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A Message from the President

With more than half of the world's population now living in cities, construction is on the rise across the globe. From housing to commercial buildings to building service facilities supporting growing communities, the construction industry is on a significant upswing.

Today more and more developers rely on digital blueprints to construct tomorrow's structures. Project Surveyors in Australia used Leica Geosystems 3D laser scanning technology to capture and model a major shopping centre for an international retail group, increasing the firm's productivity by more than 50 percent. In Switzerland, Grunder Ingenieure AG employed Leica Geosystems mobile mapping solution Pegasus:Two to capture the entire infrastructure of the Gotthard Base Tunnel, one of the world's longest traffic tunnels, conducting the as-built survey quicker, safer and more efficiently.

Reliable and safe transportation is important for a community's sustainability. Strukton, as part of an international consortium, is constructing the first public transportation system in the capital city of Saudi Arabia with an array of our precision measurement solutions. Sefiani Enterprises in Morocco is using Leica Geosystems machine control system to provide a smooth ride on the country's newest high-speed rail line, seeing savings of more than 15,000 Euros per day on the project.

On this construction journey, I'm glad we are able to support those who are shaping this onward surge of construction. Enjoy your read.

Juergen Dold
President, Hexagon Geosystems

Written by Benjamin Federmann

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LAND AIR WATER

Knowing the volume of material in a gravel quarry can be the difference between profit and loss. For Knobel-Bau GmbH, a company in the aggregates sector that manages gravel quarries, concrete factories and tar mixing plants, this information is critical for business success. That's why the firm relies on the engineering expertise of IngenieurTeam GEO GmbH (formerly known as Ingenieurteam Trenkle GmbH) in Karlsruhe, Germany, to accurately calculate and model its quarries.

Focusing on surveying engineering technologies, IngenieurTeam GEO was contracted to determine the remaining volume in Knobel-Bau's quarries. By creating georeferenced orthophotos and digital terrain models using the Aibotix Aibot X6 unmanned aerial vehicle (UAV), the firm was able to present the current situation in detail and provide an effective inventory reduction plan.

"With this detailed historical overview, our customer can coordinate the extraction processes more precisely," said Martin Schwall, owner and managing director of IngenieurTeam GEO. "This enables the customer to securely plan what to do with the remaining material, based on the most current and accurate information available."

COMBINING TO OVERCOME UNIQUE CHALLENGES

The gravel quarries of Knobel-Bau also include artificial lakes. An expertise of the company, IngenieurTeam GEO uses specially equipped boats for hydrography surveys. What was missing, though, was an aerial view of the entire quarry.

A longtime user of Leica Geosystems levelling and GNSS instruments, IngenieurTeam GEO first became interested in UAV technology when Aibotix became part of the portfolio in 2014. Streamlining surveying components into a fast and efficient process for projects was a key factor in pursuing UAVs for spatial data collection.

"The accuracy of the collected data is important to us, but also the reliability, functionality and quality of all surveying equipment," said Schwall. "We decided to use the Aibotix Aibot X6 UAV for its trusted reputation in the industry. We then trained one of our employees to become a professional pilot, and we've been able to expand our business. Since his training and certification, we not only offer surveying services on land and water but also from the air."

The aerial survey of the extraction site, including its artificial lakes, and the simultaneous hydrographic survey of the water using the special survey boat posed a specific challenge. Essential to this particular project, both tasks had to be precisely coordinated to provide Kobel-Bau with accurate information.

FLYING HIGH, MEASURING LOW

To create the common dataset for the most efficient deliverable, the various survey methods had to be linked, which required technical solutions and the pilot's expertise to generate reliable data. To obtain this, the firm devised an exact flight plan using Aibotix's AiProFlight software. Using an overview map, a waypoint flight plan facilitated precise planning of the autonomously conducted aerial survey.

"The open interfaces of the Aibotix workflow deriving from Aibotix AiProFlight and Agisoft PhotoScan Professional provide us with top quality data with virtually no loss," said Schwall. "We could then easily

combine the aerial and hydrography data seamlessly for one valuable deliverable."

The aerial survey was conducted after determining highly visible and suitable ground points for the georeferencing of the data. With the ability to immediately review the generated data (pictures taken with a high-resolution compact camera) after each flight, the survey quality was quickly validated. The camera, fixed to the free-floating gimbal of the Aibot X6 multi-sensor platform, enables the pilot and others to review the photographic material as soon as the UAV is on the ground. The images are added automatically during the waypoint flight and tagged with GPS coordinates that are generated by the Aibotix AiGeoBox mounted on the camera.

Calculations showed the project would need five flights each lasting six minutes to cover the 55 hectare area. The flight altitude for this kind of topography was established at 90 metres. Due to the wind conditions of the area on the day of the survey, the pilot decided to carry out a total of seven individual flights. As a responsible UAV owner, IngenieurTeam GEO flies the Aibot X6 in conditions of a maximum wind speed of 6 m/s to ensure safety.

Combined with the results from the hydrography survey, IngenieurTeam GEO was able to provide a complete overview of the site and the current situation that Knobel-Bau used to further its business.

"The combination of survey data from the air, from the ground and from the surveying boat has led to an excellent result. The orthophoto, the exact volume calculation and the 3D model of the gravel pit permit prospective planning and accurate assessment of the actual situation," said Bertram Knobel, managing director of Knobel-Bau. "The economic implementation of large-scale projects and the associated results of IngenieurTeam GEO is a decisive advantage in comparison to all conventional and traditional methods."

A GROWING POTENTIAL

Apart from this project, IngenieurTeam GEO uses the Aibot X6 with various sensors mainly for terrain surveys, surface evidence documentation and visualisation tasks, such as animations, simulations and 3D displays. With direct access to point clouds, the firm is accepting more and more complex projects, something it was unable to do in the past. After more than 45 aerial projects and about 350 individual flights, IngenieurTeam GEO continues to be impressed by the data accuracy of its Aibotix Aibot X6 while seeing nothing but positive ROI on its investment.

"Using the Aibot X6 for aerial data generation has allowed us already to reduce our outdoor process times from entire days to hours or even minutes," said Schwall. "We consider the interlinking of different Leica Geosystems technologies and the interaction between software and survey instruments to be the crucial difference to classical surveying methods and commercially available photo drones. This combo make it easy for us to generate data and to provide our customers with essential information."

Written by Katherine Lehmuller

SEEING THE ENTIRE PICTURE IN DETAIL

Nelson Surveys, based in Seaford, Australia, offers surveying services for some of South Australia's largest infrastructure projects. Whether steel or concrete bridge constructions, building or road setouts, as-built reporting or volume surveys, Nelson Surveys can tell you exactly what is on-site, supplying vital information for construction projects.

© Nelson Surveys

When significant upgrades are being made to infrastructure, Nelson Surveys knows how difficult it is to make sense of how the new design will fit with already existing features. Today's infrastructure is extremely complex, and surveying tasks need to be done quickly, reliably and with precision to remain on budget.

Surveying on such construction sites is no easy task. 2D line drawing plans offer little guidance to understanding structural complexities. Quite often jobs are delayed because of the need to check paper plans on-site. To be absolutely sure work is completed properly, surveyors and construction crews usually walk the site in order to understand what changes are going to be made. Such on-site visits add additional unnecessary costs and delays to already complicated projects.

ADDING INSIGHT TO TODAY'S COMPLEXITIES

It was little wonder, then, when Leica Geosystems released the new Leica Captivate software, Nelson Surveys was eager to use it for their time-consuming and complicated construction projects. With Leica Captivate, they could easily view measurements on interactive 3D point cloud scans. These scans are clear representations of infrastructure sections taken on site. These scans provide reality capture 3D design visualisations to better understand and verify construction projects in real time. Measurements can also be superimposed onto 2D colour images and linework can be assigned different colours for quicker identification of complicated plans.

All measurements taken can also be simultaneously viewed by both crews and surveyors on the display screens used by any instruments on site, such as Leica Geosystems total stations, handheld tablets or field


© Nelson Surveys

controllers. All work on site is referenced to just one plan that automatically links any data as it is collected, saving valuable time.

With these new features, Nelson Survey completed surveying tasks much more efficiently and increased productivity immensely.

SIMPLE AS A SMARTPHONE

Since the Leica Captivate software is so incredibly intuitive and familiar– just like using a smartphone – almost anyone could figure it out with little more than a swipe of the screen. The experience is also fun and enjoyable, and the professionals at Nelson Survey could hardly wait to put it to use.

One of the first projects Nelson Surveys used Leica Captivate on was a complicated road design of a concrete structure positioned on top of an underground storm water system. The structure is being built to support a parking area. The road base, or foundation layer, had already been laid, but due to its odd shape and a cross-fall for water runoff, crews had difficulty understanding what the finished design should look like.

Leica Captivate provided even the smallest details, and yet, the entire picture was always there. The software enabled fast and easy understanding for crews and engineers on site. Now crews could see all data: points, lines, scans, digital terrain models (DTMs), and alignments or data from DXF files in 3D at any location and from everywhere. All jobs could be completed using a variety of apps to make such tasks as staking out points and coding linework as simple as possible.

No longer were crews limited to 2D paper maps displaying lines without any visual references. Design lines could now be quickly understood with background information or 3D point cloud scans added. Nelson Boquin, director of Nelson Surveys, explains, "For anyone experiencing this for the first time, the world

of digital reality in construction is truly amazing. Leica Captivate has brought design data to life. Users can zoom, pan and rotate, as needed, to understand any project." Nelson Surveys choose to work with the Leica Captivate Road App, which is designed to import specific road data and complete road specific tasks as simply as possible.

Boquin adds, "This 3D software gives a great visualisation of what the final finished product will look like on site. Construction issues can be easily resolved with the aid of Leica Captivate by checking the alignment (horizontal and vertical) levels and grades."

FEWER TRIPS, BIGGER SAVINGS

Engineers now made fewer trips to jobs, with data captured on site feeding measurements directly into one-source documentation. With only one file for crews to share what was going on with engineers back in the office, unforeseen problems could be easily avoided and significant time and cost savings added.

"With Leica Captivate, engineers and surveyors can work together to see what can or cannot be done," said Boquin. "It saves a lot of time when you can do this on the ground rather than going back to the site office and refer to a plan.

"The Leica Captivate user interface, especially the 3D Viewer, is very intuitive. Different types of objects can be displayed, configured and inspected. You can easily interact with data directly, as it is collected. All points and measurements are scaled and users can see which objects are close or further away by the size of the point symbols and text next to it," continued Boquin. "Using the Leica Captivate is something new that we have been trying out. It will be something we will be using a lot more in the future."

Nelson Boquin concludes "Background imagery makes users more visually aware of what a jobsite includes. It helps us make better decisions in real time and ultimately helps us to increase productivity."

Written by Katherine Lehmuller

© Golden Construction

ESTABLISHING RELIABLE POSITIONS WITH SPEED

Working on a multi-family housing project in Colorado, US, covering six three-story apartment complexes, 25 townhomes and a clubhouse with a pool successfully kicked off a business relationship between Golden Construction and a local client. Leica Geosystems' iCON products enabled the construction crews on this project to work efficiently and consequently to bring big savings in time and money.

Golden Construction, LLC provides general construction services to clients in major industries, including medical, commercial, industrial, multi-family and educational fields. Based in Birmingham, Alabama, Golden Construction has been a customer of Leica Geosystems for almost two decades.

The housing project going up in Fort Collins, Colorado, is one of the largest multi-family projects under construction in the area and consists mainly of more than 300 one-, two- and three-bedroom units, to be completed by the end of summer 2016. One of Golden Construction's main tasks on this project, before concrete was poured, was to verify that plumbing and electrical items were in their correct positions. Another task was to establish control lines on floor slabs for the framing contractor to layout and build the wooden framework.

REDUCING POTENTIAL ERRORS

Making sure all of the plumbing is in the correct location has certainly been one of the largest tasks of this year-long project. All totalled, there are roughly 1,900 pipes to be installed throughout the buildings. The complex's plumbing and electrical contractors were using string lines and measuring tapes to carry out their layouts. With a project of this size, this method of layout is likely to contain errors leading to substantial problems in the building process, leading to higher costs.

© Golden Construction

© Golden Construction

In order to be certain everything is built as designed, Golden Construction opted to use Leica iCON robots. Golden Construction has confidence using Leica Geosystems iCON products because the results are very reliable. Since this was the company's first business venture into the state of Colorado, the project played an important role and successful verifications of plumbing, electrical lines and framework control lines were important to the completion of this project.

The vast amount of items to be checked and laid out represented a major challenge. Not only accuracy was important – speed was, too. Should the concrete contractors be delayed in pouring the concrete, it would be costly. Golden Construction decided on the Leica iCON robot 60 running the latest iCON field software. Also, the Leica iCON CC80 controller was used to facilitate point collection and transfer the data back to the office.

SPEEDY VERIFICATIONS WITH COST SAVINGS

Steven Denney, project support at Golden Construction, specialises in building layout and supports most project crews on-site with CAD drawings, point files and by establishing control points. Denney points out, "The ability to quickly find the problems and get that information back to the related trades helped them save time and money. If concrete pours were delayed because of time spent verifying the work, it would be costly to all parties involved and any rework after concrete has been poured could be detrimental."

Also commenting on the iCON build field software, he went on to say, "We found the Reference Line command to be really helpful checking points. This field software allows real-time distance readings that are relative to building lines (parallel and perpendicular) instead of just referenced to the position of the instrument. Information transferred this way is much more helpful and practical for field crews to know."

Using Leica iCON robot total stations enabled just one person to control all the work, fast and effectively. Golden Construction's Co-op Chris Dixon, a student at Auburn University in Alabama, was able to check the work extremely fast. Dixon could then also quickly pass the information on to the subcontractors, in the event that something needed to be corrected. Autodesk's AutoCAD software was used to take the information recorded in the field and overlay it with the building plan to verify that everything was in its correct position. The software was also used in the office to help with layout across all of Golden Construction's projects.

Project Superintendent Lynn Spradlin adds, "We could train a less experienced up-and-coming employee to perform layout like a seasoned veteran and repurpose our experienced superintendent to lead subs instead of staying behind the equipment collecting points."

Bonding a new, strong business partnership, Golden Construction has been able to grow its geographical footprint thanks to this first-time project with its new partner in Colorado. The firm's commitment to fast and reliable professional services as contractors has been the basis for the development for a new strong business relationship.

Written by Monica Miller Rodgers

SCAN TILL YOU DROP

When an international retail group approached the Australian surveying firm, Project Surveyors, about creating a survey-accurate architectural and structural Revit model for the country's second largest shopping centre, the firm was excited to participate. When the deadline was set for only 90 days later, Project Surveyors knew while future centre customers may shop till they dropped, the firm's seven qualified laser scanning surveyors would be doing the same with 3D laser scanning.

The Sydney shopping centre is currently undergoing redevelopment, and the client needed a fully-parametric Building Information Modelling (BIM) model for architects, engineers and facility managers to accurately plan the work needed. Covering a space of 375,000 square metres with various dimensional obstacles, such as cascading floors, topographic level changes and add-on buildings of diverse sizes, Project Surveyors faced one of its most complex jobs in its 43-year history.

"The enormity and complicated aspects to the building meant that our surveyors had to be meticulous when documenting scan positions and on field notes to assist in the registration of scans," said Andy Jackson, Project Surveyors' BIM Spatial manager. "With our Leica Geosystems instruments and software, we could ensure this."

SCANNING, MODELLING WITH CONFIDENCE

Project Surveyors used a variety of Leica Geosystems solutions to capture, model and analyse the data. Starting with the Leica ScanStations C10 and P20, the surveyors were able to capture minute details. The Leica ScanStation C10 was used for the external facades and inside for large structures, such as the parking garages, due to its long-range capability. Inside, the Leica ScanStation P20 was used for its quality of producing reliable data at fast speeds.

"The fast scanning time of the P20 helped us improve site workflow, increasing the number of scans per day fourfold," said Jackson.

For survey control, Project Surveyors used the Leica TS15 and Leica Nova MS50 MultiStation. The MultiStation was also used to scan windows for simpler capturing. Establishing a survey control network around the perimetre of the site and throughout the shopping centre at each level, these instruments ensured millimetre precision for aligning scans of the retrofitting construction. Laser scan targets were coordinated within the control network to maintain the accuracy of the overall point clouds.

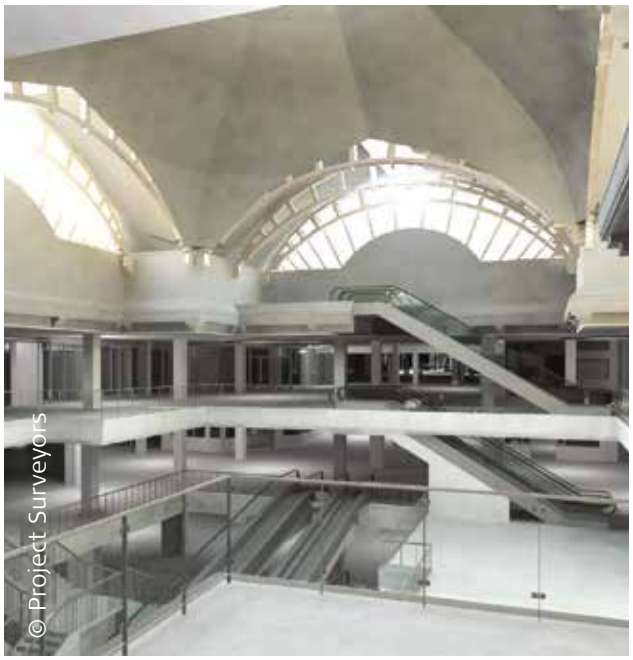
A total of 3,700 scans from 55 days on site resulted from the project. The point clouds from these scans were cleaned and registered using Leica Cyclone 9.0. The entire process only took 20 days due to the addition of the auto-alignment registration within the software. Compared to cloud-to-cloud visual alignment, which would take around two minutes each to visually find common points, auto-alignment only takes 30 seconds to one minute.

"The time does not sound like much for a few scans, but when we're talking about thousands of scans, this becomes a significant amount of time saved," said Jackson. "With these savings, we were able to increase our productivity by at least 50 percent."

The firm also used Leica TruView to provide the architects with the point cloud data so they could overlay in the model and have extra information, such as dimensions they needed to extract for accurate and realistic planning.

"Leica Truview images were a deliverable for the client, but they also helped the modeller to have a complete understanding of what they are modelling over," said Jackson.

Autodesk Revit 2014 was used to model architectural elements while Autodesk Revit Mechanical, Electrical, Piping (MEP) was used to create pipes, plant, ducts and other services to create a partial MEP model of the loading docks. As the size and detail of this project would have taken one modeller 120 days to complete, Project Surveyors worked with a team of modellers in collaboration on one central model across a wired and large-data network.



Using the export option in Leica Cyclone 9.0, the surveyors exported the point clouds either separately as binary ptg files or unified as pts files. Autodesk Recap was then used to convert the files into Autodesk-compatible rcs files, which could then be inserted into Revit and modelled over. Using Leica Cloudworx for Revit, Jackson added that the exportation and conversion steps of the workflow would be eliminated, providing modellers with point cloud conversion tools as well as a single master data source rather than multiple files and versions of files to deal with.

"Using this laser scanning technology, we have won similar large projects, such as one in Sydney where we're working with the same consultants who used this model as an example to the project owner of what they required as survey information," said Scott Deveridge, Project Surveyors director. "Referrals to provide a similar service on another challenging project is the best feedback we can get."

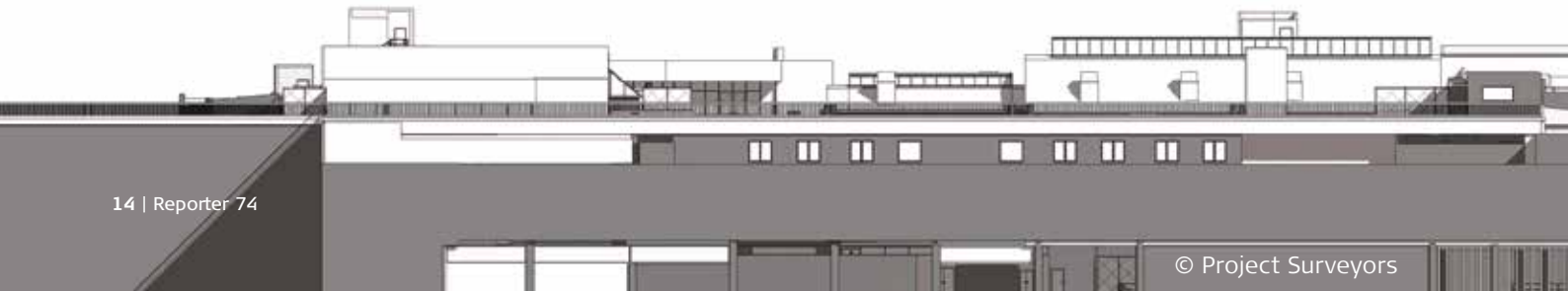
LESSONS LEARNED FROM HXGN LIVE

With attending HxGN LIVE 2014 in Las Vegas only a few months before the start of the project, Project Surveyors found the shopping centre project a valuable opportunity to put some of the lessons it learned at the international conference and exhibition to practice. Using these new ideas, the firm realised an approximate time savings of 75 percent.

Using scan-to-scan registration and auto alignment, the firm decreased its dependence on targets for every scan. The surveyors also used a lower resolution, kept the scanner operating between setups, and created a wheeled-transport tripod to relocate the scanner faster.

"Whereas before we were only able to collect about 16 scans per day, using what we learned from HxGN LIVE, we can now collect anywhere between 60 to 80 scans per day," said Jackson. "We are also registering about 30 scans per hour, twice as much as before. This translates into significant efficiency gains, and therefore cost savings, for us."

Returning to HxGN LIVE 2015 in Las Vegas, the project took top honors in the annual Leica Geosystems High-Definition Surveying (HDS) Plan Contest. A panel of



11 qualified judges evaluated 24 entries based on the completeness and usefulness of the plans, the creative use of point clouds and models, and overall appearance. Project Surveyors took first place with the project in the Buildings/Heritage category.

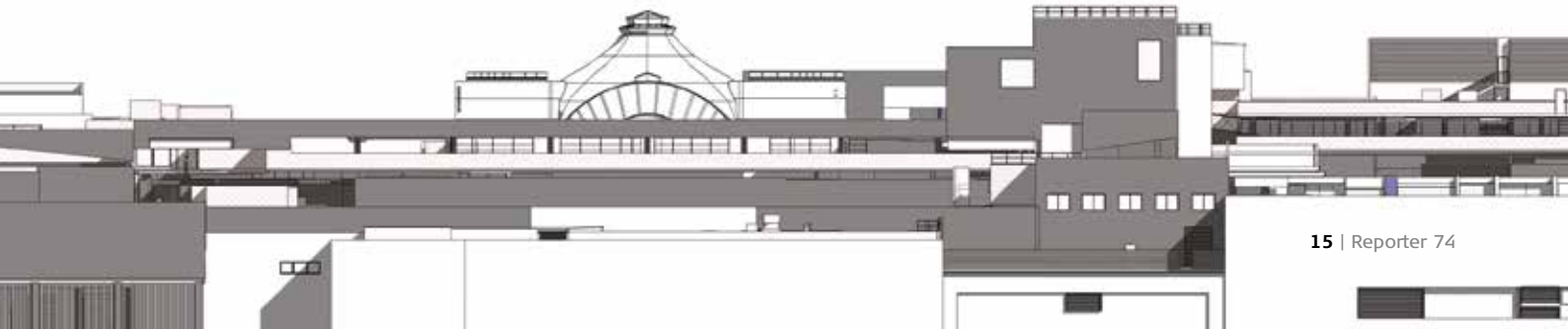
"Our team has worked hard, and we are always looking for innovative ways to improve our business," said Jackson. "Winning this award confirms our commitment to the profession and our dedication to the clients."

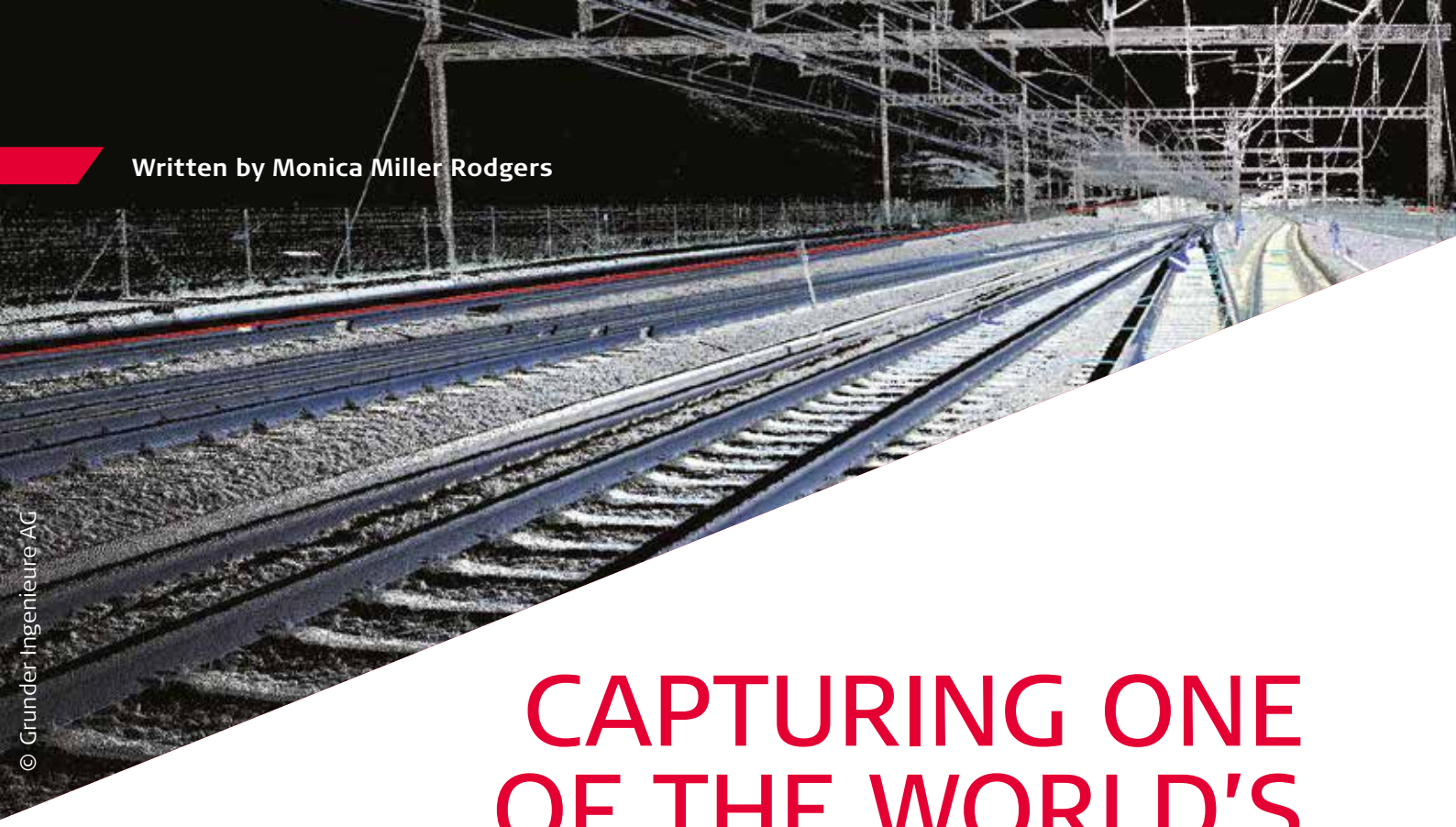
A PRIME EXAMPLE

Another aspect of the Sydney shopping centre project is the innovative use of HDS in BIM. Through the use of a variety of HDS techniques in the field and in the office, Project Surveyors was able to organise and collaborate building information across an accessible platform.

"Using laser scanning in BIM helps us to have a complete understanding of what's already there, what needs to be done, and how well the building process took place," said Jackson. "Using laser scanning in BIM allows us to provide value-added deliverables to our clients."
This project is an ideal demonstration of making the real digital world. As HDS captures the most current and accurate situation, professionals can then implement that data into software programs, such as Leica Cyclone or CloudWorx for Revit, to produce the realistic workable models. Exact adaptions can then be made so that when work is carried out on site, intelligent information is clear and error-free.

"The technology of HDS provides the tools and workflows needed to accurately and definitively capture digital assets in minutes," said Faheem Khan, vice president, business development manager for Leica Geosystems HDS. "Being able to capture, manage and deliver information and knowledge to all stakeholders underpins our strategy to provide the fastest, cleanest and most reliable hardware as well as a software portfolio that scales for all project sizes, disciplines and users."





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Written by Monica Miller Rodgers

CAPTURING ONE OF THE WORLD'S LONGEST TUNNELS

When the Gotthard Base Tunnel officially opens in June 2016 as part of the New Rail Link through the Alps (NRLA), a construction project 20 plus years in the making at 9.8 billion Swiss francs will be one of the world's longest and deepest railway tunnels. At 57 kilometres long and with a rock overburden of 2,300 metres, the tunnel increases the total transport capacity across the Swiss Alps while reducing passenger travel time between northern and southern Europe by one hour. With minimal gradient and wide curves, the route is also a flatter, lower-level journey at only 550m above sea level. The whole tunnel system measures a total of 152km, plus almost 50km of new built outdoor tracks.

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When Grunder Ingenieure AG, a leading Swiss engineering firm specialising in rail surveys and long-time user of Leica Geosystems solutions, was sub-contracted by the Alptransit Gotthard AG, the firm knew it would be a challenging task but one for the history books. One of the main tasks, before the tracks open for the test operation, was to capture all the infrastructure of the tunnel for as-built documentation.

"There are several stakeholders working on the overall project, and we were tasked with registering the entire infrastructure to collect for the infrastructure database of the Swiss Federal Railways. All these users can now access this information," said Gilbert Roulier, Grunder's director of Imaging, Laser Scanning and Mobile Mapping. "Entering the under-construction tunnel and outdoor tracks also presented organising challenges that we needed to account for with our engineers and surveying instruments."

The firm selected the Leica Pegasus:Two to safely and efficiently capture the entire infrastructure of the newly-built open tracks. In combination with Leica Geosystems total stations, Grunder was able to provide a complete database of 3D imagery and point clouds covering the rails, signage, posts, electrical lines, and further installations and structural elements.

ON THE FAST TRACK

Facing a very short and divided up timeframe of only a few weeks, Roulier and his team knew they needed a fast and efficient method to capture all the available data. They found this in the Leica Pegasus:Two's seven cameras providing full 360-degree dome imagery combined with the scans of the onboard LiDAR profiler.

Easily attaching the capture platform to the prototype of the firm's specially-designed rail trolley, the engineers were able to quickly and effectively maneuver over the outdoor tracks to collect a few billion points. By constantly capturing data on the move without disrupting ongoing construction, safety increased for Grunder and other employees. No longer were the surveying engineers required to trapeze through a risk-filled construction site, and construction workers no longer needed to worry about avoiding surveyors or instruments set up in the midst of their site.

"This non-contact and kinematic measurement ability allows us to record everything without interruption, significantly decreasing risks," said Roulier. "This mobile method also reduces the effort, saving the entire project on costs and time, with benefit for all working stakeholders."

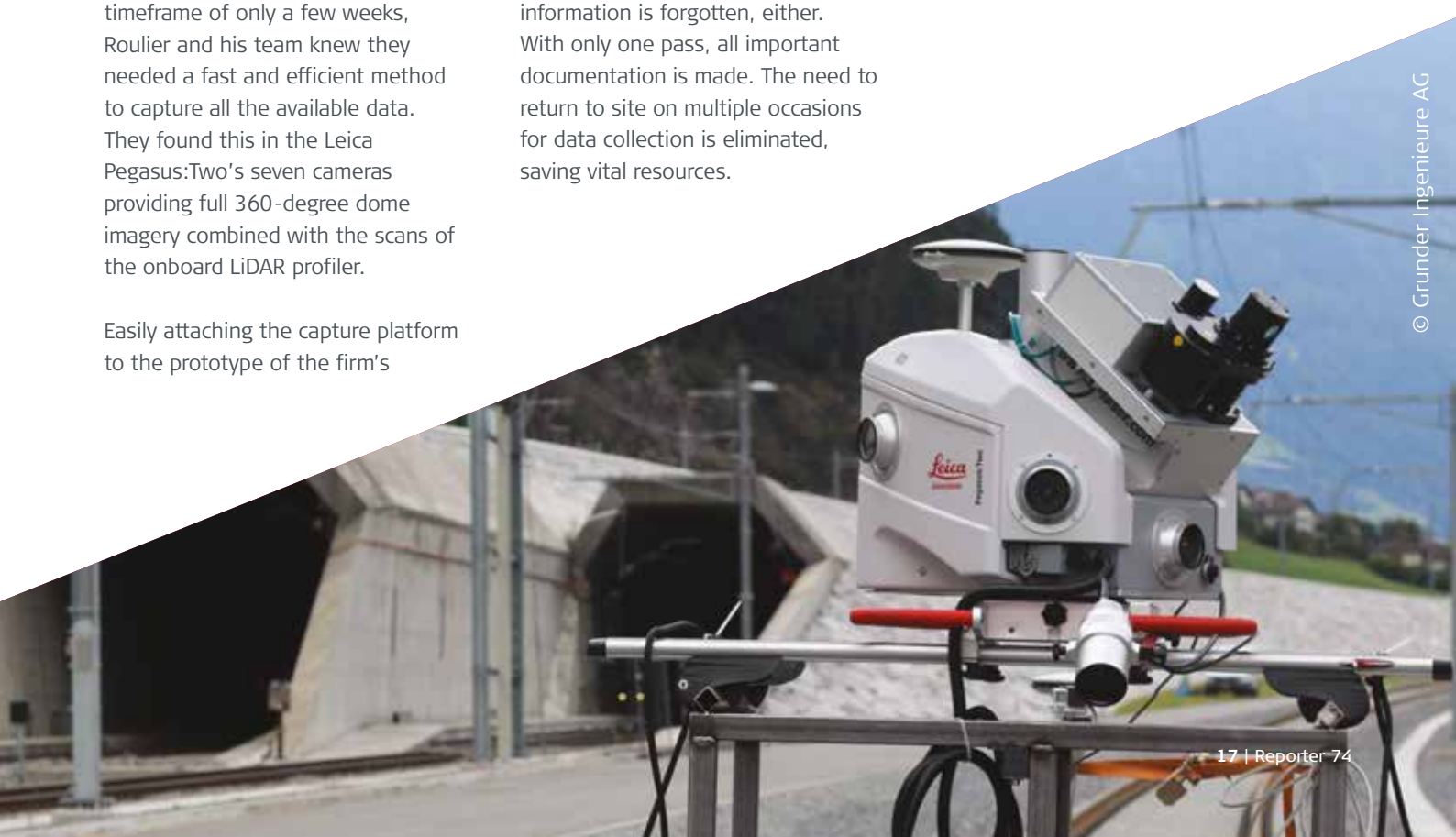
With the complete 3D surround capture of the Leica Pegasus:Two's images and point clouds, no critical information is forgotten, either. With only one pass, all important documentation is made. The need to return to site on multiple occasions for data collection is eliminated, saving vital resources.

SENSOR MERGING FOR DIGITAL REALITY

With the combination of imaging and scanning data, all visual information is brought to reality. The Leica Pegasus:Two and reality capture solutions marry traditional surveying technology, such as positioning systems, laser scanning and radar imagining, into one convenient and easy-to-use platform. A complete and fluid workflow follows reality capture of calibration, post-processing, object extraction and GIS storage.

Enabling the engineers to work with the most accurate and current representation available, the open tracks were presented in 2D and 3D display for maximum manipulation capability. In the rail industry, working with highly realistic models translates into safer design, faster production and reduced costs.

"Being able to provide such a detailed dataset to the stakeholders enabled all interested parties to conduct their work swiftly and successfully," said Martin Baumeler, Grunder's managing director. "The Leica Pegasus:Two increases our business and ensures we provide quality deliverables to our customers."



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Written by Fabiano Moura

MASTERING BIG DATA IN MINES

Three years ago, Mexico's Cobre del Mayo (CDM) was attempting to solve common, yet complex issues at its open-pit copper mine in southern Sonora, 21 kilometres from the town of Alamos. That's when the company started using Hexagon Mining's fleet management solution. The results are impressive.

THREE CHALLENGES TO OVERCOME

The geology of the mine presented CDM with its first mining challenge. CDM produces grade-A copper cathode, supplied as refractory, and vein-type ore for processing into concentrate. The mine is a copper porphyry system, structurally controlled by shear faulting with mineralisation stockwork, disseminated and variable depth ranging oxidation.

Oxidation is from the surface up to 430 metres, with chalcocite from 40 to 430m. The challenge lies in two types of minerals that cannot be processed the same way. The dominant alteration is quartz-sericite and sporadic areas with intense argillic alterations, meaning that close control is essential in the dilution and the selectivity of the ore.

The next challenge to overcome was fleet management. CDM's fleet comprises the following:

- Three hydraulic shovels, Komatsu and Terex
- Two retro excavators, Komatsu and Caterpillar
- Three loaders and three high-precision first loaders
- 26 haul trucks (20 789s and six 777s)
- Three drills, Sandvik, D75KS and a high-precision dozer
- Auxiliary equipment, including dozers, graders and water trucks
- Retro excavators, which are roughly the size of the ore polygons (deposit areas)

The potential 2,000 tonnes in one polygon make a system for dilution control essential.

Finally, tracking and reporting can be an overwhelming task.

CDM must deal with waste in various forms, from low-grade to medium- and high-grade. Constant awareness of waste type is important because the loading equipment can be working with three or more polygons simultaneously, requiring frequent changes from truck to truck. So, like any mine, fleet management is important to CDM. The complicated ore distribution means CDM's teams of operators must use the best tools to avoid dilution and improve selectivity.

Even great systems and great tools can fall short, however, if reliable and accurate reporting is not part of the process. Since CDM began commercial production in 2006, operators had compiled reports manually in the absence of an automated reporting process. Truck operators would include their cycles from origin to destination, and the dispatcher would capture all the information from the operators by hand and compile them. CDM tracked usage times and equipment delays by hand and by radio. Real-time alerts of delays were unavailable and receiving reliable data from the drill operator was difficult. Without a system to automate tracking and reporting, valuable time was being squandered.

HEXAGON MINING SOLUTION SELECTED

Hexagon Mining's fleet management solution, Jigsaw, was among six systems evaluated by CDM to help solve these issues. After careful analysis, CDM selected Jigsaw.

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© Cobre del Mayo

"The best option was Hexagon Mining," said CDM's Dispatch Manager Victor Rodriguez. "The evaluation process was done in the form of a cost evaluation, as well as with a group of people who visited various mines. Most of them were in Chile and observed first-hand the Jigsaw system working."

Less than two months later, initial hardware and software were deployed and CDM went live with Jigsaw. CDM began officially logging reports with Jview, Hexagon Mining's business intelligence suite shortly after.

The system installation included a room for the dispatch in the highest part of the mine. This offered a full view of mine operations via visual controls. Three 52-inch screens were installed to display different dashboard views of the mine. Each dispatcher was supplied with three additional 32-inch screen displays. The smaller screens manage the roads on Jview and allow for real-time reports. The other dispatcher handles control of the operation and production equipment, including loaders and trucks.

For CDM, the core implementation timeframe from first installment to go-live was roughly three months. Like most mines, CDM's overriding objective is to produce more while lowering costs. Armed with Hexagon Mining's fleet management solution, CDM was quickly able to increase safe mining operations and production output, while managing cost, quality and control.

REAL-TIME INFORMATION FOR BETTER DECISION MAKING

Now CDM has designated maintenance dispatchers equipped with the proper notification systems, preventing maintenance issues from draining time and resources. Operators needing support or experiencing problems with equipment can speak directly with maintenance or text messages from the system, thus reducing radio frequency demands.

The primary crusher is now monitored in real time. Any delay generates an immediate alert, avoiding the need for phone calls or radios, which can sometimes be unreliable. Individual dumps in the crusher, waste, leach pads, and stockpiles are monitored and reported on. With multiple destinations, every truck is unloading exactly where and when it needs to be.

"Prior to partnering with Hexagon Mining, it had been extremely difficult for us to achieve precision in our extraction, given the size of our equipment," said Rodriguez. "Since the implementation, significant improvements have been achieved in our ore control, as can be seen in our current production increases.

"The solution provides reliable and flexible and automatic reporting, for production, productivity, availability, drilling information, and many other aspects of the mine operation," concludes Rodriguez.

ON THE FAST

Building Information Modelling (BIM), the completely digital and 3D structural work lifecycle, is sweeping across the industry and moving professionals into the future at incredible speed. To help understand this fast-growing and ever-popular concept, Leica Geosystems BIM experts around the globe, Bernd Moeller (Global), Mark King (Europe, Middle East, Africa), Owen Williams (Asia Pacific) and Cathi Hayes (North America), share their insights.

IN THE PAST FEW YEARS, BIM HAS SEEN A REMARKABLE GROWTH. WHY IS BIM BECOMING SO POPULAR THROUGHOUT THE INDUSTRY?

Moeller: Due to the fact that BIM is designed as a process and in the meantime is also understood as such by most parts of the construction industry, it can help improve efficiency at multiple phases of the life cycle of a building or other constructs. Similar to our development processes where teams are aiming at identifying and minimising risks at an early stage in the project, BIM does exactly the same. It's common sense that the ability to impact costs goes down over time (of a project), but the cost of changes go up. In order to keep the "scope of action" high, the objective of the construction industry is to shift the planning process to an earlier point in time. To achieve this, BIM as a coordinated approach across all phases and involved trades, allows to keep control of cost overruns, schedule slippage, communication between all involved parties, transparency, planning of labour and material, and finally to stay competitive by doing more with less.

The integration of actionable information based on measurement and positioning technology further increases the quality of the BIM data. Capturing the reality by laser scanning as base for construction model designs, progress verification during construction or clash detection and as-built checking, is as beneficial as transporting design model geometry to the construction site, where the same digital model information is applied by means of laying out points and lines with total stations to immediately construct from. Especially to satisfy the desire for complex structures makes the use of such technology almost indispensable.

King: The construction industry around the globe historically has been focused on a here-and-now approach with assets constructed as one-offs and individual disciplines working in isolation. Now BIM is attempting to bring the process driven approach that industries, such as engineering and oil and gas, have been using for years. Projects that have implemented BIM processes are seeing positive ROIs, but with more countries making BIM a legislated requirement, it is no longer if BIM should be implemented but rather when and how successfully. Adoption of BIM has still not truly hit the masses of our industries, but there has been significant adoption in companies focused on design and within larger contractors and sub-contractors where the biggest positive impact can be seen. There is still some way to go to ensure the whole supply chain adopts BIM, but many contractors are now switching the focus away from their internal process improvements to that of their sub-contractors and to the construction site itself. Companies want to eliminate wastage and rework through the adoption of more digitised and technologically advanced workflows. In simple terms, companies want to get the right information to the right people at the right time.

Williams: Many governments around the world are engaging BIM with mandates and setting industry goals. Countries such as the US, and UK are leading the way with others in the APAC region such as Singapore, Japan and Australia following suit. Major contractors all have BIM teams to encompass and help sub-contractors with their deliverables and working methodology. For contractors, the benefits are many:

- Complete access to original project data from the BIM model
- The ability to visualise what will be built through a digital model
- Information from the model can be used in your control system
- The ability to create multiple "what if " scenarios
- Fewer on-site errors and changes due to BIM being used from the early phase

TRACK OF BIM

Hayes: In the past, digital models created in the office have typically been converted to 2D paper drawings for use in the field. This leads to guesswork and manual layout processes, which can cause errors that might not become evident until later in the construction process. Additionally, on renovation or retrofit projects, the models themselves might contain errors since many models are developed from outdated and inaccurate as-built paper drawings. These inaccuracies also lead to problems in the field during construction, which drive up project costs, increase risks and even derail entire projects.

In an ideal BIM workflow, the data remains digital all the way through the process. First, the project team captures reality and informs the 3D model with highly accurate as-built point clouds. New design models are then created around the accurate as-built data, and construction layout points are added to the model. These points are then replicated on the jobsite using tools, such as robotic total stations, to bring 3D models to reality. During construction, as-built information is captured with high-accuracy robotic total stations and high definition scanners. The accurate discrete measurement points and point clouds are compared against the as-designed model to immediately identify deviations and head off expensive downstream coordination issues in the field. The result is a lifecycle process that brings reality into BIM and BIM into reality for a holistic building construction approach that minimises rework and maximises efficiency, predictability and profitability.

HOW IS THE BIM ADOPTION RATE IN YOUR SPECIFIC REGION?

Moeller: From a global perspective, the markets are in different phases. In the US and Canada, construction companies are very open to adopt BIM. The dominance of key BIM authoring tools helps stimulate the market (studies on efficiency arose mainly in the US), so the sensitising simply is very high. In Europe and the Middle East, the markets are either led by early adopters (typically big construction companies) or regulations by the different countries to apply BIM for public projects. This legal push increases the necessity of contractors to find appropriate BIM solutions to rollout across their complete businesses. Many of them are in the process of evaluating which solutions fit best to the companies' setup or are piloting solutions on test projects. The markets are rather fragmented, crystalising in various BIM authoring tools across the many European countries. Also applying BIM processes for infrastructure projects has been pushed for, especially in the Scandinavian countries. In APAC, Australia and New Zealand are greatly influenced by the impulses from the US. Contractors are keen to apply proven theory into practice.

King: From one country to another, adoption rates vary across the region. This also includes the different industries in which BIM is being adopted, with some areas seeing a higher adoption in infrastructure than in building construction. Within EMEA, the UK has been vocal in its ambition to adopt BIM, with an aim to reduce the cost and carbon output on government funded construction projects by up to 20 per cent. Its target of April 2016 to hit 'Level 2' BIM has accelerated the UK industry to adopt BIM. Other countries, such as Spain, France and Portugal, have begun the development of standards and strategies to increase the adoption of BIM. Groups have been set up to support and advise both the government and companies, using industry experts to define the roadmaps and requirements for each unique country and culture. With anything that requires change and adoption of new processes and technology, people can be resistant - particularly if they are confused or disappointed with the potential change. BIM is no different, with much of the work for successful adoption relying on gaining buy-in from all stakeholders and proving the real value, whether that be through improved quality or reduced costs.

Williams: BIM adoption rates in APAC are wide and varied. Statistically there are high adoption rates in Singapore, Korea, Japan and New Zealand. Governments in APAC are starting to deploy new regulations regarding the building construction permit. Japan, South Korea and Singapore have already included BIM documents as mandatory requirement, especially for public buildings, alongside green certification related documents. On the other hand, Hong Kong, India and Malaysia are starting to evaluate

and only just starting the process. Other countries are expected to follow.

The current issue in APAC, especially Southeast Asia, is the Technology Block. Many people are providing BIM data but reverting to standard practices down the chain. The term "Shadow BIM" has been used.

Hayes: BIM adoption in North America is growing. According to the SmartMarket report, "The Business Value of BIM in North America," published by McGraw Hill Construction in 2012, overall adoption of BIM increased from 17 per cent in 2007 to 71 per cent in 2012. In a global report published in 2013 ("The Business Value of BIM for Construction in Major Global Markets"), 24 per cent of respondents reported "heavy" use of BIM (using it on 31-60 per cent of all projects), and 28 per cent reported "very heavy use" (more than 60 per cent of projects).

Despite this growth, there are some challenges. One hurdle is that many field teams are still working in 2D. They don't always have the easy-to-use 3D field tools available to them, and they might not even be aware of the solutions that exist. They also distrust the 3D information coming from the office because it hasn't always been accurate in the past. Having the right tools in the field is imperative to overcoming these challenges.

Recent developments are making BIM easier and lowering the barrier to entry. For example, Leica iCON build is very easy to use and provides the ability to overlay 3D models with layout points in the field; the Leica ScanStation P16 with one-button-push scanning is helping to democratise scanning in construction; and the automatic registration and visual alignment capabilities in Leica Cyclone makes it easier for contractors to use point clouds on their construction projects.

WHAT ADVICE WOULD YOU GIVE PROFESSIONALS LOOKING TO START A BIM PROGRAM OR IMPROVE AN ALREADY EXISTING ONE?

Moeller: An internal as-is and gap analysis and their alignment with the strategic direction would be the starting point. Also, the user should decide if his organisation needs to apply BIM in just the "office space" as means to, for example, reduce risk in the planning phase and as a collaboration tool between the stakeholders, such as owner, architect, structural engineering, trades, etc. Or, if the goal is to realise a complete BIM Field Trip (bringing reality to the design model and the model to reality), then a thorough approach involving all groups in the process chain is required, including their buy-in for the new or adapted technology and tools - from design and data champions to foreman and field engineers.

From there, several options exist to adopt BIM. There are solutions for entry level BIM, for BIM in quality assurance/control, for planning and project control, for collaboration, material and contract management, and documentation.

King: With the growth in adoption of BIM within the design office over the past five years, organisations are starting to turn their attention to the link between this digital world and reality. This link is often missing in projects and can be the cause of costly mistakes and litigation. Leica Geosystems has a long history of delivering innovative and reliable solutions that deliver when it has to be right. Our experts in both the field and office can provide guidance and expert advice on best practice and on solving today's issues.

Williams: Generally it is the main contractor who is mandated to provide BIM deliverables and work with their sub-contractors to implement BIM systems and practices. Today, it is generally seen that BIM is important, but many small to mid-sized contractors are unaware and revert to "normal practices," unless they are assisted by BIM experts from the main contractors. This affects the use of BIM in the construction and quality assurance work periods. We have identified this as a gap in the market, and we have seen this with customers time and time again. For example, many MEP contractors may not know what to do with the data and how to set it out accurately.

Leica Geosystems can deploy the right hardware and software to assist in the construction and as-built environment, assisting customers to implement BIM guidelines, thereby, improving efficiency and ROI. Through partnerships with Autodesk and internal software, such as LISTECH Neo, we are able to streamline our offerings to the BIM world and improve workflows. It has never been easier to implement full 3D IFC data on total stations or GNSS, setting out and checking exactly what the client needs.

Hayes: Simply choose a starting point and build up from there. The simplest way to begin is with digital layout using paper, 2D CAD or 3D models. Easy-to-use, highly accurate tools, such as the Leica iCON robot, combined with intelligent, intuitive field and office software create an easy on-ramp to BIM for concrete layout, MEP layout and quality assurance. Another common on-ramp to BIM is pre-construction validation with laser scanning. Here, Leica ScanStations capture existing building conditions in the form of near photorealistic, highly-accurate point clouds that can be used directly in Revit for faster and more accurate modelling or in Navisworks for automated clash or anti-clash detection to help mitigate change orders during construction.

For digital layout, high-precision Leica iCON robotic total stations combined with intuitive field software creates a "paint-by-numbers" installation in the field that reduces errors and provides a higher level of predictability of project outcomes.

For pre-construction as-builting, layout and quality assurance, the innovative new "BIM One Box" Leica Nova MS60 MultiStation performs robotic layout with ease while the field software tracks the layout locations. When quality control checks are performed, any deviations are identified in real time with a BIM delta report and can be easily scanned with the same device, producing point clouds that are automatically oriented and positioned so they flow back into the model perfectly aligned. This substantially reduces post-processing so teams can focus on comparing field data with model data to avoid rework in the field.

Contractors experienced in BIM and ready to take their capabilities to the next level will want to combine hardware solutions, such as the innovative MultiStations, ultra-fast high-definition laser scanners and high-precision robotic total stations, with full-featured field and office software to create advanced 3D workflows that streamline and optimise

preconstruction as-builting, construction layout, and quality assurance as-builting. It's worth noting that the MultiStation introduces a new era of versatility in BIM workflows with the ability to use a single instrument for pre-construction as-built point cloud data capture, replicating highly accurate BIM layout points in the field, and then high-definition laser scanning for quality assurance as-builts for comparing with as-designed models to create a complete 3D BIM lifecycle.

Bernd Moeller is the Leica Geosystems global senior product manager for Construction & Engineering. He is a graduate engineer in Surveying and Geomatics and holds a Master of Advanced Studies in Business Administration and Engineering.

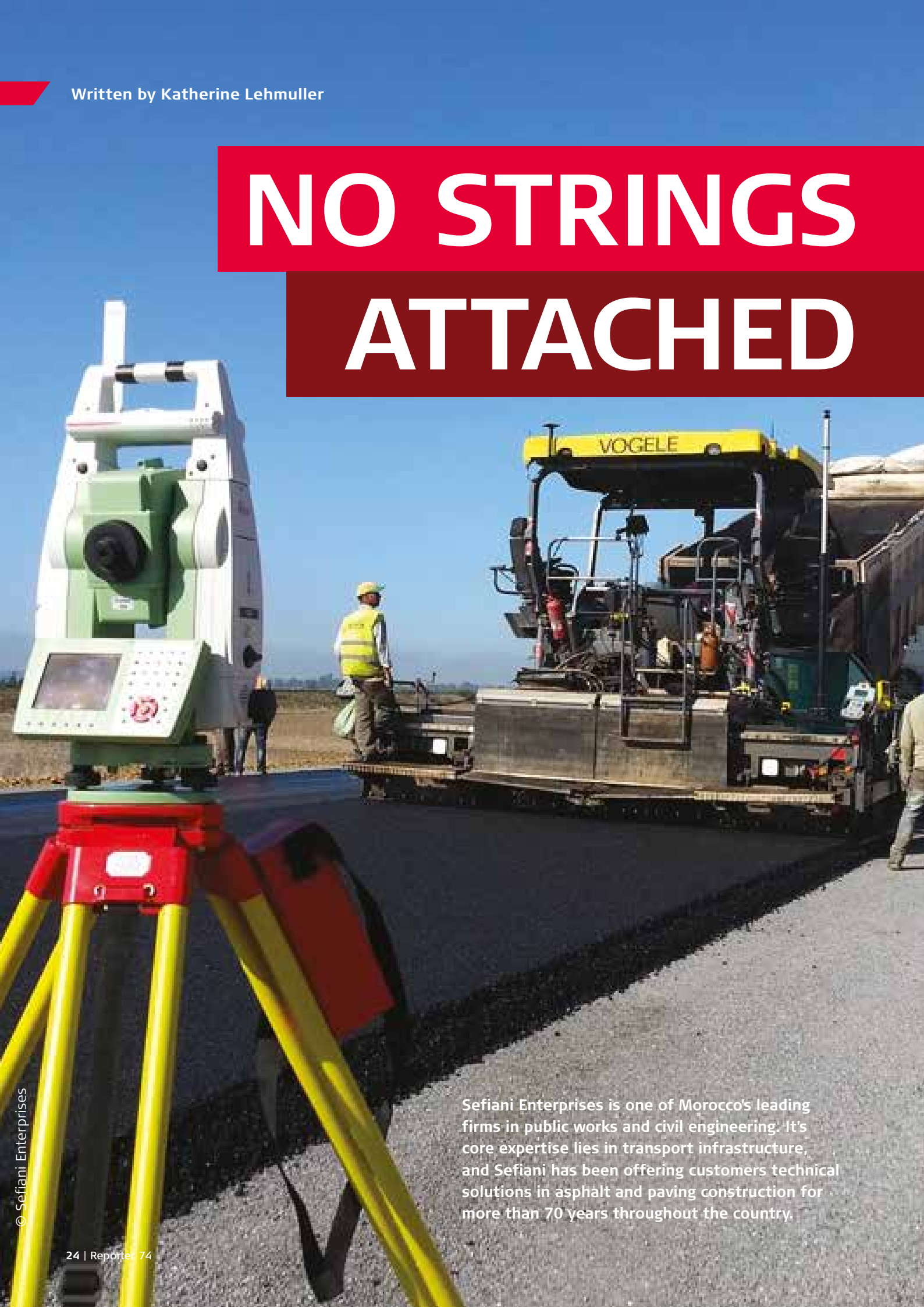
Mark King, a former BIM project manager at an UK survey company, now serves as the Leica Geosystems EMEA BIM Solutions manager. He holds a Bachelor of Science in Industrial Design.

Owen Williams is the Leica Geosystems APAC segment manager for the Machine Control Division. He holds a Bachelor of Science in Surveying and Mapping Sciences.

Cathi Hayes serves as the Leica Geosystems NAFTA director of BIM Strategy and Business Development. She holds a Bachelor of Environmental Design in Architecture and Professional Bachelor of Architecture.

Written by Katherine Lehmuller

NO STRINGS ATTACHED



Sefiani Enterprises is one of Morocco's leading firms in public works and civil engineering. It's core expertise lies in transport infrastructure, and Sefiani has been offering customers technical solutions in asphalt and paving construction for more than 70 years throughout the country.

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Recently, Sefiani began working on the high-speed rail line between Tangier to Kénitra, known as the LGV. With trains expected to travel a top speed of 320 kilometres per hour on the new line, it is important that paving quality be perfect. Customers therefore set this as an important condition for Sefiani to fulfil along with reducing operating costs. With these requirements in mind, Sefiani began using the Leica PaveSmart 3D Machine Control system on its asphalt paver.

"It is the first Leica PaveSmart 3D system we sold for an asphalt paving application in Morocco," proudly states Slim Meslameni, Leica Geosystems' North Africa sales manager. "Our customer informed us that the project's set targets were easily achieved, using the Leica Geosystems Machine Control solutions. Without a doubt, we have now set a new quality standard in the local paving market."

EXCELLENCE IN TRAINING

Leica Geosystems' paving application expert, Michalis Karizonis, was asked to train the Operating Asphalt Team at Sefiani Enterprises, concentrating on specific project needs. For an entire week, the team focused on the three important performance pillars: quality, quantity and simplicity.

Training began with an explanation of the individual hardware components followed by mounting procedures and settings for the asphalt paver equipment. In this case, the paver used was a Vögele Super 1800-2, which was adapted with the Mobamatic 1 levelling system. Using Plug & Play, the Leica PaveSmart 3D was quickly and easily connected to the Mobamatic asphalt paver. Almost all concrete slip form machines, asphalt finishers and milling machines from industry-leading paving manufacturers, such as Bomag, Dynapac, ABG and Vögele, are supported and work seamlessly with Leica Geosystems' 3D Machine Control technology.

"The interchangeability from one paving brand to another helps to utilise customers' machinery fleet nearly 100 per cent," said Rainer Bippen, business development manager at Leica Geosystems. "The cost savings are tremendous for construction companies. Practically any paver can be upgraded to run with the Leica PaveSmart 3D. With the software's high accuracy performance and the improved concrete yield due to its precise grade control, the Leica Geosystems 3D Machine Control solution gives us major savings in a project's life cycle calculations."

On the second day, the training had already reached the asphalt performing level, which means the team was ready to pave the asphalt road "stringless." While paving the first few metres, the surveying experts from Sefiani made quick as-built checks to compare the paving results with the project design. Surveyors measured the overall deviation at 3mm. The requirements of the contract were set at 15mm. The Leica PaveSmart 3D system, however, improved deviation by 12mm, which is enormous in the road construction industry. Setting new quality standards in Morocco had been achieved.

"The daily goal of the project was to pave 8,000m² of asphalt road. With the improvement of 12mm thickness, this resulted in a best case cost savings of around 15,000 Euros per day on the project. Within a very short period of time, the investment was easily


© Sefiani Enterprises

covered," said Tarik Elasri, support manager at Leica Geosystems' representative Marcotec. In addition, stakeout, surveying and time costs had been saved due to no longer using string lines as part of the project. Staking out with strings would normally cost the project an additional 1,000 Euros per km length. On this 32km project section, Sefiani figured it saved another 32,000 Euros for the customer by replacing the string lines with 3D machine control.

SUPERIORITY IN SERVICE

Mohamad Erraray, leading Sefiani Enterprises, has another view on the improved accuracy and cost performance achieved. In the coming years, many infrastructure projects with high requirements will be released by the Morocco Ministry of Infrastructure, such as high-speed railways, airports, highways and harbour projects. Demands of these projects will focus on achieving the highest accuracy possible in order to ensure safe usage and also the longest life cycle possible for government investments.

"The current performance of Leica PaveSmart 3D sets standards for future tenders, which can no longer be achieved using the old paving process. Leica Geosystems 3D Machine Control makes such accuracy possible and Sefiani is ahead of the game," said Erraray.

Due to the outstanding performance of construction machines using Leica Geosystems 3D Machine Control systems, Marcotec has become the largest dealer for 3D construction solutions in Morocco. Another advantage Marcotec offers customers is service. "We guarantee Leica Geosystems Machine Control will be working within six hours on the machine anywhere in Morocco. We are also able to deliver missing parts from our service shop within 12 hours," states Fahd Benomar, general manager at Marcotec.

This is certainly a strong argument for construction companies who depend on performing machines on site and certainly one that is now easily achievable.


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Written by Natalie Binder

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SATELLITES BRING SAVINGS TO EARTHWORKS

Commuters travelling through one of the most exclusive areas of Cheshire, England, United Kingdom will soon be able to do so without the usual holdups and inconvenience of traffic chaos thanks to Highways England, Costain, the Walters Group and Leica Geosystems.


© The Walters Group

The A556 Knutsford to Bowdon road improvement scheme is a 7.5 kilometre stretch of dual carriageway running from junction 19 of the M6 to junction 7 of the M56. Numerous accidents have occurred over the years on this stretch of road and the local community has been very vocal about wanting road improvements. Speed cameras have been introduced to try and reduce speed-related incidents, but an increase in traffic to almost 50,000 vehicle movements per day has seen holdups and delays on the road increase to a daily event. The existing dual carriageway encompasses a variety of busy traffic light controlled junctions, and while these generate holdups, traffic turning right off the A556 causes further disruption. To alleviate these problems and to improve access to and from Manchester Airport, Highways England drew up plans to construct a new road to allow free flowing traffic between the motorway junctions with the help of Leica Geosystems Machine Control.

The Walters Group is based in Hirwaun, South Wales but operates nationwide on civil engineering and earthmoving contracts, currently operating one of the largest earthmoving fleets in Europe. Walters is the preferred earthmoving sub-contractor for Costain for projects throughout the UK, bringing its expertise to the table through Early Contractor Involvement (ECI).

This ECI allows both the contractor and sub-contractor to assess the best possible working methods for undertaking the project and negates the possibility of conflict as the job progresses.

While many road schemes in recent years have centred on realignment and widening of existing carriageways, the A556 will only involve altering 1km of existing carriageway with the remaining 6.5km in greenfield away from the existing road. The use of Leica Geosystems Machine Control proved to be the perfect accompaniment to this construction project.

STAYING ON TRACK WITH GNSS SOLUTIONS

The cut and fill project will keep the muck-shifting team from Walters busy for 79 weeks with the project being split into five separate sections, dictated by existing lanes and roads that cross the new route.

The muck shifting is well underway with Walters employing four teams in various sections of the project. The initial section leaving the M56 has been completed using a pair of Walters 730C trucks ferrying soil to a Leica Geosystems-GNSS enabled Cat 329D, which was undertaking the final trimming work to one of the large drainage lagoons to be built on the site.

Each muck shifting team has been allocated a section of the project and consists of an excavator using Leica iCON excavate iXE3, which provides integrated tilt rotator support, giving the operator clear guidance information about the actual tilt and rotation position as well as dump trucks and a GNSS-equipped dozer.

Leica Geosystems Machine Control GNSS solutions have played a major part in the Walters armoury with the aforementioned excavator and four new D6T dozers resident on the site fitted with the Leica iCON iGD4 3D system. Working with GNSS reduces the need to have engineers out on site working in close proximity with moving vehicles and does away with the large amount of timber pegs and rails that have to be installed.

"The use of Leica's iGD4SP high speed dozer solution with GNSS as well as Leica's iCG82 GNSS machine receivers in each earthmoving team has significantly reduced the time spent on setting out for the project," explains Mark Sabbato, Walters works manager. "While time savings have been made using the GNSS machines, there is also a massive impact on health and safety. We don't need to have engineers walking around the site constantly, climbing batters and putting in profile boards. We have also encountered areas of poor material on the site and by using Leica's iGD4SP high speed dozer system, we are able to accurately measure the extra depth that has been removed resulting in more accurate figures being obtained for the project."

JUST THE RIGHT AMOUNT

While the excavator and truck fleet is mixed on this project, the same cannot be said of Walters choice of dozer. The company has purchased four new Caterpillar D6TLGP tractors for this project with the aforementioned Leica Geosystems GNSS solutions. The D6T is seen as the ideal machine for Walters' requirements and copes more than ably with assisting the excavators in obtaining the correct profiles and levels of dig. The dozers are used to clean up between each truck and profile the batters to the road.

"Once the dozer has the topography on its system, it is by far the quickest and safest way of surveying the site and ensuring we do not remove too much or too little material," said Simon Maher, Walters project manager. "If we do have to remove more material than expected, we are able to quantify this almost immediately."

With the muck shifting season coming to an end, Walters plans to have the majority of the bulk earthworks completed before the wet weather sets in. This will allow the smaller excavators to concentrate on the final removal of material and placing of fill material over the winter months.

"Working this way ensures we can keep the project moving along as it isn't cost effective for anyone to be stripping soils through the rainy season," concludes Maher.

The use of Leica Geosystems Machine Control solutions has significantly reduced the time in setting out on the A556 Knutsford to Bowden road improvement scheme, improving overall site health and safety and productivity.

*A version of this article first appeared in **EarthMovers** magazine by Paul Argent, RPA Photography.*

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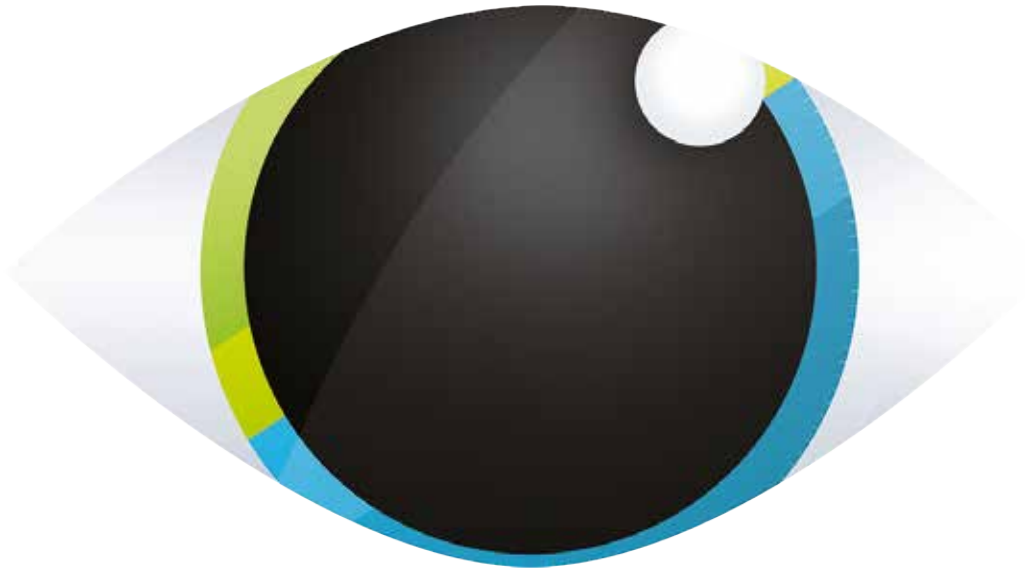

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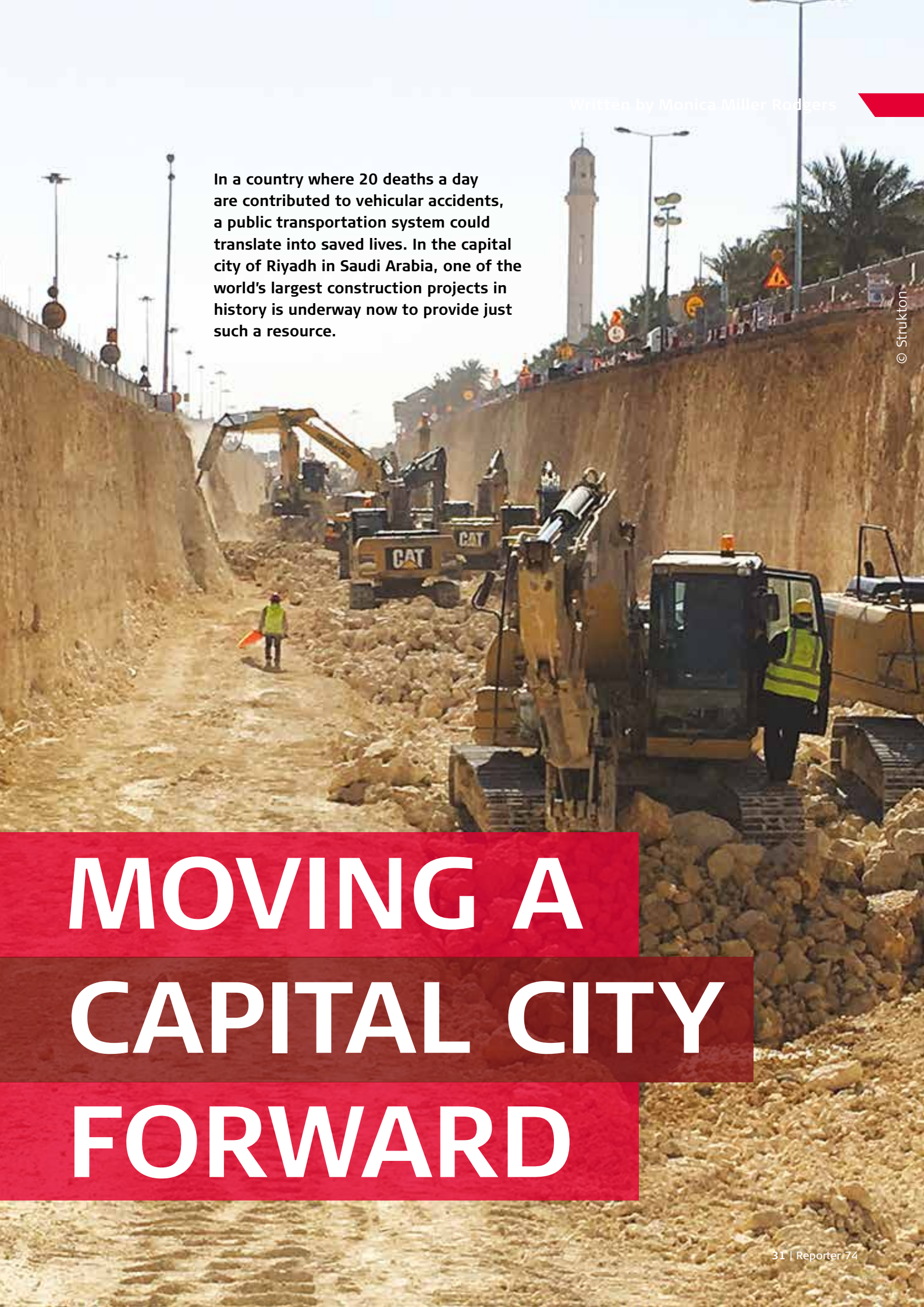
Written by Monica Miller Rodgers

In a country where 20 deaths a day are contributed to vehicular accidents, a public transportation system could translate into saved lives. In the capital city of Riyadh in Saudi Arabia, one of the world's largest construction projects in history is underway now to provide just such a resource.



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MOVING A CAPITAL CITY FORWARD

With 90 per cent of the nearly 6 million population in the city using cars, a sustainable public transportation system was desperately needed. The current public transportation system, though, was close to non-existent with no metro and no bus lines travelling inside the city. In 2014, ground was broken to begin the Riyadh Metro Project with an ambitious due date of late 2018.

The city's first rail metro will have six lines with 85 stations covering 176 kilometres with about 40 per cent of the lines underground. The metro will be able to move up to 3 million passengers a day. All together, the project comes in at an approximate 20.1 billion Euros.

FINDING COMMON GLOBAL SOLUTIONS

To build one of the largest infrastructure construction projects in the world, it took a multicultural team. Three multinational consortiums are working together on the project, combining companies from around the world.

FAST Consortium, led by FCC Construccion from Spain with Freyssinet of Saudi Arabia, Atkins of England, Alstom and Setec from France, Samsung C&T from South Korea, Typsa also of Spain, and Strukton of The Netherlands, was contracted to construct and design Lines 4 (Yellow), 5 (Green) and 6 (Purple) of the metro. The project oversees 64.6km of the rail track, 29.8km of viaducts and 24 stations at an overall cost of 7.1 billion Euros.

Construction of these three lines is overseen by three partners in the Consortium: FCC Construccion, Samsung C&T and Strukton. Each line has a dedicated survey team with all using solutions from Leica Geosystems.

Strukton, in charge of Line 6 (Purple), has been tasked with capturing data for topographic surveys, as-built checks, volume calculation, and inventory of existing utilities. The technology company specialising in rail systems and civil infrastructure is also in charge of stakeouts for construction and deviation monitoring.

"Though these are typical tasks for us, the sheer size of the project is new for us," said Clemens Tierie, survey manager for Strukton. "Only on Line 6, I have 28 teams with more than 10 nationalities represented."

With such a diverse mix, Tierie needed to find common solutions familiar to all the team members. He found that in Leica Geosystems. Using a combination of total stations, GNSS receivers, and construction lasers and levels combined with measurement software, the Strukton team is well on its way to completing the project on time and on budget.

"Surveying is teamwork, and surveyors from all across the world know and appreciate Leica Geosystems solutions," said Tierie.

RACING AGAINST THE ELEMENTS

With an ambitious deadline of just more than four years for such a large project, Tierie knew the team couldn't allow for any disruption.

First, working in temperatures upward of 50 degrees Celsius in desert conditions, they needed to be able to trust the instruments to withstand.

"Due to our time schedule, there have been many days we've had to work straight through. We couldn't wait for evenings or cooler temperatures," said Tierie. "With the durability of our Leica Viva TS15 total station, we were able to perform high-accuracy stakeouts at any part of the working day. This enabled us to ensure everything was ready for construction to start on time."

Using Leica Geo Office and Infinity software, the team was able to instantly transfer reality capture data back to the office from the field for quicker processing. This way, if there were extra measurements needed, the team could do so while on site without having to return later.

The team also used the Leica Rugby rotating laser and construction levels to perform accurate as-built checks. With almost all of Leica Geosystems instruments able to operate from -20 to 50 degrees Celsius, the Strukton team is on schedule to finish the project.

Next, as the largest city in the country and with a unprecedented growth in the past decade, the city's utilities have created a complex infrastructure challenge. While constructing the Riyadh Metro Line, the team had to remain vigilant not to interfere with any of the buried utilities or lines running above, many times not knowing exactly where these utilities were located. Combining the Leica GS14 GNSS smart antenna with the Leica GR10 GNSS reference station receiver, Tierie and his team were able to precisely locate and account for rogue utilities. Saving precious time and avoiding dangerous utility strikes, the team was able to work quicker, safer and more efficiently.

"Due to precise locating abilities of these instruments, we were able to inform our designers in the early stages of the project exactly where the utilities were located so they could incorporate this new information in the metro design," said Tierie.

Finally, the constant ongoing construction put roads and buildings in unstable environments. With the vibration from heavy machinery, such as when excavating trenches for cut and cover tunnels, these city assets were in danger of uneven and unsafe settlement. In conjunction with their measuring task, the surveyors were also in charge of monitoring the ongoing construction and its impact on the surrounding areas.

"With the accuracy of the Leica TM50 total station, we were able to quickly determine if construction operations were negatively impacting surrounding structures," said Tierie. "Improving the safety for the crew and community, our work has been well received here in Riyadh."

The team has future plans to supplement the monitoring process with Leica GeoMoS monitoring software for instant alerts to deviations in the structures.

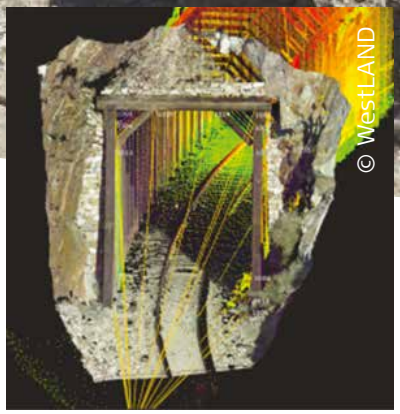
WORLDWIDE SUPPORT

Perhaps even more critical in an international environment such as the construction site of the Riyadh Metro Project is the assurance of support at anytime, anywhere.

Tierie says he arranged the project in Saudi Arabia through a combined effort of Leica Geosystems locations. His former Leica Geosystems network in The Netherlands with support from the Dubai and Switzerland locations and the local dealer in Riyadh all pitched in to make the project possible. Since moving to the desert nation at the beginning of the project in 2014, he has relied on the excellent support he receives from the many locations of Leica Geosystems.

"The quality of Leica Geosystems solutions is great, but the support for me is the biggest benefit. I've received very good support from Leica Geosystems Netherlands, Dubai and the local dealer SITML," said Tierie. "Due to the Active Customer Care support, we can quickly and efficiently handle any problems we encounter on site."

Written by Katherine Lehmuller

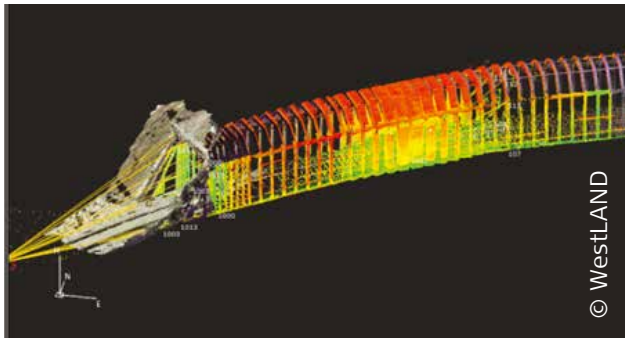


THE "REAL DEAL" PAYS OUT

3D laser scanners are big investments, and WestLAND Group, Inc., founded in 2000 in Rancho Cucamonga, California, US spent years looking for the right instrument. The company had a definite need; the work they do for railroads, which often calls for clearance surveys around tunnels and bridges, ideally fits into point clouds and cloud-based models.

A month after WestLAND received the Leica Nova MS50 MultiStation, one of their customers J.L. Patterson & Associates (JLP), a rail-specialised engineering company, came to WestLAND and requested ground control for a mobile LiDAR survey. Sophisticated users of 3D geospatial data, JLP wanted WestLAND to set control along and within several railroad tunnels near the Mexican border, with someone else doing the LIDAR work. JLP was used to working with point clouds, but didn't necessarily think of WestLAND when it came to 3D laser scanning. WestLAND suggested they not only provide control, but also scan one tunnel, and see if the deliverable worked and was cost-effective for JLP. The offer was accepted, and WestLAND got to work.

The deliverable was ultimately for Pacific Imperial Railroad (PIR) on a section of rail known as "The Impossible Railroad." PIR is rehabilitating the Impossible Railroad for use with double stacked trains, and 17 tunnels will have to be surveyed for clearance analysis and possible grading and track redesign. WestLAND saw the scan of one tunnel as basically a marketing investment and offered to scan one of the smaller tunnels, No. 15, which was only 91.4 metres long. It was the first project to make use of the MultiStation and it went very well.



While traversing the tunnel with the MultiStation for the control survey, the equipment was switched to scan mode and after a few setups, immediately started scanning. The entire tunnel took only a few more hours to scan and also gave the engineers time to clean up notes and sketches, and take pictures of the site to supplement the MultiStation's images.

FROM FIELD TO OFFICE

Leica Infinity, the software used to process the collected data, has become invaluable to WestLAND engineers. The ability to import and view the raw survey and scan data so easily has quickly convinced them. WestLAND was also impressed by the ease of doing control traverse network adjustments for precision, using conventional survey points and point cloud data. This data could then be easily exported into multiple file formats and imported directly into MicroStation, AutoCAD Civil 3D, and/or Revit, depending on the application and required deliverables.

The suggestion of using the Leica Nova MS50 MultiStation to scan the JLP tunnel for producing working, cost-effective deliverables has become a very profitable proposal for WestLAND. The data collected from the original pilot project tunnel has turned into a further proposal to JLP for the remaining 16 tunnels. Given the satisfaction of JLP's end customer, WestLAND expects the additional tunnel proposal to be accepted and looks forward to using the MultiStation on future projects.

Written by Vincent Bertheau

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NO TIME FOR ERROR

Four days, 96 hours - this was all one French contractor was given to complete the monitoring and guiding operations during a major railway bridge shift project. Authorities could only allow for a major train route to be out of service for four days before causing significant strain on the country's transportation system.

SCP Bertheau Saint-Criq, a chartered surveying firm with extensive experience in rail operations, was hired by the project surveying company on record, civil engineering company GTM Sud-Ouest, to ensure the Toulicou Bridge in southwest France safely underwent several repositioning procedures to move 47 metres to its final location. The undertaking wouldn't be easy as the bridge measured in at 75m long, 12m wide and 9m high.

The Toulicou Bridge was built between February and October 2014 to provide a safer crossing for the RN21 train between Tarbes and Lourdes. The bridge was constructed at 47m away from its final location, resting on a concrete slab. The existing track portion of the Toulouse-Bayonne railway needed to move for better maintenance of the line.

A LONG WORKING WEEKEND

From 7 to 10 November 2014, several tasks had to be completed to ensure the Toulicou Bridge was shifted to its new location in the short time the Toulouse-Bayonne train would be out of service. First, the railway tracks of the bridge had to be removed along with the overhead lines. Next, the existing embankment slope had to be levelled to accommodate the bridge plus another slope had to be created. After the shifting was completed, the tracks needed to be replaced. Finally, a concrete wall had to be poured.


© SCP Bertheau Saint-Criq

To accomplish all this on such a tight deadline, 200 people were mobilised on a scheduled that covered 96 hours:

- 15 hours for the removal of the track and overhead lines
- 26 hours of earthworks
- 13 hours of skidding
- 9 hours of filling
- 31 hours of replacing the catenary

Between the interruption and restart of the circulation for the construction accounted for two more hours.

If everything went to schedule, the bridge would be ready for turn over to the customer one hour before deadline.

ENSURING A SMOOTH SHIFT

Planning for the shift, SCP Bertheau Saint-Criq had to ensure when the bridge was lifted that its 8,000 tonnes wouldn't sag and risk breakage. To do this, the firm conducted a preliminary as-built survey of the structure to verity that it was built to plan specifications. Also, the surveyors needed to ensure the concrete slab the bridge rested upon hadn't moved during the nine months of construction and the batteries axes were in alignment with the planned trajectory of the shift.

During this first phase, SCP Bertheau Saint-Criq used the Leica Viva TS15 targeted to 10 Leica GMP104 prisms set up on the bridge piers. With the high accuracy and dedicated lock-on capabilities of the total station, the firm was able to accurately verify the integrity of the structure and calculate the bridge's final position.

Another concern the firm had to address was the capability of the cylinders that would guide the actual shift. Two cylinders per line would push 1,000 tonnes each. The cylinders would act in parallel to ensure the direction of the skid as it is essential to avoid an offset, which can cause a blockage.

In the next phase, the actual shifting, the Leica TS15 was set up on a concrete pillar and six prisms were fixed on known points, consistently retargeted to the total station to account for temperature and humidity

changes. These adjustments allowed SCP Bertheau Saint-Criq to avoid costly errors that would have thrown off the entire schedule, causing the whole project to fail.

The shifting was a slow process, moving only 5m every hour. With the precise calculations provided by the monitoring solutions of the total station and prisms, the firm was easily able to predict how far the bridge would move.

Far less easy for the surveyors was determining how the structure would react to the actual shift due to angle and weight. The greatest fear was the structure breaking and nose-diving into the gorge below.

"Confidence in the accuracy of measurements and the material used is paramount. Especially when the results do not match the expectations of different stakeholders and can be challenged. It is then important to quickly prove the reliability of what is ahead," said Nicolas Bazerque, the SCP Bertheau Saint-Criq surveyor in charge of the project.

AUTOMATING FOR ACCURACY

To precisely understand the strain on the bridge from the shift, the surveyors made an inventory and consistently re-measured all the prisms. This provided a baseline to compare against where the bridge should be and where it actually was. These measurements were taken at every 4m of the shift. The discrepancy in the theoretical and actual results was recovered with mechanical adjustments to the trench bottom.

"For such a repetitive but critical process, automation is the best option to avoid operator error due to fatigue or stress," said Bazerque. "We were able to use the auto set-up of Leica Viva, avoiding costly errors."

At each cycle, the surveyors got a picture of deviations and compensation made. The table allowed the firm to keep a written record of the transactions.

These challenging operations are often under particular conditions, such as at night or in difficult environments, adding stress to the issues. The methods used are then cobbled together in-house, and, unfortunately there are no records. This time, however, SCP Bertheau Saint-Criq was able to provide its customer a specific progress report with the hours of measurement and results, which is a guarantee of quality.

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Imprint

Reporter: Leica Geosystems customer magazine

Published by: Leica Geosystems AG, CH-9435 Heerbrugg

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Cover: © Sefiani Enterprises

NEWS

Leica Geosystems releases new calibration system for value-added service

In a compact size, the new Leica CalMaster uses intuitive software and automatic functionality to perform laser checks, adjustments and issues calibration reports at the push of a button. The system is the only checking and calibration system in the industry to issue the ISO 17123-6 certification for repeated accuracy and reliability of rotating lasers.

New Leica LS15 digital level provides industry-leading accuracy, ease

The new Leica LS15 completes all steps of a project, streamlining the traditionally demanding, often tedious, tasks associated with the levelling process. Industry-leading 0.2mm accuracy is achieved by simply aiming at the target via the colour touch display and pressing the measuring button. An electronic bubble, tilt checks prior to each measurement and autofocus help ease fatigue over the course of a day's work, significantly reducing the risk of human-based errors.

New Leica ULTRA locator: Best accuracy results in faster, more confident work

The outstanding performance of the new Leica ULTRA locator with operational ease and flexibility help users attain the highest accuracy to avoid costly mistakes, such as cutting utility lines or delaying project schedules during excavation work. By providing a wide range of transmitter mode frequencies, operators in segments such as power, water, gas or telecom can easily and quickly optimise the locator performance in any operating condition. Users save time and effort by tracing utility depths and distances.

Hexagon acquires Sigma Space

Today, accurate and geo-referenced 3D visualisations have become an absolute necessity in real-world situations due to the insight they can provide. Sigma Space, a provider of next-generation technologies used to rapidly deliver high-quality 3D maps of the Earth, has been enabling private and government clients to respond to the growing need for this kind of data. Complementing Hexagon Geosystems' sensor business, Sigma Space represents an important technology provider for multiple businesses within the company.

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