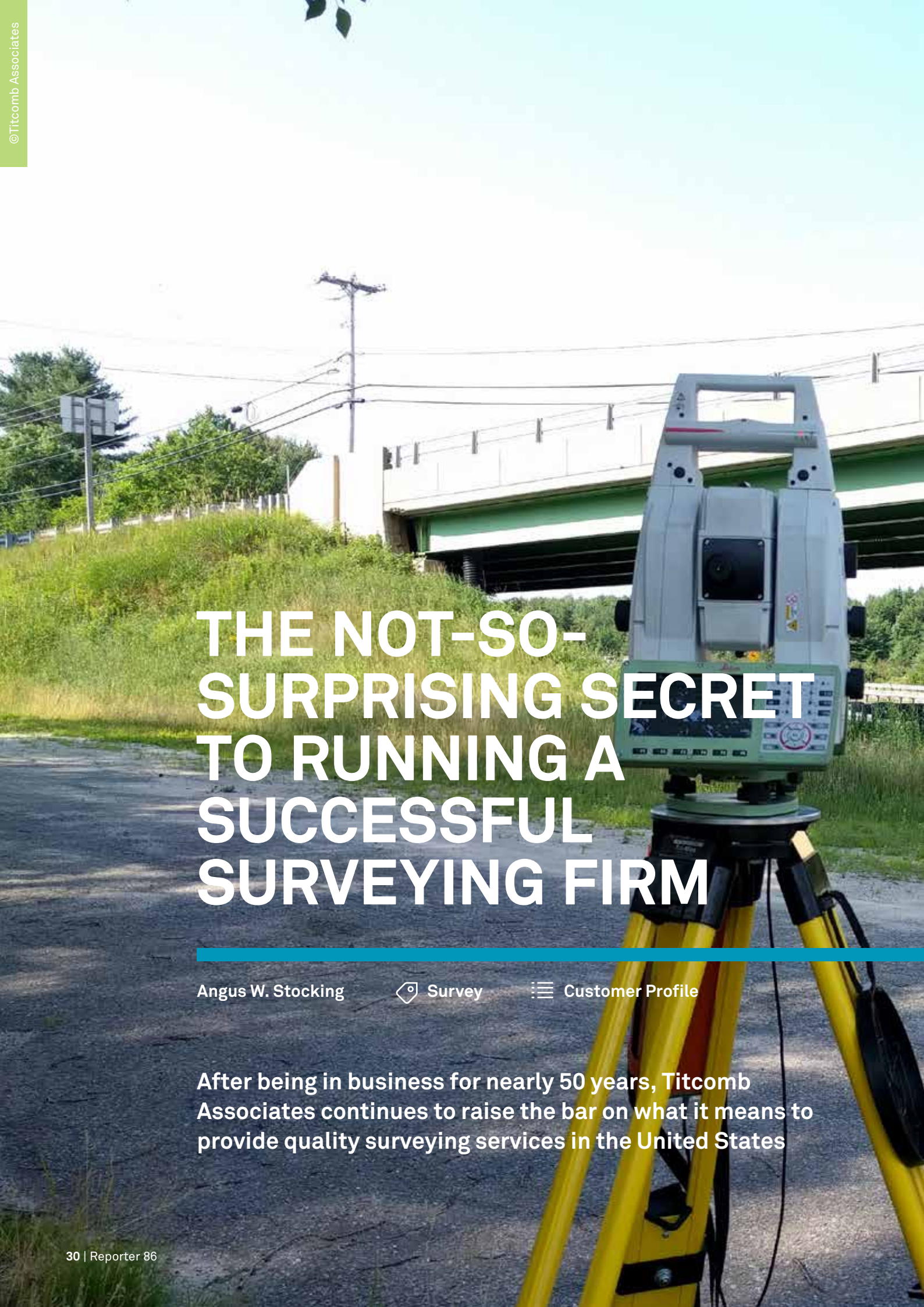
So, everything from our MinePlan product portfolio, where we touch on exploration from drillhole analysis, and storage into design, scheduling, planning, and then to the production world for drill and blast. We then have the technology to push that into the operations world. We have capabilities through fleet management, asset health, and then our safety portfolio where we have collision avoidance, personal alert, including vehicle-to-vehicle and vehicle-to-person protection, as well as vehicle intervention.

We also have a really exciting area we're starting to work on as well with our autonomous portfolio, where we are looking at assistive technologies. We're working with our clients on the journey and the roadmap to autonomy, so we can facilitate that change-management process in those mines.

All these technologies generate a substantial amount of data. So, we also have the enterprise platform, which enables us to pull all this information together and drive value through understanding the interactions between these different technologies and giving unparalleled insights into each of those portfolios, but also a holistic view as well.

- **What are the long-term challenges you're keeping an eye on with regards to research and development?**

The hot topic in the mining industry is around autonomous systems, but for me there's also a whole other world of autonomous in terms of technology with processes and some of the office-type technologies that we can automate as well. I'm keen to look at how those two worlds - the office and the field - can merge in that autonomous role.



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THE NOT-SO-SURPRISING SECRET TO RUNNING A SUCCESSFUL SURVEYING FIRM

Angus W. Stocking

Survey

Customer Profile

After being in business for nearly 50 years, Titcomb Associates continues to raise the bar on what it means to provide quality surveying services in the United States

David E. Titcomb, PLS, runs a small but thriving survey business in Falmouth, Maine, USA. Founded in 1969 by David's father, Robert P. Titcomb, PLS, Titcomb Associates has two offices, employs three professional land surveyors and six field crews, and has provided services to hundreds of clients in Maine, New Hampshire and Vermont, including numerous engineering firms and the Maine Department of Transportation (MaineDOT). Among the company's key business decisions has been an unwavering commitment to providing excellent service and using best-in-class technology. It's a forward-thinking strategy that often requires making significant investments — the sort that give many small business owners pause. But David Titcomb takes a different view.

"We're always looking at how we can make life easier for our clients," he says. "For example, we're one of the few surveying firms in our region that works in MicroStation as well as AutoCAD, and MaineDOT and a lot of engineering firms prefer to work with us because they get files in the format that's best for them."

Achieving a faster turnaround on high-quality deliverables is another way Titcomb Associates aims to provide better service. To that end, the firm recently invested in two new technologies after consulting with solution provider Maine Technical Source. One is the Leica GS18 T GNSS receiver, billed as the world's fastest RTK rover, and the other is the Leica Nova MS60 MultiStation, which combines a laser scanner and a robotic total station in one platform. According to Titcomb, these investments have paid off in ways both predictable and unexpected.

GNSS THAT'S TWICE AS FAST… AND SAFER, TOO

The GS18 T GNSS rover is one of the most technologically advanced receivers on the market. It's both the fastest RTK rover and the first to provide the first true "plumb-free" pole solution—that is, the GS18 T uses GNSS and inertial sensors to make an antenna that always knows exactly where it is and, importantly, where the end of the pole is. It doesn't need to be calibrated before use, doesn't need to be plumbed before readings, and it's foolproof against magnetic disturbances.

For Titcomb, these capabilities, combined with the "trust factor," were far more important than price when considering the investment.

"Dad started with a Wild theodolite, so we've always had a trust in Wild and now Leica Geosystems instruments—they're bulletproof. So I trusted this receiver to be as fast as advertised, and I knew that speed would pay off for us."

Project Manager Nicholas S. Elliston, PLS, says that has definitely been the case.

"We've already seen the difference with the GS18 T being able to collect additional constellations and frequencies over our previous receiver. We're now getting data in places we couldn't have used RTK before—that's a game changer."

This is especially true given the particular conditions in Maine.

"We obviously have a lot of trees here, and we developed a good sense of where we could work with our previous RTK solution—more often than not, in tree cover, we couldn't," Elliston adds. "With the GS18 T, more often than not, we can. That means we don't have to go back with a total station, and, of course, saving trips is a big-time saver."

But it's not just better coverage and faster readings that make a difference. According to Elliston, the calibration-free pole is a time saver in itself.

"Not having to take those couple of seconds to plumb a rod—for every single shot—speeds us up by 20-30 per cent. And it makes an even bigger difference when we can tilt the rod to get a shot right on the point we want—for example, building corners or the line under a guardrail. We get accurate locations without extra measurements or offsets or coming back with the total station. When all these factors are considered, there are projects we're now doing in half the time compared to previous methods."

A surprise benefit to the tilt rover was safety.

"We do a lot of roadway surveying on the Maine Turnpike," Elliston explains. "I'm often working near live traffic, and now I can be a step farther

away just by leaning the pole out and taking the shot without plumbing up. The increased speed is great, of course, but working more safely is probably the biggest advantage."

Clearly, the investment in a more advanced GNSS receiver was a good one for Titcomb Associates, paying off with faster work, more effective work in Maine forests, reduced total station work, and greater safety. The firm leveraged the new receiver's superb performance even more by making a further investment in an echosounder kit for bathymetric surveys.

"We connected the GS18 T to the echosounder and now we're able to collect one shot every second when doing bathymetric surveys," Titcomb says. "It's pretty slick!"

What about the Nova MS60? It was a bigger bet on another advanced technology. Did it work out for this relatively small surveying firm in Maine?

THE PAYOFF OF A SCANNING TOTAL STATION

When asked if he had any concerns before investing in a MultiStation that was nearly twice as expensive as a really good robotic total station, Titcomb is frank.

"Sure—it's an expensive option for our relatively small company, and I had questions about our field crews being able to get the most out of it."

So, what convinced him to take the plunge?

"My father was always convinced that a survey company needed to be able to gather a lot of information in the shortest time possible because, well, time is money. I agree with that, and I've also decided that we'll only buy robotic total stations now because they give us so much flexibility and power," Titcomb explains. "So, first of all, the MS60 is a great, and very fast, robotic total station. Adding scanning to that made sense for us. It lets us do work we couldn't do before, is much faster for some projects, and, most importantly, I already knew that there was

some work we were doing that would be much safer with a scanner."

The work he was thinking of was roadway projects, one of Titcomb Associates' largest areas of focus. The company regularly surveys bridges, roadways and intersections for a number of engineering consultants. "For interstate or turnpike projects, they'll always close lanes for us, but there are some places, like on ramps, where it's just really hard to do a lane closure and make it safe," explains Titcomb. Now, in those situations, Titcomb crews set up the Nova MS60 well off the road and use the scanning capabilities to perform a fast, accurate topographic survey without getting anywhere near traffic.

The safety benefits of scanning are even more obvious when surveying bridges.

"We used to be up on ladders, near traffic, when we surveyed bridges," Titcomb explains. "It was very unsafe. Now we'll never have to do it that way again."

Instead, his crews can simply scan the entire bridge deck in just a few minutes with greater accuracy than before and from a safe vantage point on the ground.

Aside from roadway and bridge projects, Titcomb Associates keeps the Nova MS60 busy with standard engineering and architectural support projects. The firm realised early on that most of their clients don't really care how data is gathered, and very few in their region wanted a point cloud as deliverable. But the MS60, used as a scanner, can do most of this work—topos, as-built surveys, roadway cross sections, site monitoring, building interior surveys, etc.—much faster than conventional surveying, more accurately and more safely, while gathering far more data. An important side benefit is being able to view the point cloud data in the field with the Leica Captivate software to make sure the crew has captured everything they need before they come back to the office, thereby eliminating return trips.

"If we can do all that," says Titcomb. "Then it doesn't matter if the client knows that we're using a scanner—we're still getting a lot more quality work done and making money at it."

A SOLID APPROACH TO BUSINESS

Commitment to quality and to always working with the latest technology is not for the faint of heart, and it is not necessarily the right strategy for every

©Titcomb Associates

survey firm. But for Titcomb Associates, it's a strategy that has proven itself over nearly five decades and made the company one of the most trusted surveying specialists in New England, USA.

"It's like my father used to say—'You have to spend money to make money,'" Titcomb says. "In our experience, that's true. Spending money on advanced equipment from a reliable source has always worked out for us."


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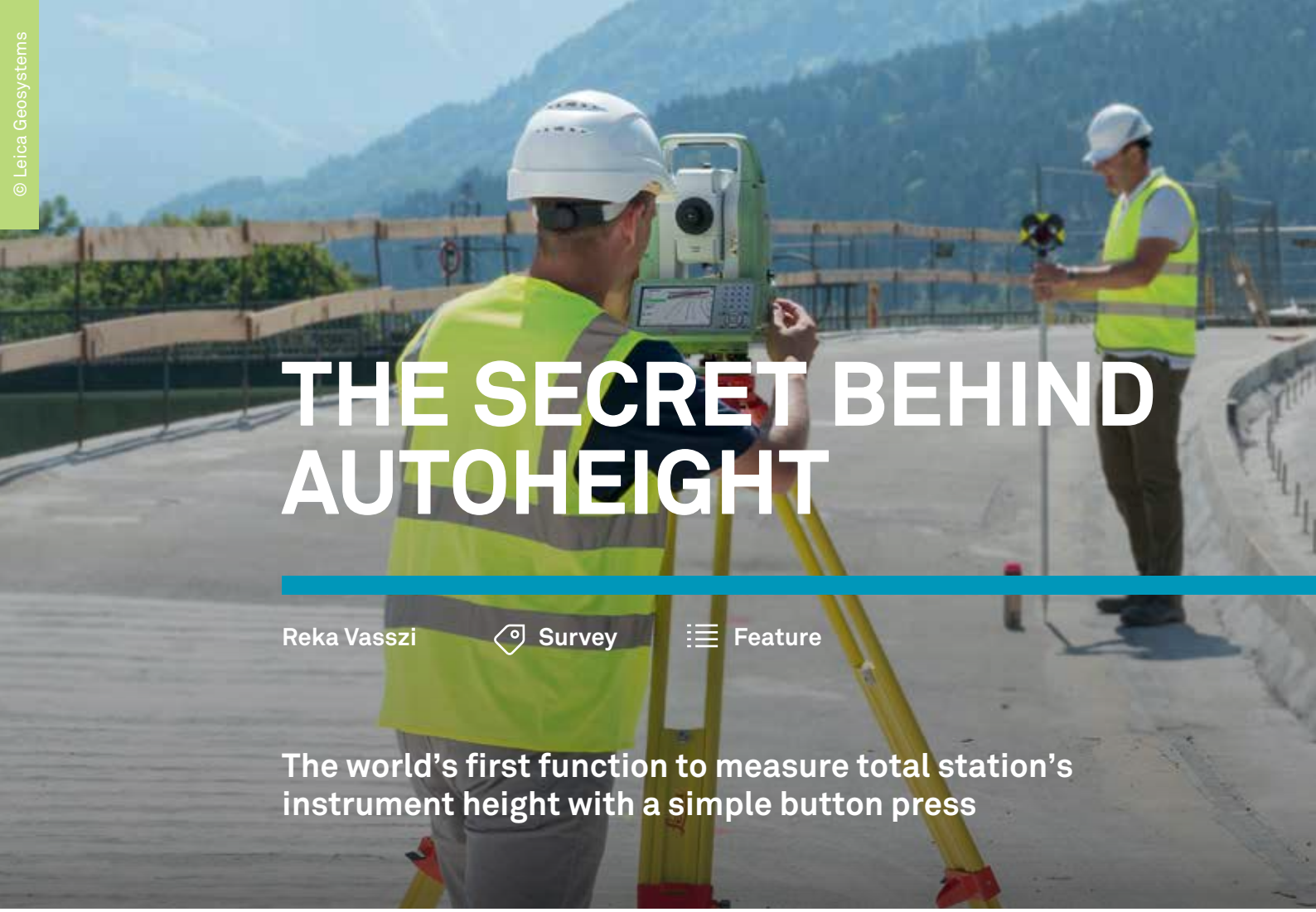

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THE SECRET BEHIND AUTOHEIGHT

Reka Vasszi

Survey | Feature

The world's first function to measure total station's instrument height with a simple button press

Up to now, the height of the total station was measured manually with analogue tapes, potentially leading to missing traceability and inconspicuous height errors in the final point measurements. To ensure accurate and reliable instrument heights and enable the operator to finish the station setup quickly and more efficiently, the Leica FlexLine TS07 and TS10 manual total stations were developed with a unique feature to automatically measure instrument height.

The manual total stations enable highly accurate instrument readings, thus mistakes within tolerances can be avoided, saving time and increasing productivity. With a user-friendly design, the new FlexLine Series manual total stations do not require special knowledge to operate, making it easier to do stakeouts and collect reliable data.

TWO FUNCTIONALITIES IN ONE SENSOR

AutoHeight is an innovative function built in the TS07 (optional) and TS10 manual total stations (standard) for getting the instrument height with a simple button press. Combining the downward-facing laser plummet with an electro-optical distance measurement (EDM) system, the sensor uses the pointer mode for centring above ground and the EDM mode for taking heights. The instrument height can, in this way, directly be measured where the visible laser hits the ground and then applied inside the Setup App. AutoHeight can also measure any surface and does not require a specific target.

This integrated feature automatically levels and centres the instrument, without interrupting the workflow, enabling the operator to focus on the actual working task, instead of losing time on manually measuring the manual total station's height.

DELIVERING PROJECTS ON SCHEDULE, ON BUDGET, WITH MINIMAL DOWNTIME

Communication delays between the job site, operators, design office, and engineering can be costly and aggravating. Taking advantage of emerging technologies, companies can embrace state-of-the-art equipment to manage the complex tasks, costs, schedules and improve the safety, efficiency and quality of building projects.

Automating tasks using advanced technology, such as modern manual total stations, is an

easy way to reduce on-site time pressure. The FlexLine offers industry-leading quality and durability even in harsh environments, whilst simplifying workflows and data collection.

Investing in modern equipment that automatise previously manually coordinated tasks, such as measuring the total station's height, can result in:

- Faster and reliable measurements
- Reducing time spent on rework or remeasurement
- Accurate audit trail thanks to the documentation on who captured the data, when and where
- Low learning curve to operate the equipment
- The lowest total cost of ownership.

Whether it's a new build, large or small-scale alterations, repairs, or refurbishments project, modern equipment can enhance and simplify the entire workflow. With AutoHeight there is no more time lost on tape handling and manual measurement procedures. In addition, it is only a simple button press to gain accurate and reliable total station height. The FlexLine Series is designed to address the challenges of small and large-scale sophisticated civil infrastructure and building construction projects to ensure smooth workflows and increase productivity.

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HEXAGON'S GEOSYSTEMS DIVISION FEATURES CUSTOMERS

AROUND THE WORLD. EVERY DAY. ANY APPLICATION.

Whether it is surveying an underpass in Saudi Arabia or working on a mine in Peru, our users are working diligently to further not only the industry but global society.

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

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

As-built mapping in the Maldives

Mapping an Island Resort, in South Malé Atoll, Maldives using the Leica GS18 T and the BLK360 by Faruhath Jameel, Affan Shakir and Hamdulla Shakeeb

Road reconstruction in Bolivia

Road construction surveying in Cochabamba, Bolivia using Leica Geosystems total station by Jherman Alarcón

Hydropower station construction in Kyrgyzstan

Construction of an hydropower station in Bishkek, Kyrgyzstan using Leica TCR 1205+ by Rysbek Zholdoshov Arabia and Raja Sheraz Ahmed

Oil pipeline survey in Iraq

Surveying oil pipelines in Iraq using Leica Viva GS15 GNSS antennae by Momin Obeidi

3D laser scanning in Jordan

Conducting historical preservation using Leica RTC360 in Petra, Jordan by Qasem Ahmad Al-Betar

Topographical survey of a farm in the UK

Carrying out a topographical survey of a large farm with floor plans, elevations in Cheshire, United Kingdom, using Leica TS16 and TS15, GS08 and GS16, Leica DISTO by Dan Martin and Alan Coombs

Scanning a War Memorial in England

Scanning the Cenotaph in Liverpool's world heritage site St. Georges Hall using Leica RTC360 by Rebecca Jones in the United Kingdom

Construction project in the USA

Surveying in a coastal snowstorm the adjacent houses and roof peaks for a new construction project in New Jersey, United States, using Leica Viva GS15 GNSS, TS09 plus total station and CS15 field controller by Jason Krwawecz

Housing project in Algeria

Building project in Algeria using Leica FlexLine TS06 manual total station by Fares Fares

Light rail project in Australia

Surveying for an urban rail transit project in Adelaide, Australia using Leica TS15 total stations by Nelson Boquin

Sidewalk improvement project in Norway

Improving old sidewalks and laying down new electric cables along a main road in Tønsberg, Norway using Leica iCON iXE2 machine control solution by Andreas Clausen

Surveying in the sunset in Spain

Cemetery survey project in the town of Caldes d'Estrac, using Leica Viva TS16 total station and GS15 GNSS by Alfonso-D. Martínez Ezpeleta

© Careys Civil Engineering

PRECISE POSITIONING IN LONDON'S SKY

Renata Barradas Gutiérrez, Marco Di Mauro

Survey

Case Study

Obtaining precise and reliable coordinates during the construction process of London's second tallest skyscraper with a tailor-made GNSS solution

City landmarks are not built overnight. In between planning, design and construction, there are other crucial activities - just like monitoring and positioning - happening at the same time.

22 Bishopsgate, a 287-metre-tall skyscraper, rose through the air in London's financial district in the United Kingdom. Planned with the ambition to be the capital's first 'vertical village', 22 Bishopsgate is London's second tallest building.

To construct the cores that make this landmark rise, Careys Civil Engineering, a well-known construction company with a proven track record of delivering projects that enhance the built and natural environments of communities and infrastructure in the United Kingdom and Ireland, delivered the concrete works using a self-erecting jump form system – the first of its kind to be used in the UK.

Building 62 storeys, with a floor space of more than 120,000 square metres required Careys Civil Engineering to pour 58,000 cubic metres of concrete and use 7,500 tonnes of reinforcement. Thriving on complex and challenging projects of this magnitude requires innovative methodologies – just like the building positioning system developed for Careys Civil Engineering by Leica Geosystems. This tailor-made solution for jump form high-rise buildings was chosen by Careys Civil Engineering to provide reference coordinates to monitor and carry out the surveying tasks during construction.

DOING IT THE CAREYS' AND GEOSYSTEMS' WAY

The two core walls of 22 Bishopsgate were constructed by Careys Civil Engineering in a sequence of several concrete pours using a jump form system. Jump form systems are working platforms or rigs for fixing of the formwork, steel fixing and concreting. This system is suitable for the construction of multi-storey vertical concrete elements in high-rise structures.

After each jump, or elevation of the rig to build a new level, the Careys Civil Engineering surveying team needed reliable coordinates to proceed setting out the structure and verifying the correct positioning of the core. The main task of the automated positioning system Leica Geosystems created is to obtain precise and reliable coordinates during the entire

construction process that are not influenced by the movement of the building.

This tailor-made GNSS-based monitoring solution consisted of:

- Seven Leica GM30 GNSS receivers for monitoring
- Seven Leica AR10 GNSS antennae
- Leica GeoMoS Monitor
- Leica GNSS Spider software
- HxGN SmartNet reference station network
- Tiltmeters

With the above-mentioned hardware and software combination, Leica Geosystems developed a procedure, using GNSS observations combined with tiltmeters (precision inclination sensors), to obtain reliable coordinated points at the top of the formwork of the ascending skyscraper. Those coordinated points, or Active Control Points (ACP), are sighted by Leica Geosystems robotic total stations to setup its coordinates and orientation.

“Above a certain height, in central London, ground control points were not usable or visible anymore; the GNSS system was able to provide reliable coordinates with no need for ground controls,” said Damien Watson, senior engineer at Careys Civil Engineering, Plant and Fleet Department.

To set up the automated positioning system, GNSS stations were coupled with Leica Geosystems 360-degrees prisms, so the positioning information provided by the GNSS sensors was available to be used as reference points for the surveyors performing the survey of the core wall with Leica Geosystems robotic total stations.

High-precision tiltmeters, fixed at the same locations of the GNSS antennae, were coupled to the GNSS station to track the verticality of the GNSS antennae in order to provide, at each computation, the most accurate coordinates. SmartNet network was used to provide reference coordinates to the GNSS stations on the rigs and compute the baselines.

ENSURING A SMOOTH DATA FLOW

To obtain the ACP, data was collected, stored and post processed with Spider software at a dedicated PC to deliver the most accurate coordinates for the team. Spider is the control centre software where positioning information

was computed. The data from the GNSS stations on the rig and data from the SmartNet reference network was combined to provide every six hours the most accurate set of coordinates for each point for Careys Civil Engineering team. Spider coordinates were automatically transferred to GeoMoS Monitor where they were transformed into local coordinates and adjusted based on tiltmeter data.

"The Leica Geosystems solution allowed for a fully-automated workflow and computation of the results and fast delivery of coordinates when required, optimising costs and time of operation for the surveying team compared to different methodologies," said Watson.

The team was, furthermore, able to check the number of satellites tracked and data quality of each single point in the Spider interface in real time. All these quality checks provided in real time the high level of positioning measurement accuracy that Careys Civil Engineering needed to build this landmark.

After each jump and processing period, new valid control points coordinates were available for the robotic total station to measure any mark or object in the structure. The Careys Civil Engineering team on site then proceeded to set up the robotic total station at the top level where all control points were visible.

The robotic total station determined its own position and orientation observing the control points and checking the results with the coordinates given by GeoMoS. In this way, the robotic total station observed all relevant points to be checked during the construction.

BUILDING ON THE RISE

Accurate and reliable positioning on the status of structures displayed as actionable data is crucial to make fast and informed decisions and react to potential problems. The GNSS-based monitoring system has proven so successful that Careys Civil Engineering will be using it in future projects, such as the construction of a new tower in Manchester.

"The Leica Geosystems solution automatically delivered reference coordinates to the surveying team when needed, and the accuracy got better and better while the structure was growing building confidence after every jump," concluded Watson.

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70 MILES OF HIGHWAY MAPPING TO FULL ENGINEERING DESIGN IN 99 DAYS

Penny Boviatsou

Survey

Case Study

Completing a demanding 70-mile highway mapping project in only 99 days in the United States

©E.L Robinson and Rice Associates, Inc.

E.L. Robinson Engineering, a civil engineering and planning firm with 40 years of experience in transportation planning, analysis and design, was selected by West Virginia Department of Highways (WVDOH) in the United States to complete a demanding 70-mile highway mapping project in only 99 days.

This transportation project had no existing as-built map. To meet the timeline, the data had to be collected by mobile mapping, including:

- Mapping a 70-mile, two-lane highway
- Static scanning of 12 bridges
- Curve widening and slide repair
- Creation of the Digital Terrain Model (DTM)
- Extraction of topographic features, such as edge of pavement, striping, signage and utility poles
- Culvert survey and inspection of more than 500 culverts and pipes
- Setting permanent control for bridges.

KEEPING PACE WITH DEMANDING DEADLINES

Given the short delivery time of full design deliverables, E.L. Robinson Engineering began with the mobile mapping data acquisition immediately. The challenge was with completing the engineering deliverables needed from the mobile data – this is where the Leica Pegasus:Two mobile sensor platform user network provided a significant advantage. Rice Associates, Inc., a geospatial services firm that provides conventional surveying, in-house photogrammetry, static, mobile, and terrestrial LiDAR scanning, also owns a Leica Pegasus:Two mobile sensor platform. The company was able to support E.L. Robinson Engineering with the data extraction capacity to help meet the project timeline.

“Surveying a highway requires capturing enormous amount of data with the highest precision and standards. The Leica Pegasus:Two enabled us to collect millions of points per second; the team mapped 5 miles per day, and it took us only 14 days for the complete data extraction of the 70 miles of a two-lane highway,” said Obadyah Foord, regional director at Rice Associates.

Given that both companies, E.L. Robinson Engineering and Rice Associates, use the same hardware and software, the data integration and exchange were seamless; bringing scheduled delivery of data and keeping engineers moving forward into final design without delays.

THRIVING ON A CHALLENGING PROJECT

A total of 36 Real Time Kinematics (RTK) base stations were used for this project to locate targets and other topographic features. While 120 mobile scanner targets were used to control the mobile scan, these were scanned at 40 kilometres per hour with a target every 610 metres. A DTM was created for the highway design, which included:

- The raw point cloud
- Isolated ground points
- A triangulated surface mesh.

“The surveyors working from the office were able to create traditional topographical surveys from the point clouds and images,” said Tom Rayburn, manager of surveying at E.L. Robinson Engineering. “7.8 billion raw data points were collected, and we produced in 45 days the DTM, edges of pavement, guardrail, utility poles and signage for the entire length.

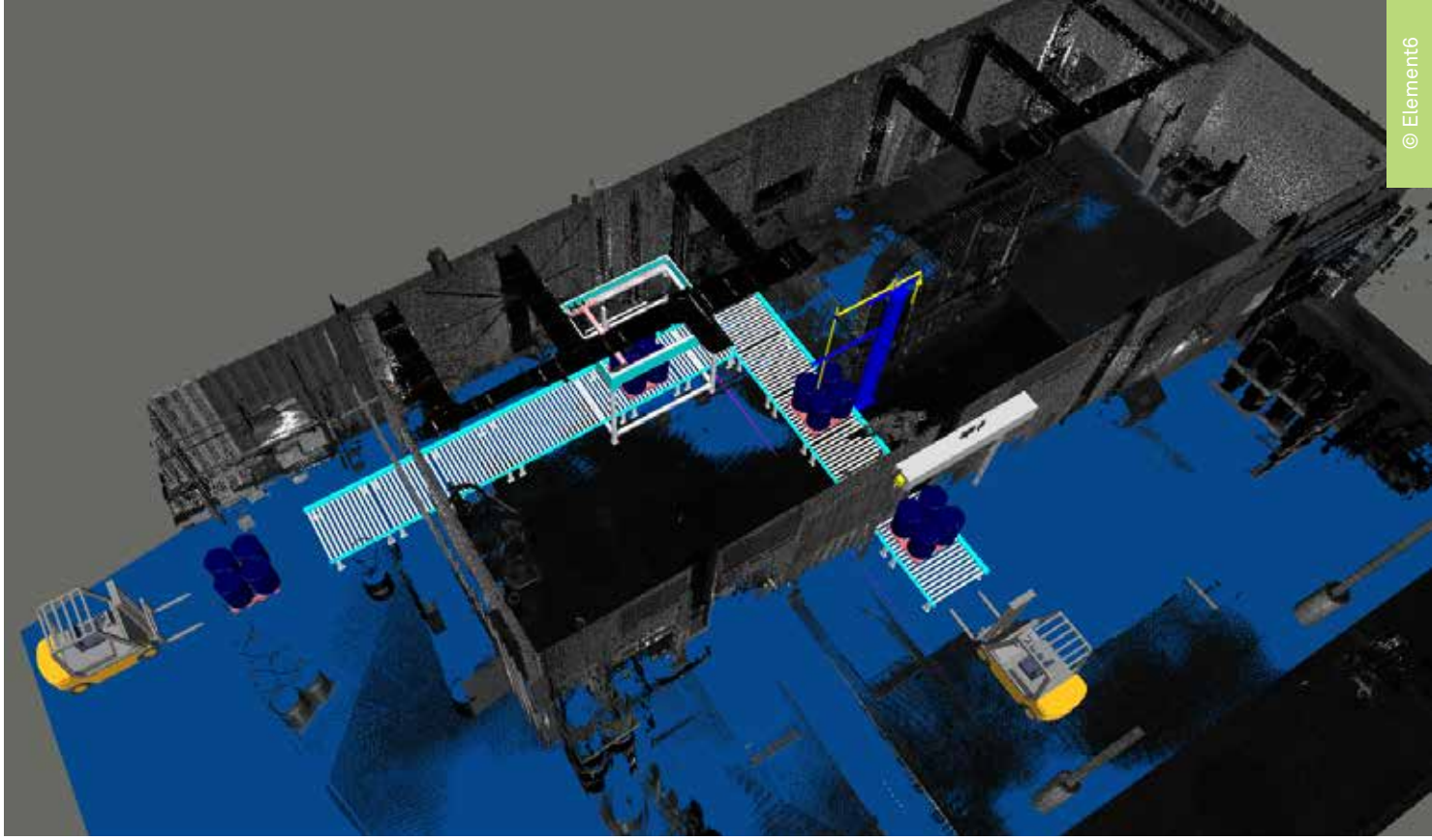
“The Leica Pegasus:Two provided a rapid data capture solution for this large-scale project, saving us time and reducing safety risks,” said Rayburn. “With Rice Associates support, we delivered the project on time and within budget thanks to the speed and accuracy delivered by using the Pegasus:Two.”

© Element6

HOW ELEMENT6 DELIVERS THE FUTURE OF PLANT ENGINEERING WITH LASER SCANNING

Christine Grahl Survey Customer Profile

Using laser scanning with a digital Virtual Plant Design approach to create an innovative business model in the United States



At one o'clock on a Friday afternoon, Element6 received a call. A client had a critical need for precise measurements for a fit-for-purpose evaluation. Would Element6 be able to come in that day, get the information, and provide deliverables that evening if needed?

The Georgetown, Ontario, Canada-based boutique engineering consulting firm has built a reputation providing fast and cost-effective service to clients in the specialty chemicals industry, so it's used to handling time-sensitive requests, but this was the tightest deadline the firm had ever encountered. Still, Rob Jickling, Element6 Consulting Principal, didn't hesitate. He told his team to get ready.

At 3 p.m., the client confirmed they needed Element6 on the job; an hour later, Element6 was on site. Greg Schneider, regional manager of Industrial Plant Solutions Canada and Northern United States for Leica Geosystems also lent his support on the project. By 1 a.m., just 12 hours after the initial call, Element6 delivered the requested data to the client.

Traditionally, meeting this type of request would have taken weeks and required a significant amount of labour. But Element6 relies on a lean, fully digital approach to plant engineering and design that makes all the difference when time is of the essence.

LASER SCANNING INNOVATION ENABLES SPEED AND QUALITY

Element6 works fast with one goal in mind: client success. "Most people in the engineering business think about engineering," says Jickling. "We focus exclusively on getting that end result for our clients. They might want to make money, save money or reduce risk. Maybe they want to improve productivity or introduce new products, or maybe they've got health and safety issues they want resolved. Whatever their objective, that is our goal."

To deliver low-cost, high-quality, high-speed service, the team uses an all-digital approach they call Virtual Plant Design (VPD). The firm begins with a digital point cloud of the as-built conditions, captured with high-accuracy laser scanning, which helps them quickly find the solution to issues regarding plant renovations, process optimisation, new equipment installations, or whatever challenges the clients face.

Using its lean workflow, the company works so fast that it sometimes has to wait for clients to catch up and provide feedback on the proposed solution. Clients who are used to traditional blueprints and CAD modelling work are stunned by how quickly Element6 can provide high-quality engineering consulting, performing work in weeks or even days that would traditionally have taken months, with deliverables that are much more comprehensive and informative.


© Element6

This is all made possible by Element6 laser scanning technology. While some engineering consulting firms prefer to rent their technology on an as-needed basis, Element6 has strategically invested in several scanners, including a professional-grade Leica ScanStation P30, a Leica BLK360 imaging laser scanner, and, most recently, two Leica RTC360 portable, automated, high-speed laser scanners that capture complete scans with high-dynamic-range (HDR) imagery in less than two minutes and automatically pre-register the scans in the field with Cyclone FIELD 360. The company also handles its own point cloud processing using Leica Cyclone software, along with JetStream and CloudWorx for easy CAD integration, and TruView for easy client visualisation.

Purchasing the technology instead of renting it has enabled Element6 to become experts in capturing and using point clouds—which, in turn, allows the company to offer unexpected benefits to its clients. For example, in a traditional approach, an initial consultation would be followed by a proposal and then a return to the site to capture as-built conditions before work could begin. In contrast, Element6 often brings one of its RTC360 laser scanners to the first meeting and captures 10 or 20 scans on site in a matter of minutes. The scanning and registration are done so quickly that the firm is often able to begin work on the project immediately, significantly reducing turnaround time.

LASER SCANNING INTEGRITY ALLOWS FOR AN INNOVATIVE BUSINESS MODEL

When Jickling founded Element6, he wanted to create a business centred around accountability and a results-oriented approach. Element6 spends time up front identifying exactly what the client needs and then sets a price based on the service that will be required—not the amount of time required to complete the work.

This fixed price model radically sets Element6 apart from other engineering consulting firms. “We’re not incentivised to spend more man hours doing things,” Jickling says. “We’re incentivised to get the project done as quickly and productively as possible.”

This business model constantly challenges the company to find new ways to be faster, more innovative, and more focused on meeting the client’s needs. When making technology decisions, Element6 carefully considers not just the capabilities of the hardware, but the

complete field-to-finish workflow, the support provided by the manufacturer, and the track record of innovation. “Leica Geosystems has industry-leading hardware, but it also has a fully integrated workflow and a commitment to reliable service and continued innovation,” Jickling says. “We rely on Leica Geosystems as a partner that will help us stay on the leading edge.”

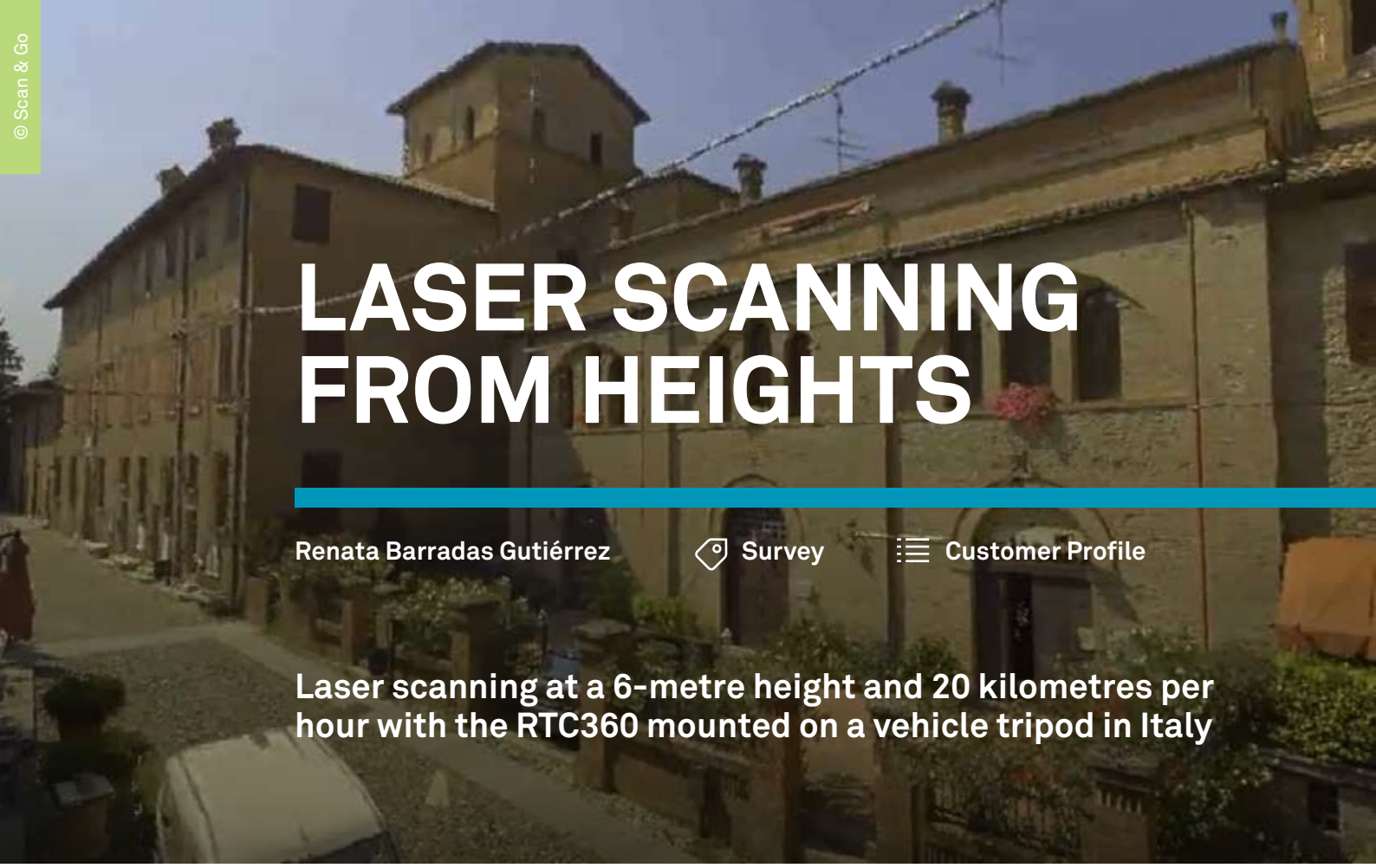
This type of partnership builds confidence into the company’s operations and enables Element6 to provide clients with outstanding service. “We've been in this business a long time, so we have the knowledge and understanding not just of engineering but of our clients’ businesses and their business needs,” Jickling says. “That understanding, combined with our efficiency and productivity because of technology, allows us to provide our clients with significant advantages in terms of both pricing and value. Our clients know they can count on us to exceed their expectations, and that’s a win for everyone.”

POINT CLOUDS PROVIDE REAL-TIME INTELLIGENCE

The days of blueprints and spending hours measuring as-builts are over. With laser scanning, Element6 produces high-detail point clouds of engineering plants that can be quickly referenced with something as easy as a few clicks on a computer or taps on a mobile device. No more costly delays due to flawed measurements—it’s all there in the point cloud.

Jickling envisions a future in which every plant has an accurate 3D point cloud as-built. As technology develops, live data could be fed into the point cloud to keep the as-built current, with constantly updated information regarding temperature, pressure, and other variables within the plant. With a complete and up-to-date point cloud, clients wouldn’t need last-minute scans of elbows on a Friday afternoon; they could just pull up the already-existing data. Instead of waiting for engineers to travel to their site, they could work with consultants remotely to identify solutions and avoid downtime.

“Why create a bunch of blueprints?” Jickling says. “The model is here, all the information is here—why would anyone want to spend money creating paper? We’re working with plant owners and EPC contractors to up their game using technology, which reduces costs and significantly improves outcomes.”



LASER SCANNING FROM HEIGHTS

Renata Barradas Gutiérrez

Survey

Customer Profile

Laser scanning at a 6-metre height and 20 kilometres per hour with the RTC360 mounted on a vehicle tripod in Italy

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

As processes digitise and businesses digitalise, surveyor firms around the world, like Scan&Go, are adapting new technologies to offer better, faster and more specialised services to their clients. In collaboration with Leica Geosystems, Scan&Go, an Italian company leader in the field of topography and 3D high-definition survey, performed a functional test of its vehicle/tripod installation for 3D laser scanning using the Leica RTC360 3D laser scanner.

TAILORED SOLUTION FOR 3D LASER SCANNING

To achieve a faster and more effective use of terrestrial laser scanners, Scan&Go creates systems that can be installed on any type of vehicle or on a pneumatic pole to allow easy movement between scan sessions and ensure greater measurement range.

Mounted on the Scan&Go System, the RTC360 captured at 2 million points per second the centre of Castelvetro di Modena, Italy, in only a few minutes. The Scan&Go team mounted the RTC360 on Scan&Go's level lift roof and automatic LP16R leveller. For the first scan, the team captured the centre of Castelvetro di Modena from a 3-metre height. The remaining three scans were done at a 6-metre altitude from the ground using Scan&Go vehicle installation.

"The height of the scanner allows to overcome the obstacles present and increases the scanning range and its accuracy of measurement," explained Cristina Valchuk, sales manager at Scan&Go. "All scans are perfectly levelled – this eliminates vertical variations. Our satisfaction of the test made is very high. This approach ensures the safety of the operator and the instrumentation in the field and increases the productivity of the RTC360."

The aim of the test was to verify the potential of the new RTC360 in combination with the Scan&Go system for laser scanning in mobile "stop" and "go" mode with the instrumentation installed on the vehicle. The Scan&Go team also wanted to test the correct functioning of the Visual Inertial System (VIS), performing the

automatic point-cloud registration in the field, with speeds higher than those achieved by foot. The point cloud collected at a vehicle speed ranging from 10 to 20 kilometres and registered in real-time surprised the team.

“The results obtained with the RTC360 are very good. During the scans, the system is very stable ensuring maximum measurement accuracy,” said Valchuk. “It is very fast because the 3D laser scanner is mounted on the vehicle and you do not have to disassemble anything during the movements between one scan and the other.”

FROM RAW DATA TO SMART DATA

Point clouds are only a set of data points in space until stakeholders can visualise and interact with them. 3D models obtained from the point clouds help to inform the perception of reality and provide a georeferenced digital base for operations. Scan&Go creates 3D models for their clients so they can document, manage, renew or maintain any assets or environments. After post-processing data with Cyclone REGISTER 360, experts created a 3D model of Castelvetro di Modena.

Designed with simple and highly automated workflows in mind, the RTC360 solution uses edge computing to stream scan data to a tablet in real time and automatically processes the scan data to provide real-time quality control and data registration in the field.

With automatic pre-registration, high-quality point clouds were immediately available for the Scan&Go team. Quality assurance and completeness checks were also done in the field with the Cyclone FIELD 360 mobile application running on a tablet. This reduced the complexity of the data capture process in the field and saved the team members time in the field and in the office since they were able to leave the project site with a pre-registration that can be finalised in Cyclone REGISTER 360 much more quickly than raw scan data. Scan&Go is aware that time savings, workflow simplifications and productivity gains automatically translate into increased profits and accelerated paybacks.

Reality capture systems from Geosystems increase the flexibility and mobility of professionals to map, geo-position, capture and extract features over LiDAR or photogrammetry measurements in restricted areas with millimetric precision in an extremely agile and fast way.

CREATING NEW 3D EXPERIENCES, SERVICES FOR REAL ESTATE

Kevin Rinaldi-Young

Survey

Customer Profile

Redefining speed and quality to create a wide range of deliverables for the real estate industry using the Leica BLK360 in the United Kingdom

Technology is one of the driving forces behind industry progress, but often limited access and availability can stand in the way of it reaching full potential and capacity for real change. For this reason, democratising exclusive technology, as well as its deliverables, has become a way for businesses to lead their fields and have meaningful impact, transforming the way entire industries operate.

Launched in 2015, United Kingdom's spatial data company Pupil was one of those companies with a tangible and ambitious vision on how geospatial assets could revolutionise the valuation of real estate. When Leica Geosystems unveiled the world's smallest and easiest-to-use reality capture laser scanner in November 2016, the Leica BLK360, Pupil was presented with the perfect tool to capture 360° High Dynamic Range (HDR) spherical imagery and point cloud data within minutes. This miniaturised 3D imaging laser scanner has enabled a raft of new applications in architecture, design, construction and engineering and plays an essential part in the data Pupil delivers today.

What's more, Pupil's initial thesis that accurate, data-rich captures of interiors could create a new gold standard within the real estate industry has now become a reality with the use of the BLK360.

THE VISION

Both companies are aligned in their mission to democratise access to accurate data, which is manifested in the deliverables Pupil provide to its clients. 3D reconstruction and scene-understanding systems allow Pupil to take real-world spaces and convert them into hyper-accurate digital records. This guarantees correct measurements that assist accurate valuations and help to avoid potentially misleading real estate transactions.

Founded four years ago by James D. Marshall (CEO), Oliver Breach (COO) and David Mullett (CDO), Pupil's aim is to capture, publish and deliver 3D information available on an industrial scale. With a team of more than 85 employees based in central London and an advisory board made up of former senior executives at companies including JPMorgan, Uber and IAC, Pupil launched its first brand, *Spec,* in June 2018.

Spec is building the new standard for the residential property industry by offering agents ensured and accurate assets, including:

- Professional photography
- 360° imagery
- Floor plans
- Immersive VR content
- Area measurement reports
- Condition reports.

Pupil is also currently at a beta stage with its second brand which focuses solely on the commercial property market - *Stak*.

THE MISSION

Even though the residential and commercial property markets require different processes and deliverables, *Spec* and *Stak* both rely on the data collected by the BLK360 imaging laser scanner. By placing this technology in hands of a qualified team of digital surveyors, more than 3 billion points of measurement are captured each week, translating into millions of square metres in the real world. To support global consistency and transparency in data, Pupil works in partnership with the Royal Institution of Chartered Surveyors (RICS) towards setting new surveying industry standards.

Pupil's army of digital surveyors visit and scan properties and locations across London daily. The large amounts of data experts generate is then fed through a proprietary cloud architecture and processed by a team that provides *Spec's* clients with access to consumer-ready assets within 24 hours. This includes 360° imagery and an immersive experience with life-like viewings that can be accessed from a desktop computer, smartphone or the *Spec* mobile app from anywhere in the world.

At the touch of a button, the BLK360 captures 360° HDR spherical imagery and takes a 360,000 point per second laser scan with a +-4 millimetre accuracy at 10 metres with an overall 0.6 to 60 metre range. It's only minutes before the spherical image and laser scan are complete and available to view on the digital surveyor propriety app, before being uploaded to the cloud. "The intuitive usability and highly accurate data delivery are truly game-changing for us," says James Hennessey, Pupil head of computer vision. "We capture everything within a property with a level of accuracy that ensures trust and confidence in our digital assets."

Hennessey leads Pupil's team of research engineers who work on capturing, processing and understanding the geometric data gathered by the BLK360. He and his team are responsible

for creating high-fidelity 3D reconstructions, professional-grade images and applying computational photography techniques and machine learning to understand what has been captured.

Pupil designed and now deploys its own software that seamlessly combines with Leica Geosystems' 3D imaging laser scanner. "Our current capture and data pipeline are integrated with the BLK360 and has enabled us to produce better data and faster imagery than ever before," adds Hennessey. "For the industrial scale of our service and the mobile nature of the digital surveyor's day, the lightweight BLK360 has truly redefined the speed and quality of our *Spec* and *Stak* captures and service."

THE FUTURE

Pupil believes laser scanning and technology, such as the BLK360, is not only going to redefine the future of the built environment and the way properties are valued and transacted, but also deliver data that powers countless other applications in and around interior space. Devices, such as those created by Leica Geosystems, are helping to make this a reality for the real estate industry and are also disrupting and leading other industries in the right direction toward more accurate data.

"Leica Geosystems' accurate and easy-to-use laser scanning devices are currently allowing us to offer more reliable and accurate property measurements to our customers. In the future, using this high-quality data and artificial intelligence will also allow us to offer a series of new products and experiences to them," says Hennessey. Now, more than ever, building trust with customers is a priority for businesses like Pupil that want to stay one step ahead in a rapidly changing market and technology landscape.

© The Newport Yacht Collaborative

LUXURY YACHTS TRANSFORMED WITH HELP OF BLK360

Kevin Rinaldi-Young

Survey

Case Study

The Newport Yacht Collaborative uses laser scanning data for improved interior fittings in the United States

© The Newport Yacht Collaborative

What makes the Leica BLK360 so valuable for creators of all types is its versatility. We've seen how it can help restore architectural gems, virtually recreate Frank Lloyd Wright marvels, and even help construct Hollywood movie sets. Each of those structures is impressive, but they all involve spaces with right-angle corners and upright walls. What happens when you need to build something incredibly precise, but with practically no straight lines?

The BLK360 team caught up with the Newport Yacht Collaborative in Newport, Rhode Island, United States, to answer that question. The Newport Yacht Collaborative offers its clients a seamless experience in yacht refits and rebuilds, covering everything from concept through delivery. Their biggest challenge, however, is creating new interior spaces that fit the boat hulls' curved shapes and limited spaces.

The Newport Yacht Collaborative credits much of its success in overcoming this challenge to using the BLK360. The device's accurate scans and point clouds allow the design and construction teams to complete their jobs more efficiently, saving everyone time, money and headaches.

FROM 3D SCANS TO INTERIOR INSTALLS

The Newport Yacht Collaborative's three-step process involves Ashley Reville of CaptureRI, who manages the 3D yacht scan; Ezra Smith of Ezra Smith Design, who concepts and designs the interior packages; and Jim Thompson of J. Thompson Marine Carpentry, who builds and installs the new interiors.

For Smith, incorporating the BLK360 into his design process has transformed his workflow. He imports the point cloud as a mesh into Rhino, where he can then build out highly accurate 3D components using his AutoCAD layout drawings.

He values using the BLK360 because it makes it easier to design with the unusual materials and measurements. "[We're] fitting complex shapes into a very complex shape – it's pretty awesome."

In addition to saving Smith design time, the new workflow also saves the builders time in execution. "I would design the bunk components in the morning," Smith recalls. "I would send the drawings off at noon. They would have the pieces built by noon the next day, and they would be in the boat that afternoon – with no trimming, no sawdust, just glued right in and off to the next piece. We were able to basically fabricate and install the whole forward cube of that boat in a few weeks, which was unheard of."

Time isn't the only efficiency gained. The precision of the scans also allows the team to take advantage of space that might have been lost in measurements done by hand. This is particularly important on a boat, where space is at a premium.

"We're not worried about inches but about quarter inches, eighth inches, to really maximise every available spot," Johnson explains. Using BLK360's data, the J. Thompson Marine Carpentry team can correctly install the interior pieces on the first go, minimising man hours and maximising usable space.

STAYING ON THE SAME 3D PAGE

The Newport Yacht Collaborative team cites one more advantage to using the BLK360 – pleasing their clients. "I have an incredibly accurate rendering for the owners. We can look at it from any view and put all the surfaces in. We can put whatever type of leather they want to use on the couches, whatever the countertops are going to be, different veneers, different types of wood. We can do it all from one master model now, which is wonderful," says Smith.

The project moves along smoothly and quickly with everyone on the same page. Reville likes that the scans serve as a collaborative access point for designers, builders and clients alike. "Compared to the typical techniques we are used to, work with the BLK360 is revelatory," Thompson raves. "It's an amazing process. It's completely changed how we do this stuff. We're really excited about it," agrees Smith.

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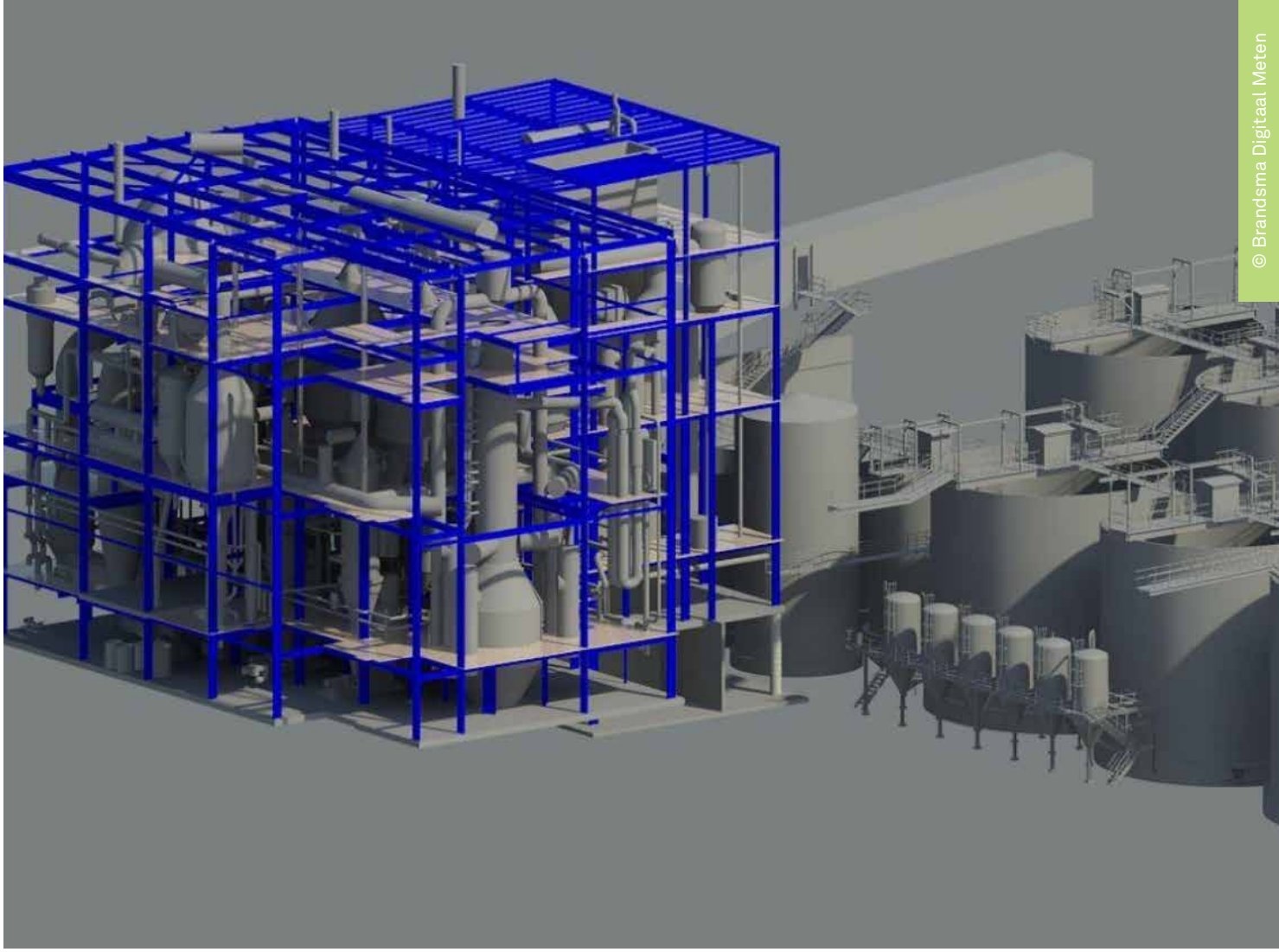
DIGITALISING FROM PLANNING TO EXECUTION

Reka Vasszi

Survey

Customer Profile

Brandsma Digitaal Meten provides smart solutions covering the full life cycle of projects in the Netherlands



As the Internet of Things (IoT) continues to become more universally available, technology is transforming the way entire industries conduct business. With leading-edge technology, previously manual-based processes have become more automated and that enhanced visibility increases productivity and efficiency both on the job site and in the office.

Brandsma Digitaal Meten, a land surveying company in the Netherlands, provides innovative and smart solutions across different fields, including:

- Building construction
- Surveying
- Civil engineering
- Infrastructure analysis
- Yacht construction

Developing innovative, quality and tailored solutions for each customer is a priority for Brandsma Digitaal Meten. To achieve this goal, the company uses the most advanced technology for its projects, and its portfolio includes various Leica Geosystems products, such as:

- Leica ScanStation P40 terrestrial laser scanner
- Leica RTC360 3D laser scanner
- Leica BLK360 imaging laser scanner
- Leica Geosystems smart antennas
- Leica Geosystems software solutions:
- Leica Infinity survey software:
  - Leica Cyclone 3D point cloud processing software
  - Leica Cyclone REGISTER 360 3D laser scanning point cloud registration software
  - Leica Exchange data transferring solution
  - Leica ConX cloud solution and web interface
  - Leica Captivate surveying field software
  - Leica iCON construction software series

“At Brandsma Digitaal Meten we look forward to every new challenge and we always go for quality. That is why we work with the latest equipment and software available on the market,” said Rein Brandsma, founder and owner of Brandsma Digitaal Meten. “Our latest addition to our equipment portfolio is the new Leica RTC360 3D laser scanner, which is an efficient product in coping with the multitude of challenges and environments we are facing.”

TAKING THE LEAD FROM PLANNING TO EXECUTION

The right dimensions serve as the basis for every building project, whether it concerns the construction of a house, a factory or a bridge. Specialists at Brandsma Digitaal Meten are involved in every stage of a project from initial planning to execution and monitoring.

The company has gained extensive experience in scanning bridges and developing 3D models and 2D drawings. In their latest project, Brandsma Digitaal Meten scanned a new bridge in Aduard, the Netherlands, to perform a dimensional check of the retrieval mechanism. Once the bridge was scanned with the Leica ScanStation P40 terrestrial laser scanner and the data registered in Cyclone REGISTER 360, 3D models were created through Autodesk Recap® and Autodesk Revit®.

DIGITALISING FACTORIES

Re-modelling a complete factory or developing production lines require detailed measurements and drawings of every part of the facility so the modifications can be effectively adjusted. Accurately measuring the whole building could be time-consuming, so Brandsma Digitaal Meten experts offer complete 3D laser scanning from machine components to factory halls.

One of the leading salt producers in Europe, the Salinen Austria AG, asked Brandsma Digitaal Meten to scan their entire factory and produce a 3D model of the infrastructure. With the help of the detailed and accurate 3D model, Salinen Austria AG can now modernise the salt factory and lead the 7,000-year-old tradition of salt mining in the Salzkammergut into the future.

VISUALISING SHIPS IN 3D

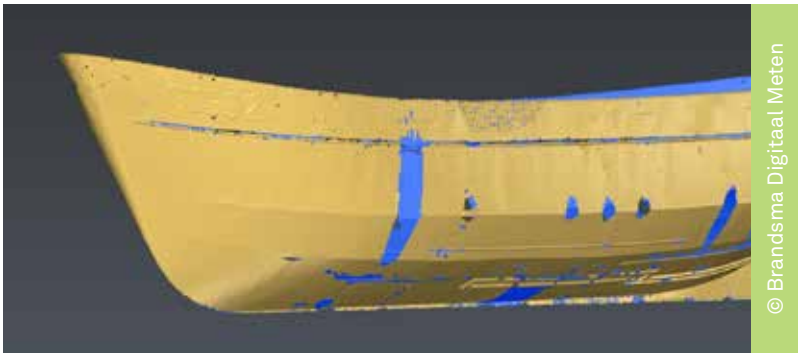
Brandsma Digitaal Meten is also engaged with the yacht- and boat-surveying industry and measures entire ships or different parts of a vessel. Visualising the ships in 3D enables the effective maintenance of yachts and serves as a basis for further development or replacements.

The UK-92 fishing vessel was built in 1983 and is in need of a renovation. Before maintenance could be carried out on the ship, the customer asked Brandsma Digitaal Meten experts to scan the entire vessel and identify the parts of the

hull that needed to be replaced. Once the ship was scanned, the raw data was registered in Cyclone REGISTER 360 and a refined mesh was created with 3DReshaper point cloud processing software. The mesh provided was imported by Brandsma Digitaal Meten's client into a 3D modelling software to calculate the water displacement and stability of the UK-92 fishing ship. The data acquired also helped the customer to re-build and replace parts of the fuselage.

DEVELOPING SMART SOLUTIONS

Digitising construction, building or surveying projects, from initial plans through execution can significantly increase productivity and efficiency. Brandsma Digitaal Meten's smart solutions cover the full life cycle of a project. The company leverages Leica Geosystems' state-of-the-art technology to always offer the best solution for each and every customer.



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TRANSFORMING RUINS TO 3D MODELS

Reka Vasszi

Survey

Case Study

Transforming the ancient Bacchus Temple in Lebanon into a 3D digital model

Heliopolis, the City of the Sun was inscribed in 1984 as an UNESCO World Heritage site. This ancient Roman city, today called Baalbek, in the Beqaa Valley in Lebanon has a complex of temples that is an outstanding example of ancient Roman architecture. The Temple of Bacchus, in the sanctuary complex of Baalbek, is among the largest, best preserved and most impressive of its kind.

To digitally document and preserve the majesty of the Temple of Bacchus for further generations, master students of the Surveying Engineering Department at the Lebanese International University captured the temple in 3D.

“We used a new automatic digital 3D terrestrial laser scanning technique to create a 3D model of the Temple of Bacchus. Using the Leica ScanStation P30 enabled us to effectively and quickly capture the temple and develop 3D models that can be used for renovation and Virtual Reality (VR) applications,” said Professor Mohammad Abboud from the Lebanese International University.

IDENTIFYING LAYERS OF HISTORY

The Temple of Bacchus, built between 150 to 200 AD, is the architectural manifestation of the myths and legends surrounding the god of wine, joy, drama and fertility. The Roman God Bacchus was the personification of the blessings of nature, which is gorgeously sculptured on the walls of the ancient temple.

From the 12th to 14th century, the sanctuary complex, including the Temple of Bacchus, was combined and converted into a large castle that became part of Baalbek’s medieval fortification. Although subsequent layers of building helped to preserve the antique architecture, distinguishing the stages of this built-environment is a challenge. Archaeologists conduct a complex analysis with modern technology to reconstruct the ancient city and identify the different historical layers and materials that make up the ancient Roman settlement under the later medieval additions.

Despite the continuous reconstruction of the ancient city, the Temple of Bacchus suffered from theft, war and earthquakes through the centuries. An earthquake in 1759 greatly damaged the structure of the temple. Since the ancient Roman city is located in an area prone to earthquakes, it is important to monitor the structures and identify the possible movements to ensure the safety of visitors and preserve the temple.

© Mohammad Abboud, Lebanese International University

CREATING DIGITAL DATABASES FOR HERITAGE

Laser scanning conducted by surveying engineering students at Lebanese International University proved to be an accurate and effective solution to collect precise data in a limited amount of time and allowed researchers to present archaeology to the public in a unique way—through 3D models and interactive digital applications.

The team captured a point cloud using the ScanStation P30. The engineering students then processed the data in the office with Leica Cyclone REGISTER 360 3D point cloud processing software to register and clean the data from which a surface mesh was extracted. The point clouds provided valuable metric data to produce a detailed 3D model of the Temple of Bacchus.

In addition to the laser scanning, to collect more detailed information, aerial photogrammetry was used to capture panoramic photos of the Temple of Bacchus and its surroundings. With the help of geometric analysis, terrain modelling, photogrammetry, and 3D laser scanning, the traditional research methods of archaeologists and building researchers is supplemented with precise digital information.

COMPARING TRADITIONAL AND MODERN TECHNOLOGY

Traditional methods, such as GPS devices are more time-consuming and do not capture information in 3D. Traditional 2D drawings are limited in describing exact locations of geometries in a 3D space, and often present the ideal of a space, more so than the reality. Total stations are reliable and capable of collecting 3D data, however, lack the density of points to support 3D visualisation.

Reconstruction of archaeological sites, however, requires the density of data that laser scanning can provide. 3D data documentation can leverage traditional survey techniques to ensure data accuracy and accurate global positioning. This data lends itself to Building Information Modelling (BIM) and other visualisation techniques to create a complex digital database,

which serves as a base for future restoration or reconstruction of the Temple of Bacchus if needed.

3D SCANNING THE PAST FOR THE FUTURE

Heritage preservation is a continuous process, that includes documentation, analysis, monitoring, restoration and protection. Our cultural heritage treasures, like the Temple of Bacchus, are fragile and vulnerable to environmental and human hazards. Digitising these majestic examples of the built environment can be used to preserve the original site as it exists today and create a digital record of the site that can be accessed long into the future.

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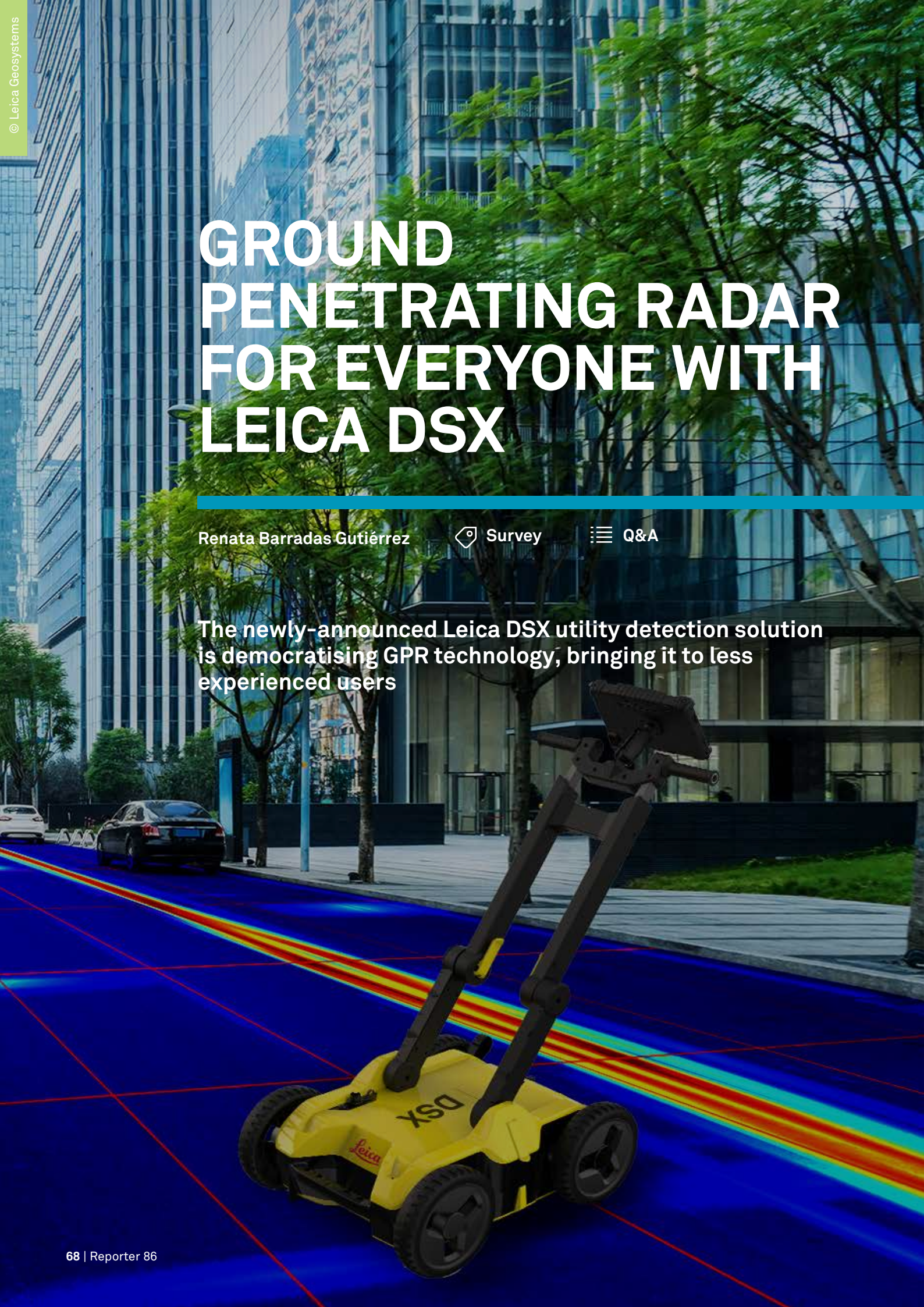
GROUND PENETRATING RADAR FOR EVERYONE WITH LEICA DSX

Renata Barradas Gutiérrez

Survey

Q&A

The newly-announced Leica DSX utility detection solution is democratising GPR technology, bringing it to less experienced users



Agata Fischer
Business director detection and services at Leica Geosystems

The use of Ground Penetrating Radar (GPR) technology is limited to highly skilled and experienced professionals trained on interpreting difficult radargrams. The newly-announced Leica DSX utility detection solution is changing this by democratising GPR technology, bringing it to less experienced users.

To learn how this disrupting GPR technology is bringing efficiency and digitalising workflows for mapping and utility location, *Reporter* caught up with Agata Fischer, business director detection and services at Leica Geosystems. Here's what she had to say.

• What is the DSX utility detection solution?

The DSX utility detection solution is a portable GPR designed to bring users the latest developments in utility detection with simplified workflow, automated data processing and the highest accuracy. Users can now easily locate underground utilities that are clearly visualised in DXplore software. DXplore is an intuitive software that gives users the flexibility to interface with various positioning systems in an easy way and perform utility verification on site. This solution combines the utmost GPR technology with the best-in-class positioning accuracy from Leica Geosystems devices.

• How is the DSX simplifying utility detection?

Today, one day of data collection with a GPR sensor results in one to two days of data post-processing in the office. The DSX utility detection solution simplifies this process with the most reliable, simple and automatic procedure detecting every type of utility and generating a 3D utility map on the field.

Users no longer have to interpret raw radar data and interpret hyperbolas as the DSX displays results clearly and directly in the field with automated GPR post processing and data analysis. A digital utility map is generated in the field within minutes and can be exported to the DX cloud and Hexagon software for further integration with additional data. With this utility detection solution, Geosystems brings to the market a more efficient, robust and easy-to-use GPR system, allowing users to detect utilities on site and easily check data quality in real time, without the need to wait for office experts to validate the work.

• Who should use the DSX utility detection solution?

The DSX was designed for users who need to locate, avoid or map buried utilities in a safe, fast and reliable way. This utility detection solution simplifies the work for companies involved in repair and maintenance of road and infrastructure as well as for surveyors with no GPR experience that need to map underground utilities.

• Why should someone invest in the DSX utility detection solution?

Utility strikes occur every day around the world. The cost of damaged utilities starts from 1,000 euro and can go as high as 100,000 euro. Contracting an expert to do the utility detection work can also cost in the multiples of thousand Euros. In addition, an expert might not always be available when you need him. Investing in the DSX will save damage costs, cost of utility surveying, and down time of damages and trainings.

• How does the DSX utility detection solution differ from the DS2000?

DS2000 is a utility surveying solution for experienced users. Data processing and interpretation requires experience, deep understanding of GPR and training users who will operate the equipment. DSX, on the other hand, is designed for non-experienced and first-time GPR users as DXplore software takes away the complexity of data processing so users can detect buried utilities. Even a user without any previous GPR experience can detect utilities on site.

• How does the DSX utility detection solution work?

Once the field to detect buried utilities has been defined, a user can collect the data in a grid method with lines in both longitudinal and transversal directions. After the data acquisition is completed, DXplore software clearly shows the detected utilities with minimum user interaction. After the detected pipes are displayed on the software, users can relocate them by using the DSX or a positioning system. Users can either mark the utilities on the ground or export the utilities map to the machine that will do the excavation work.

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DIGITISING THE CONSTRUCTION SITE FROM THE AIR

Anne Pitkaenen

Survey

Feature

Leica Geosystems UAV technology brings the construction site into the digital age and turns data into intelligent information to improve decision-making processes

The construction industry hasn't traditionally been considered as the most agile one in adopting new technologies and jumping into digitalisation. However, when it is of importance to the industry – getting a clear understanding of the project's progression, a matter of cost savings or safety – changes do happen fast. This can be seen for instance in the wide adoption of machine control systems due to the automatisation, traceability and accuracy they bring into any project.

Large construction sites are like huge living organisms - they need a constant flow of current information to run smoothly. Unmanned Aerial Vehicles (UAVs) fit well to feed current data to create a clear view on site progression, adding safety and increasing cost savings.

Many analysts claim that construction is one of the biggest areas of growth in commercial UAV and at Hexagon's Geosystems division we see it happening. A couple of years ago some companies said the orthophotos and 3D models created for construction projects were opened maybe once and then left unused. Access to fresh data, nowadays, starts to be an expectation by construction professionals. UAVs have been called the 'democratisation tool' for geospatial data since they offer fast access to information, are becoming easier to operate, and the operating cost is a fraction of other data collection methods.

The Leica Aibot CX UAV solution for construction is Hexagon's Geosystems' answer to the current and future UAV needs of any construction site. This UAV solution opens opportunities for daily progress documentation, stockpile monitoring, resource tracking, and 2D and 3D site survey to get cost savings and visibility over suppliers. Aibot CX brings the construction site into the digital age and turns data into intelligent information to improve decision-making processes.

UAVs can assist construction companies in various ways, from marketing pictures to 3D

survey data and from progress reporting to site safety analysis. The following three use cases present common ways how UAVs maximise efficiency, add transparency and offer immediate savings for any construction project.

SURVEYING THE CONSTRUCTION SITE

Through the entire construction project, accurate and up-to-date 3D data and orthophotos of the area are crucial for planning and design. For planning and designing, users need proper as-is information. The more complete the data set, the more efficient the plan will be. UAVs can provide recent and frequently updated data whenever it is needed.

Depending on the construction site, there are several data collection methods already in place, such as:

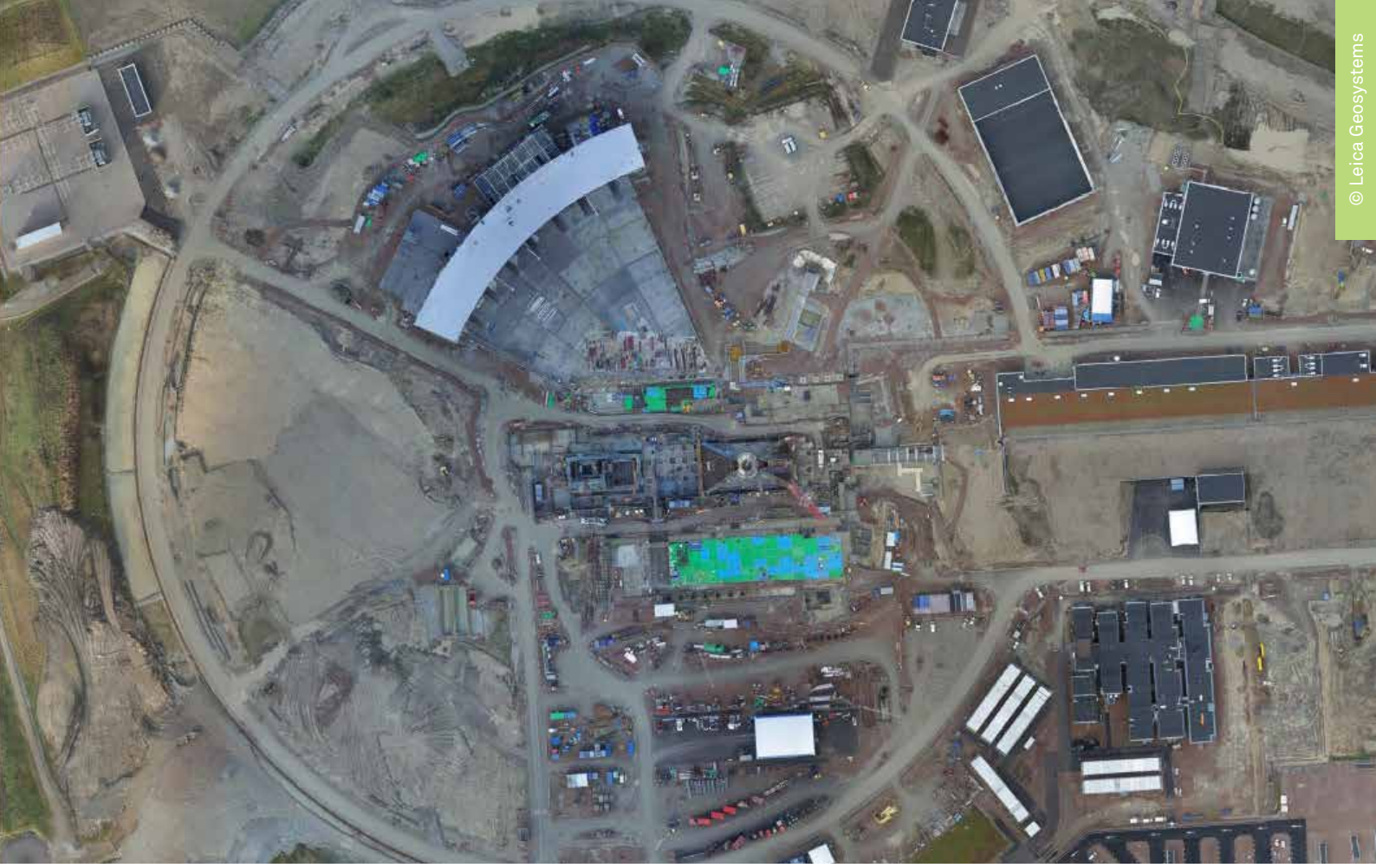
- Machine control
- GPS
- Total stations
- Laser scanning
- Rotating lasers.

UAVs will not and should not replace these solutions but can complete the view and put additional points in the right place. It is important for the UAV workflow to fit into the existing workflows and solutions. UAVs are an excellent solution for accessing hard-to-access areas, widening the view by covering the surroundings and combining aerial data with data collected from other systems.

STOCKPILE MANAGEMENT

Estimating stockpiles has always been a challenging task. Estimating by guess or by climbing isn't efficient or always safe. Knowing how much stock you have left, trusting that you have been invoiced correctly by your suppliers, and calculating the right time to reorder are important aspects for saving costs and project transparency.

Calculating volumes of stockpiles becomes an easy task when executed with a UAV compared to traditional surveying methods. With a UAV, it is fast, safe and easy to capture data from large or small areas from the air. This data is used to create a 3D model and make accurate volume calculations.



With a modern UAV solution, it is simple to make stockpile management an accurate process with automated missions; using the same flight plan and workflow repeatedly saves time and effort while ensuring the only change in the data collection is the amount of stock in the pile.

PROGRESS REPORTING FOR TRANSPARENCY

Having fresh data on every stage of the project as a base for coordinating workforces, machines, suppliers and subcontractors gives an undisputable advantage. Before UAVs, this has been a costly and even dangerous process. In construction sites with strict schedules, one must be able to cost-efficiently compare the as-designed to the actual situation of the site progression.

Flying and capturing data regularly, according to a pre-defined flight plan, provides a transparent view of the site progression throughout the project lifecycle and allows to document and compare the as-built status with the as-planned while tracking resources. This can be done safely from the air without disturbing the construction.

Having a constant flow of data from all phases of the project adds more transparency to the whole construction progress. Progress reporting can serve several different types of needs, such as communication with all stakeholders and planning for next steps. Users can use this data even for marketing.

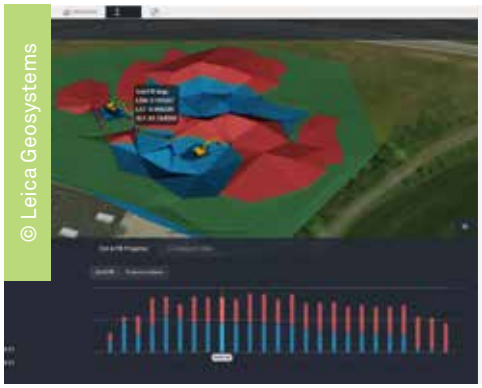
BETTER TOGETHER

Big hype in the market has been putting a lot of focus into UAVs being a “silver bullet” and a solution to all data needs. This has raised several questions whether it can really replace other technologies. Combined with existing traditional data collection methods, UAV technology can form a perfect union for smart construction data capture.

Changes in the regulation, flying beyond visual line of sight (BVLOS), and artificial intelligence will bring new opportunities to users who already know the process. We are just at the starting point of being able to use the possibilities of combining different technologies together.

Leica BLK3D recognised by prestigious global awards for innovation, engineering, design

The ground-breaking Leica BLK3D 3D imager has earned multiple prestigious global design and innovation awards, including the CES 2019 Innovation Awards Best of Innovation Honouree; the BAKA Award for Product Innovation 2019; the 2018 Good Design Award; and the Wichmann Innovation Award. Designed to impact the work of professionals across a range of industries, the compact handheld BLK3D improves productivity by enabling instant, precise 3D measurements from any image it captures.



Leica Geosystems further digitalises construction with new machine control solutions

The launch of two machine control solutions, the Leica MC1 software for excavators and the upgraded Leica ConX web interface, further the digital transformation of the construction industry. These latest machine control solutions collect, process and enable applicable intelligence in the construction phase of a project, empowering operators and machines to be smarter, safer and more effective.

Leica Geosystems introduces new entry-level construction layout tool

Designed for users moving for the first-time from conventional analogue layout methods to automated workflows, the new Leica iCON iCT30 is an entry-level construction layout tool for one-person short-range layout tasks in construction. The iCT30, combined with the construction-tailored Leica iCON build field software, is an easy-to-use and affordable solution to increase productivity by minimising labour time and mistakes, while increasing accuracy and speed.

Leica Geosystems announces new iCON manual construction total stations

The next generation of Leica iCON manual construction total stations, the Leica iCON iCB50 and iCB70, allow construction professionals to digitally layout complex structures, minimise delays and increase efficiency. With the construction tailored software iCON field across the whole construction portfolio, the iCB50 and iCB70 allow users to easily digitalise and embed BIM workflows in their construction processes.

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