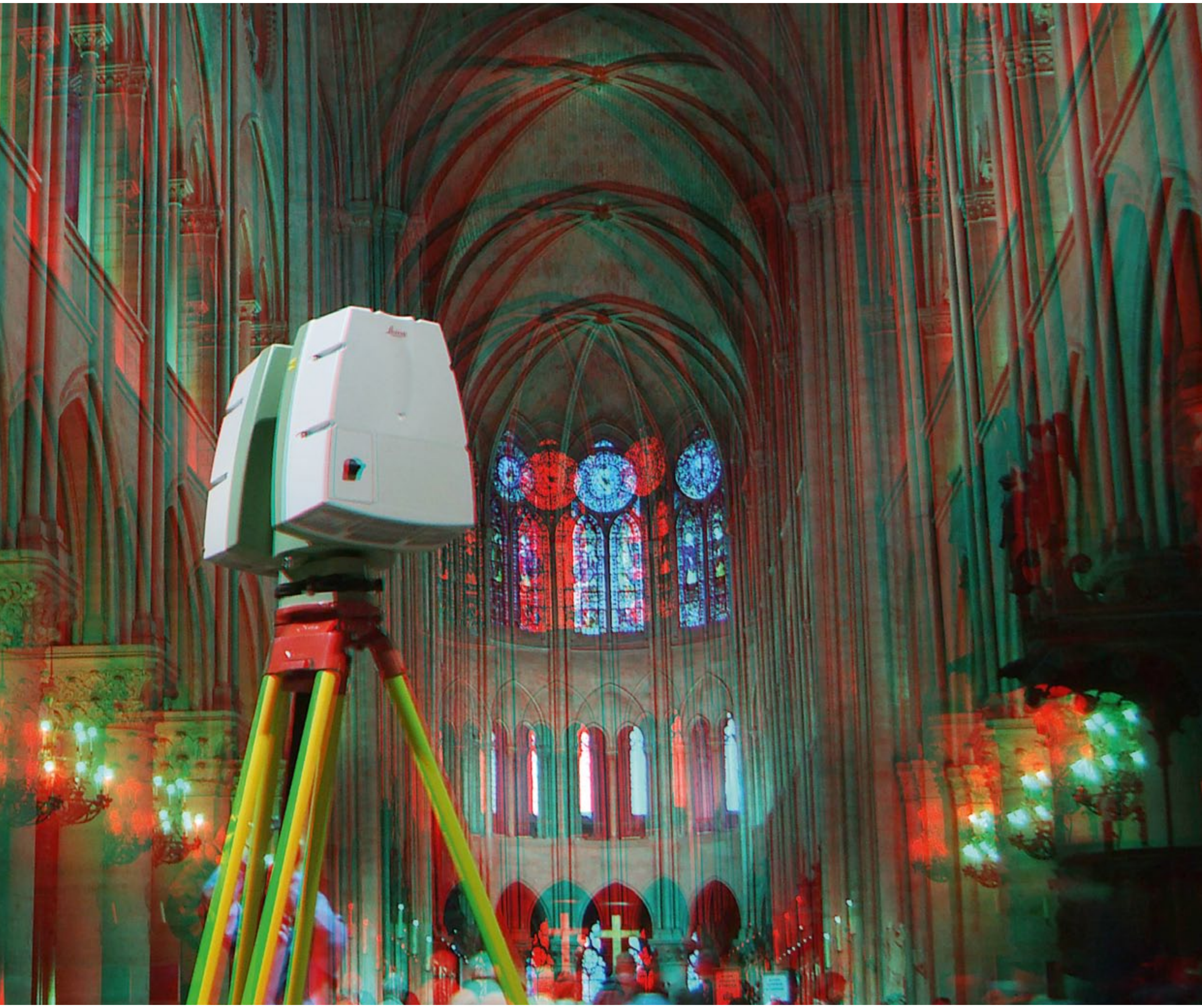
Reporter 68

The **Global Magazine** of Leica Geosystems



PART OF HEXAGON

- when it has to be **right**

Leica Geosystems

Editorial

Dear Readers,

To be more efficient, more innovative and better able to meet the increasing expectations of performance combined with the speed to deliver in today's challenging environment, one needs to have outstanding technology combined with intuitive workflows.

In this issue of the *Reporter* you will see how 3D data is captured, processed, and delivered across different applications such as construction, monitoring, GIS, airborne and heritage preservation. With a Leica ALS60, our customer McElhanney reveals the secrets of the Angkor Wat temple. Andrew Tallon used a ScanStation C10 to research Gothic architecture – and using the enclosed 3D glasses you too can get a "deeper look" at this exciting project.

One of the biggest project in Europe is the 55km long Brenner Base Tunnel, an important transalpine crossing. A GNSS network as well as other Leica Geosystems equipment is being used to continuously monitor a geologically unstable zone to protect the local inhabitants and workers.

A game changer in terms of usability and intelligent technology is the world's first MultiStation, the Leica Nova MS50. This new solution combines every significant measuring technology in one device, opening the doors to a fascinating new dimension of the geospatial world. The Leica Nova MS50 covers the complete process from capturing and visualizing data, to deciding and delivering; enabling to take faster, smarter decisions regardless of the application. I am already looking forward to sharing some great stories in our next issue of the *Reporter*.

Juergen Dold
CEO Leica Geosystems

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Laser Light on Gothic Architecture

by Marie-Caroline Rondeau

The advent of Gothic art in the 12th century marked the start of an extraordinary architectural adventure in the Middle Ages. Cities in France – and then throughout Europe – vied to build the most perfect image of Heaven on earth. The master builders of Gothic architecture conquered hitherto unknown heights with feats of technical bravado, as astonishing today as they must have been then, but left no hints, other than those hidden in the buildings themselves, as to what their process of design might have been. Traditional means of understanding Gothic structural design using modeling are fraught with conceptual and technical challenges. Andrew Tallon, Professor at Vassar College (New York) and specialist in Gothic architecture, adopted 3D laser scanning technology to circumvent these problems – to read the stories of the builders directly in the stone and mortar of the buildings, with millimeter precision.

Structural models have been used since the 1960s to explore the questions that art historians have long asked about Gothic buildings. However, the lack of precise methods of measurement, the assumptions necessary to create a workable model and the lack of

© Andrew Tallon

documentary evidence have rendered their conclusions too divergent. The invisible forces affecting the walls have inspired multiple theories based as much on intuition as on material evidence. It seemed time to tell the story of Gothic buildings anew.

Revealing Invisible Forces

In trying to achieve this goal, Andrew Tallon sought funding from the Samuel Kress Foundation to undertake a large-scale laser survey at the cathedral of Bourges in 2008. By creating a highly accurate spatial map of the building it became possible to examine, in the finest detail, every unintended departure from rectilinearity. Gothic buildings, like most buildings, were constructed along the plumb-line. The parts of the building that are no longer plumb were thrust out of line by the combined forces of the vaults, arches and wind – direct evidence of invisible forces working on the walls. By quantifying these movements using 3D laser scanning, with a precision of several millimeters, it has become possible to speak with confidence about what has actually happened in the building, and what decisions were made by the builders during construction to tame these unwanted deformations. Evidence from the cathedral of Bourges, for example, reveals that its builders actively struggled to keep the piers in perfect alignment by adjusting the position of subsequent layers of masonry; they eventually resorted to installing iron ties, hidden above the vaults, to arrest the tendency of the vaults to push the building out of plumb.

Evolving Technology

Andrew Tallon's interest in 3D laser scanning tech-

nology goes back to 2001 when his dissertation director, Columbia University Professor of Art History Stephen Murray, teamed up with Peter Allen, Professor of Computer Science at Columbia, to produce the first laser scan of Beauvais Cathedral using one of the first Cyrax laser scanners. Nearly 10 years later, Tallon, assisted by Paul Blaer, a colleague of Allen's, used one of the first Leica ScanStation C10s available in France to produce a high-density scan of the cathedral of Notre-Dame in Paris in the context of a documentary that aired in Europe on the television station Arte in 2011. After having seen the data that other 3D laser scanners produce, Andrew Tallon is convinced of the superiority of the C10 in terms of long range and accuracy. The question of speed is also of critical importance. The cathedral in Paris is visited by approximately 13 million visitors per year (an average of more than 30,000 people per day): time spent scanning the entire monument (with an area of 4,800 m² (5,740 yds²) and a total length of 128 meters (140 yards)) had to be reduced to a minimum so as not to disturb both the daily liturgy and the flocks of tourists.

Thanks to advances in technology such as the onboard interface of the Leica ScanStation C10 and sophisticated new functions in the Leica Cyclone software – particularly the advances in cloud to cloud registration – Tallon was able to be far more productive during his latest missions. He explains that he is now able to produce twice as many stations including target referencing with the Leica ScanStation C10 as he had with a Leica HDS3000. For example, he and his team were able to complete the scanning work –

over fifty stations and more than 1 billion textured data points – at Notre-Dame in only 5 days. He looks forward to being able to work with the newest Leica Geosystems laser scanner, the P20, in the context of his research, given its impressive improvements in acquisition speed.

"This type of work simply would not have been possible before the 3D laser scanner. Manual measurement would have required extensive scaffolding and months of work to accomplish – not to mention the inevitable errors due to imprecision," states Tallon.

Tallon emphasizes that the importance of laser scanning lies well beyond its ability to simply measure. "The consequences of laser scanning," he says, "are equally far-reaching in terms of representation. A three-dimensional laser-generated model allows one not only to peer into the building but also to displace it, measure it and, most importantly, immerse oneself in its spatial and structural matrix. Both the structural skeleton and the evidence of its malfunction, the deformation produced by the push and pull of its constituent elements, are made immediately apparent to expert and lay audiences alike – a picture, in this case, well worth a thousand words." ■

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Specialist in Gothic Architecture

Andrew Tallon joined the faculty at Vassar College (New York, USA) in 2007 where he teaches medieval art and architecture. He is a specialist in Gothic architecture and has published a number of articles on the subject. He is currently writing a book titled *The Structure of Gothic*, which will feature the research undertaken with Leica Geosystems laser scanners. His 3D laser scanning and research were featured in a feature-length documentary produced by Arte, *Les cathédrales dévoilées*, which aired on television in 2011. Most recently, his book on the cathedral of Paris, co-written with Dany Sandron, to be published in the spring of 2013, tells the history of the construction of the building in visual terms. The primary illustrations were created from the laser scans acquired in 2010 and 2012.

For more information please visit
www.gothicstructure.org

Precision Control

by Phil Bishop

In 2012, the United Kingdom experienced the wettest summer in 100 years. This had a massive impact on the construction industry. Among the many jobs where extra hours – and extra machinery – had to be put in to catch up was the site preparation works for the 865 Million Euro (1.2 Billion USD) Jaguar Land Rover engine factory in Staffordshire. BAM Nuttall began its 6.9 Million Euro (9 Million USD), 22-week earthmoving contract in April, but the weather was so bad that in one week just one afternoon's work was accomplished. With the help of Leica iCON GPS machine control the contractor was able to keep the tight deadlines despite the weather.

"It was a dreadfully wet summer," recalls project manager Steve Beech. "The ground was such that when it was raining we couldn't traffic the heavy plant. We just had to stop work. We had all the drivers chomping at the bit and just wanting to get out and drive. Management needed to stay patient and wait until the ground was ready to take a pounding."

BAM Nuttall's job was to create a level platform for Jaguar Land Rover to build two large halls – one for production and one for assembly – each about 120,000 m² (144,000 yrd²). This was a huge cut-and-fill undertaking, moving a million cubic meters of spoil, including 150,000 m³ (200,000 yrd³) of topsoil that was up to 60 cm (24 in) thick.

The location of the new plant is the i54 business park, a joint development by Wolverhampton City Council, Staffordshire County Council and South Staffordshire District Council, close to Junction 2 of the M54 and just three miles north of Wolverhampton city center.

■ **Leica iCON GPS 60 on the roof of the pick-up: the project manager can drive around the site, checking heights.**

To cope with the addition of the Jaguar Land Rover plant in the park, the motorway junction is being remodeled to give direct access. BAM Nuttall constructed an embankment on the south side of the junction and stockpiled spoil for a future north side embankment. The embankment on the south side used 150,000 m³ (200,000 yrd³) of engineering fill material, mostly sandstone rock crushed down, and all Class 1. The stockpile for future use for the north embankment amounts to 200,000 m² (260,000 yrd³). This currently sits within the bounds of the i54 park site until required.

In order to make up for all the time lost to rain, when work could go ahead it was all hands on deck, with a sizeable array of plant put to intensive work. Primary excavators were five 45-ton tracked Komatsu PC450s, supported by a fleet of 18 Komatsu articulated dump trucks moving to and fro on a just-in-time basis. Various crawler dozers worked to spread and level material, including a Caterpillar D10 with a ripper on the back for tearing sandstone, and Komatsu D61s and D65s.

All the equipment was supplied and operated by Shropshire-based Hawk under subcontract, with 30 machines on site at peak. While BAM Nuttall does still own more plant than most major contractors these days, its kit is mostly cranes and smaller machinery, not the kind of earthmoving machinery needed for a job like this. With all this machinery on site, working long hours and weekends to catch up, it was important to minimize the scope for human error. It was also not a good idea to have surveyors walking around, setting up total stations near the bustling machinery.

For these reasons, Hawk's excavators and dozers were fitted with Leica Geosystems GPS machine control equipment from authorized Scanlaser distribution partner. Steve Beech explains: "You upload the Moss model into the software that controls the

Machine Control Systems Save Fuel and Material

Neil Williams, engineering & infrastructure manager for Leica Geosystems, says that the UK construction industry is still at the early adopter stage when it comes to machine control technology, at least compared to its northern European neighbors, and Scandinavia especially. Prior to 2008, he says, the productivity gains that it offered prompted larger UK earthworks contractors to adopt the technology, particularly on road construction schemes.

Now, however, he says, its take-up is being driven by the cost savings on materials and fuel, and by the site safety benefits, eliminating an interface between pedestrians and heavy plant.

machines. The sensor on the dipping bucket tells the excavator operator how far to go down or dozer driver how far to go up."

Explaining the benefits, he says: "It's a speed thing. You don't have to rely on the setting-out engineers. You also don't have as many people on site on foot, so it's a health and safety benefit. When you've got 30 pieces of plant over the site, you don't want people on foot." He adds: "I wouldn't do a muck shifting job without it now." Hawk also used the iCON supervisor's kit. This technology enables site managers to drive around in their vehicle and check all levels without getting out. They can do volume calculations while touring the site, too.

■ **Height check: Leica iCON CC60 in the pick-up.**

And with the Leica iCON telematics system, all information relating to levels can be relayed back and forth between the site equipment and a remote head office.

Key to getting the job done, Beech says, was efficiency, maximizing equipment uptime and not having trucks sitting idle waiting for something to do. It all relies on having "muck shifting people who understand muck shifting," he says. "It's really quite an art."

Hawk Contracts general manager Frank Jones acknowledges the part played by machine control technology on the project. "I think the GPS played a major part in health and safety on the site and we were more efficient," he says. But, as always, the real secret was plain old hard work. Technology is great, but it cannot be expected to do everything – at least not yet. "It was a good team effort on both parts, BAM and Hawk," Jones says. "We worked bloody hard to get the job done and put the hours in. Everybody was to the pump." ■

This article is adapted from the original issue published in 'The Construction Index Magazine', issue Dec/Jan 2013. The full version is also available at www.theconstructionindex.co.uk.

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Revealing Angkor Wat's Secrets

by Chris Cromarty

Angkor Wat is one of the world's most recognizable temples. Designated as a UNESCO world heritage site in 1992, this temple was built by the ancient Angkorian civilization in the 12th century under King Suryavarman II. Angkor Wat was the center of a once massive and powerful nation suspected of being the largest in the world at the time with up to one million citizens. Supporting such a population required a large infrastructure of water works during the arid Cambodian dry season. In the past, archaeologists have used radar and remote sensing data to try to make sense of the greater Angkorian civilization. It is suspected that a sophisticated water infrastructure consisting of reservoirs, canals and dams captured the water flow from the highlands and distributed it throughout the rice paddies of the lowlands.

Archaeologists studying this civilization face many challenges while trying to map out these features. The remote areas in the hills are hampered by jungle and are still spiked with landmines from the Khmer Rouge era. PT McElhanney Indonesia proposed flying over these areas with a helicopter-mounted Leica ALS60 LiDAR scanner and Leica RCD105 medium format digital aerial camera to pinpoint and model key features for the archaeologists. This would enable them to isolate the subtle topographical changes of water infrastructure and other urban civilization planning to identify areas of interest and then organize landmine-clearing crews to make ground inspections safe.

A consortium was necessary to put a project of this scale together. PT McElhanney worked closely with Professor Roland Fletcher and Dr. Damian Evans from the University of Sydney's archaeology department to organize this group.

Preparing the Project on the Ground

Before mobilizing the equipment a ground reconnaissance trip was made and time was spent with the archaeologists to understand what information they were hoping to gain from the data. Another important aspect of this trip was to assess the terrain and vegetation on site to maximize LiDAR's potential.

PT McElhanney spent a few days travelling to various sites with the archaeologists to understand the challenges they faced. In the lowlands and built up areas, site inspections of excavation sites were conducted.

In these areas the archaeologists were hoping to get a better understanding of where the "occupation mounds" were located. These are subtle rises in topography that usually indicate some extent of habitation above the rice fields or drainage areas. Understanding that the inhabitants, including the King, lived in wooden structures made it clear that there was no possibility of identifying remaining residential building foundations. This was critical in designing a LiDAR dataset that would identify these subtle topographical changes. Only temples were made of stone so being able to identify possible stone debris was also very important. The combination of high-resolution aerial photography and LiDAR was going to help locate and identify these areas of high interest in the lowlands.

The vegetated areas posed a greater challenge. Even though the requirements for subtle terrain change were the same as in other areas, the dense Cambodian forests coupled with the random locations of the landmines meant that the archaeologists could not freely investigate areas of interest. Instead, the very time consuming and costly requirement of sending in landmine-clearing crews to clear these areas was a necessary prelude to any investigation. Identifying these areas under the forest canopy with satellite imagery and radar data was virtually impossible so LiDAR had been proposed to give them the best possible Digital Terrain Model (DTM) so they could concentrate future inspections on specific locations. The high accuracy LiDAR DTM could also aid in modeling features that were previously incorrectly identified such as roads, which were in fact reservoir walls.

Due to the danger of landmines throughout Cambodia and the relatively little exploration that has been conducted in remote areas, it is presumed that to this day there are still many undiscovered temples. LiDAR was also identified as the technology to help identify additional temples that may be in the project areas of interest.

Data Acquisition with Highest Accuracy Level

The total project had three main areas of interest around Siem Reap, covering an area of 270 km^2 (104 mi^2). Due to the high level of accuracy required, it was proposed that two main GPS base stations would be used for acquisition. The helicopter was also ideal since one particular area was approximately 100 km (60 mi) from the nearest airport so on-site refueling would be required during the acquisition of that block.

Award Winning Project

The project was nominated and declared the winner of Asia Geospatial's Award of Excellence – Archaeological Application, which was handed out in September 2012. Further nominations and regional recognition will hopefully follow and revolutionize the technology's use in archeology throughout the region and the world.

www.asiageospatialforum.org

In the forested areas, acquisition was flown using a cross hatched pattern to maximize opportunity for LiDAR penetration to the forest floor. These areas were acquired with a LiDAR point density of up to 16 points per square meter, which was essential for the modeling required beneath the forest canopy. Over temples, this approach also maximized the 3D modeling ability of the LiDAR scanner. Full waveform LiDAR was also collected over the areas of interest to ensure the best DTM would be available in the heavy grasses and vegetation present on some of the sites.

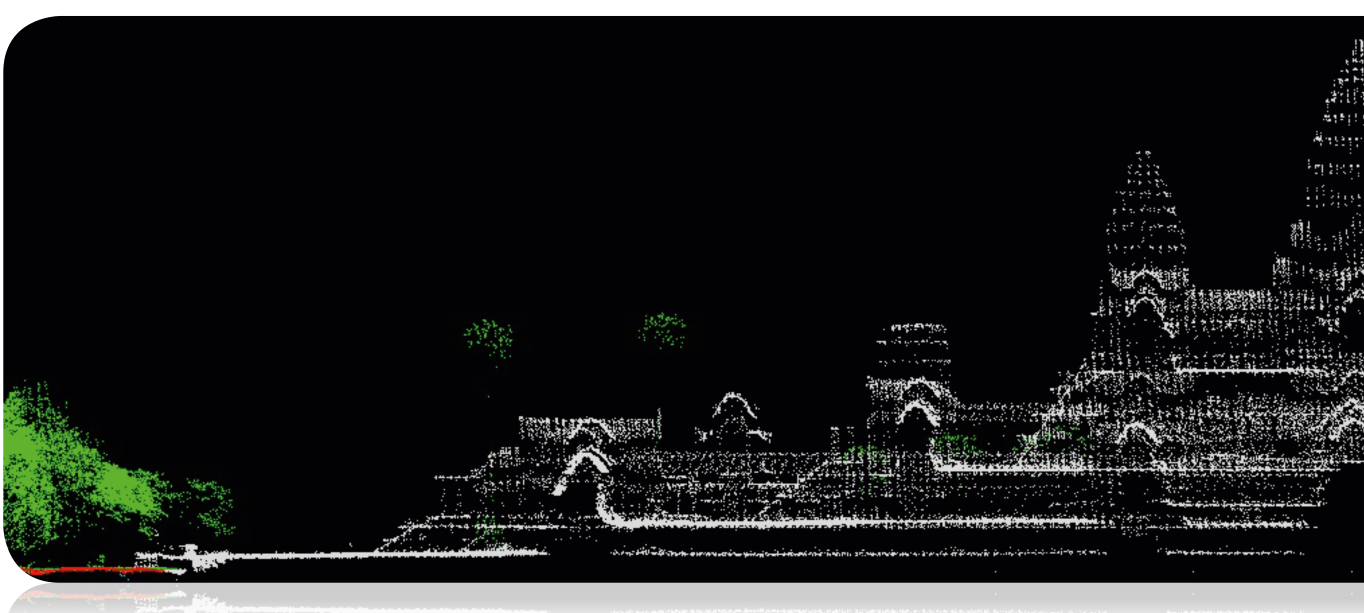
Digital aerial photography was simultaneously collected with the LiDAR data. Even though the aerial photography was a secondary product to the LiDAR, this was collected as a stereo image and had complete overlap of all the LiDAR for downstream products and viewing. This high-resolution imagery would be invaluable when completing the LiDAR modeling.

All of this data and the collected densities amounted to a very large dataset being acquired on a daily basis. Even with current, state-of-the-art computing power data management is one of the biggest problems during data acquisition. A daily challenge was to have all of this data backed up and the drives ready for acquisition the following morning.

Aerial acquisition hurdles also had to be taken during the arid Cambodian summer. Afternoon temperatures often exceeded 45°C (113°F), pushing the limits of the equipment's' operating temperatures. Summer slash burn by local farmers caused difficulties to ensure capture of the highest quality of photography. All of this was overcome without major delays and the project remained on schedule.

Tracing Angkor's History

Preliminary analysis is already revealing amazing new discoveries. According to archeologist Dr. Evans, the LiDAR survey has produced "a lifetime" of data in



a short period of time. LiDAR's ability to penetrate dense vegetation has meant that the temple complexes can be seen without vegetation for the first time since the habitation period. Subtle topographical changes have traced out road networks, occupation mounds and other urban planning signs that were previously undetectable even from the ground. Archaeologists are already speculating that the data will provide a completely new insight in the Angkor civilization and revolutionize the history of the Khmer Empire. ■

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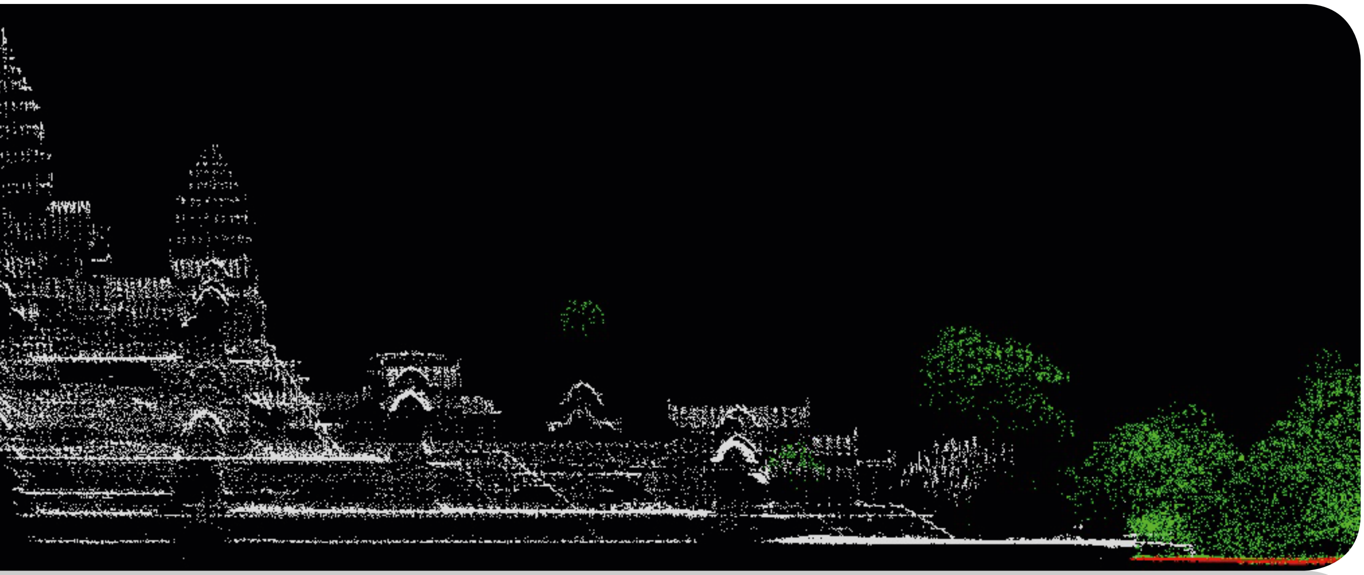

Complete and Accurate Highway Asset Data

by Mike Cobble

Reading Borough Council's Highway department in the UK manages 436 km (270 mi) of roads and footpaths which includes thousands of assets that are regularly visited throughout their lifetime by multiple highway inspectors and operatives. All relevant information about each asset is stored and controlled in an enterprise Facilities Management (FM) database. The current database includes non-standard address entries that cannot provide a recognizable spatial reference. UKPipeline were contracted by Reading Borough Council to carry out a comprehensive survey. A Leica Zeno GIS Handheld provided accurate location and attribute data for all the street lighting, illuminated equipment and gullies within the borough.

Reading Borough Council's survey information was to be incorporated into an improved FM database to facilitate their planned move to a location-based management system. To assure data integrity it was decided at an early stage that, rather than checking and modifying existing data, a complete new dataset would be collected. Every asset was to be surveyed systematically, road by road, and the existing database used to compare the results. Reading Borough Council utilized Ordnance Survey mapping within their enterprise GIS and the survey required a relative accuracy of ±0.5 m (0.2 in). Due to the nature of the data and the required accuracy it was identified at an early stage that a physical survey would prove more cost effective than vehicle mounted remote scanning. This enabled all of the attribute data to be recorded in a single visit by a single surveyor.

Rich Asset Data with Leica Zeno GIS

For such a large area survey, with high volumes of data and work in all-weather the choice of the right survey equipment was essential. UKPipeline selected Leica Zeno 10 3.5G handheld GNSS/GIS using Zeno Field software due to its compatibility with the exist-

ing Esri based GIS, its excellent mobility and screen performance, as well as reliable technical support that is essential when adopting new equipment into a business or project.

A key element was to ensure rich asset detail was captured at the point of survey, making sure all data could be collected in a single visit. The integrated 2 megapixel camera on the Zeno 10 was invaluable for internal quality processes and assessments, and enabled the office staff to understand and see exactly what assets those in the field saw, making it easier for them to work together and ensure the right data was captured at the time. This meant revisits were eliminated, minimizing costs and delivering datasets without delay. SmartNet DGNSS Network correction service powered by Leica Geosystems was used to meet the field data collection accuracy requirements requested by the client. It was chosen as it provides reliable real-time corrections via the Internet as well as efficient and secure access to data for post processing if required.

Efficient Workflow

A single spatial database was designed and Leica Zeno Office software was used to create and manage a database containing all mandatory attribute fields requested by the client as well as other information such as survey notes and site photographs. Data consistency was recognized as essential and dedicated workflows were identified for each asset type. Unique survey forms were created which included mandatory field entries and drop down lists to improve data quality and speed of collection. The entire borough was surveyed in six weeks by a specialist team of surveyors that collected 36,000 assets.

Easy Zeno Office Workflow

On completion of data collection each day, the Zeno Office 'EasyIn' workflow was used to update the database and a new project was completed using 'EasyOut'. This ensured that each survey team member had access to the latest data to avoid duplication and also, for data security, allowed daily backup to the main office and UKPipeline's cloud service provider.

Data Screening and Analysis

After completion of the field work, a comprehensive quality audit was applied to measure the overall accuracy of the data. This involved data screening on multiple levels; as well as sample bench marking against the existing FM database and, where necessary, review against Google Earth Street View. By creating a KML overlay, Google Earth Street View proved an effective tool in screening the data from a third point of reference where discrepancies could be very quickly inspected and analyzed. To corroborate the results five areas were selected at random for re-survey.

From a representative sample of approximately 5 % of the overall survey data an error rate of approximately 2 % was found. Less than 3 months after contract award the client received a comprehensive spatially-enabled data set, which exceeded their requirements in terms of quality, cost and duration. ■

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UKPipeline

UKPipeline was established in 2001 and supply engineering, survey, GIS and management services to asset owners, operators and contractors. The UKPipeline survey system provides a cost effective solution for the collection of data-rich information in the urban environment, supplying accurate information critical to the success of every asset management system.

More information about UKPipeline at:
www.ukpipeline.com

A Self-made Man's Success

by Kenneth Staack Mortensen

Imagine growing your business and creating new opportunities, expanding your knowledge and skills, and benefitting your partners – all at the same time. Jonas Nielsen managed all this and more when he bought a Leica iCON robot 50 total station in the summer of 2012. The revolutionary iCON (intelligent CONstruction) user platform introduced by Leica Geosystems serves as one integrated platform for the control of all positioning and measuring tasks in the building and construction industry.

The Danish owner of JN Gravning started out in the paving business eight years ago but has moved on in leaps and bounds from his original business model. "Where technologically based measuring equipment is concerned, in just a couple of years I have moved from absolutely nothing to a two-man manual Leica Builder R200M solution and recently to the most advanced equipment in the segment; the motorized Leica iCON robot 50 total station," says Nielsen.

Easy Start

Getting started with a new system proved to be simpler than expected: "Thanks to the iCON build

Prepared for the Future

The iCON build software is prepared for a future product range even larger than today. In the future, measurements from the Disto laser distance meter, a digital level or even a cable detector may be integrated.

Through the myWorld online portal (*myworld.leica-geosystems.com*) it is already possible to purchase new hardware and software for the update of each of the various functions in each customer's individual iCON solution. This enables customers to continuously optimize their solutions and workflows.

software, easily understood menus you are guided through the system as a new user," says Jonas Nielsen. "I was pleasantly surprised with the operating ease and accessibility of the system. At first I thought it would be very complicated, but after sitting down and using it for about two days to get acquainted with the system, I quickly found it easy to use. The iCON build field software is very intuitive and my personal experience shows that using the help menus and doing five to ten minutes of self-study in the field solved most technical questions I have had. Furthermore, one half day of free training and support was included when buying the iCON build."

Growth through Precision and Efficiency

In the past there would be daily downtimes spent waiting for the surveyor to come and stake out a point on site. This is a thing of the past, as are the old-fashioned methods he used to use: "No more using strings and stakes. With the iCON build I feel perfectly equipped to perform exact measuring and am able to design and project a given job correctly right from the start. iCON build can be programmed to focus 100% on the area to be worked on – large or small. With the 'Cut & Fill' application it is incredibly easy to determine if I am above or below the terrain. Since I complete all measurements by myself JN Gravning grades 50% more than before. The number of unproductive periods waiting for surveyors or other external partners during the workday has been dramatically reduced," says a pleased Nielsen. "Besides staking out points, iCON build allows me to upload exact measurement data and continuously document the progress of the current job from start to finish, even in the field – a very popular service with all my clients. On the other hand, a client can supply his data in a DXF file, which I upload to the system and then I am able to immediately start staking out the measurements and begin work. With iCON build I have optimized and improved the efficiency of my company's daily routines in the best possible way," Jonas Nielsen concludes.

The iCON robot 50 motorized total station allows Nielsen to work alone, which means he saves time and the expense of another worker holding the prism for tasks where reflectorless measuring is not possible. On the site he is working at now, he improves the efficiency for the contractor, as they no longer need to send a surveyor every time they need to check a height, re-stake a point, etc. This would usually take the surveyor away from the office, interrupting data management and waste time driving back and forth, etc.

Jonas Nielsen finishing a subcontractor job preparing the terrain for a large house-building project.

But Jonas Nielsen isn't the only person using the new instrument. His workers on site all use the iCON solution, accessing terrain models for Cut & Fill, staking out points and lines and checking heights. These are construction workers with no background in advanced measuring solutions – just some hands-on training by Nielsen himself and they were up and running in no time.

One Coherent Workflow

Besides being faster and more efficient, Nielsen found moving up from a Leica Builder to the iCON robot 50 also benefitted data handling both to and from site surveyors and machine control. "A new feature of the iCON build is the ability to transfer data directly from the measuring situation to a machine control unit, skipping extra data handling at the office. This saves time and money, efficiency is improved, and independence is increased."

The iCON build software is controlled from a PDA or a tablet, gathering all information. Nielsen uses a CC60/61 tablet with a built-in camera. "The user-friendly interface offers very well-arranged graphics, providing the user with an optimum overview of all jobs and projects," states Jonas Nielsen.

Nielsen is considering a 2D Machine Control System for the future but hasn't decided whether to go for it yet, as it will demand other jobs and workflows compared to what he does today. However, it wouldn't be the first time this self-made man successfully took the leap into new technology and new business opportunities.

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Pier A-Plus: Unique Scanning Project

by Theo Drechsel

Frankfurt Airport is one of the most important aviation hubs in the world. Europe's third-largest airport opened its new pier "A-Plus" in October 2012. Spread over a length of 790 m (2,600 ft) and six floors, its gross floor area is 240,000 m² (2,600,000 ft²). The airport operator, Fraport AG, used the advantages of 3D laser scanning to produce specified/as-built comparisons of the CAD data for the newly built pier. During the "A-Plus Pier" project – probably Europe's biggest-ever "scanning construction site" – up to four Leica Geosystems laser scanners were used simultaneously.

The Building Data Management Team, part of Fraport AG's Property and Facility Management Department, is responsible for the new pier's building database. "We must maintain and make available the airport's architectural and building technical services data held in the database," explains Evelyn Happel, Head of Building Data Management. "It is very much in our interest to provide up-to-date, consistent data

Fraport AG, Pier A-Plus: Scanning project key data

3D Laser Scanners used:
Leica HDS6000 series, HDS7000 and
Leica ScanStation C10

- Up to four scanners in use simultaneously
- 24/7 scanning in shift operation for more than 240 days
- Up to five scanning phases per room
- Data volume: approx. 36 TB
- Over 16,000 stations in the project
- An average of 2,000 target points per floor, 12,000 in total

Gross floor area: 240,000 m² (2,600,000 ft²)
Construction: 2009 – 2012

of our existing buildings to our design consultants and construction contractors. The specified/as-built comparison performed during construction is crucial to this."

3D Laser Scanning in Shifts

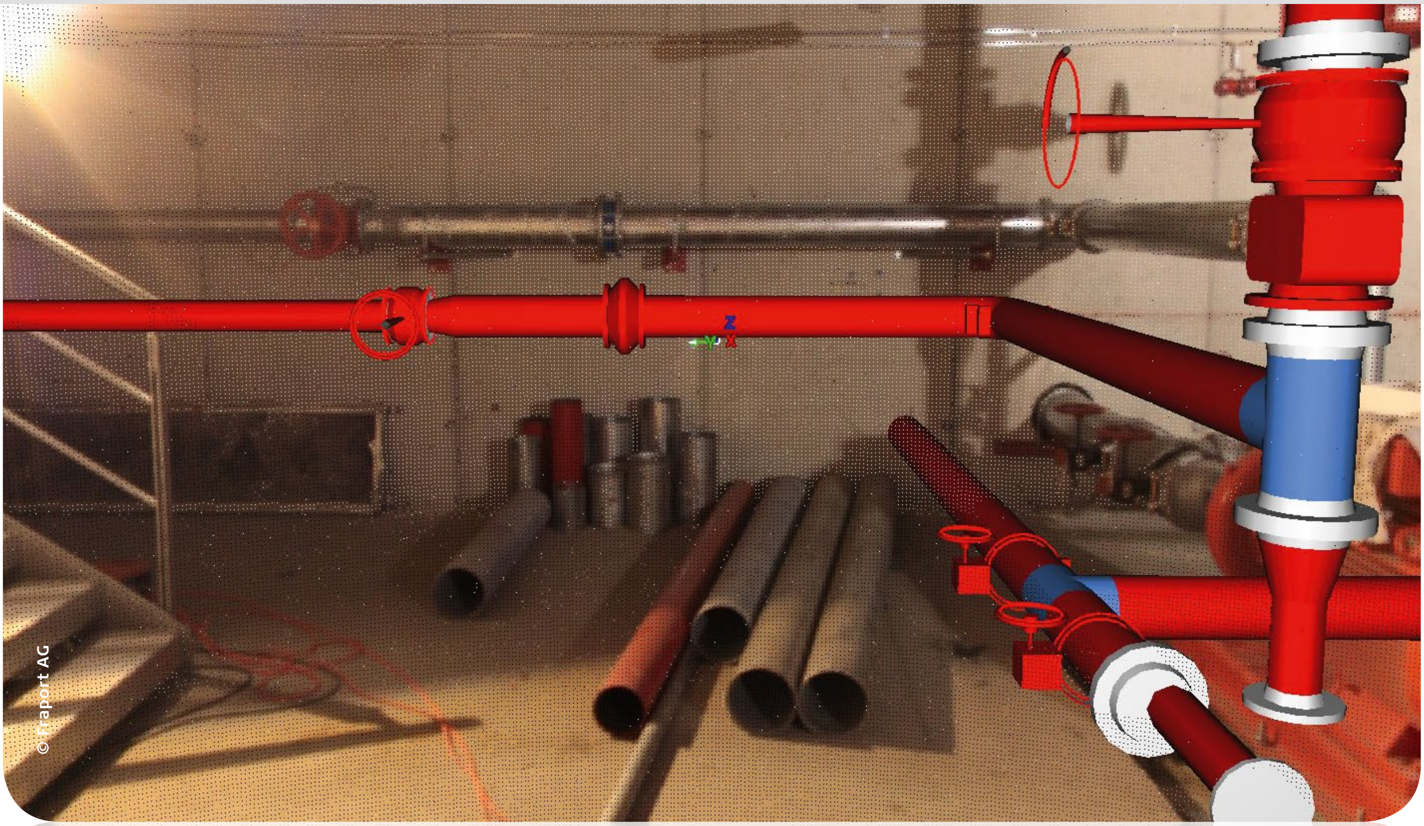
Data for the specified/as-built comparison was captured exclusively by 3D laser scanners. Fraport commissioned two local firms of consulting engineers to carry out the scans during construction. One of the consultants opted for the Leica ScanStation C10 from the beginning and later added the newer model of the proven Leica HDS6000 series, which was also the choice of the other consultant from the start. In the course of the project, both sets of engineers also used the faster HDS7000 laser scanner to keep up with the work on site.

"One scanner per consultant would not have been enough for the rapid pace of construction," says Thomas Konetzki, Manager of the Department "Geoinformation, Building Data Management, Engineering Surveying and Main Archive". "After all, we are talking about an airport pier here – quite different to a family home – with layers of technical building services infrastructure anything from 1 – 2 m (3 – 6.5 ft) deep in the ceiling space." Technical building services include heating, ventilation, water, sanitary and electrical equipment as well as measurement and control technology. Scanning also captured positions of the completed walls, deck slabs, penetrations and podiums. Due to the rate of installation of the technical equipment, each room was captured in several scanning phases to ensure high quality and completeness of the scanned data. Coordination and timing of the scanning phases were therefore extremely important.

The two scanning service-providers contributed considerably to the success of the project, not only by acquiring a second laser scanner but also through their flexibility and commitment. A further substantial advantage was their high level of knowledge gained through earlier commissions and their willingness to liaise continuously and directly with the contractors. In this way, they always had relevant information, such as the progression of work on each floor. Fraport placed great emphasis on close cooperation and continuous coordination between site management and the consultants to ensure smooth operations on site.

Leica Geosystems 3D Laser Scanner for Quality Management

In addition to the two scanning service providers, the 3D laser scanners from Leica Geosystems were



A deviation of the sprinkler pipe layout in the CAD data compared to the actual situation captured by the scanner.

key contributors to the success of the project. "It is very impressive how the technology has developed in recent years. Today's generation is significantly quicker and performed particularly strongly in the capture of object data, both at close and at long ranges," says Evelyn Happel. The scanners had to prove themselves on both of these tasks, as they were used in a variety of different situations: one of the consultants was responsible for the so-called "core building" (the existing hall and short pier of Terminal A) while the other consultant scanned the new long pier. After capture of the scan data, a specialist CAD services consultant checked the results against the as-built data.

The checked data played an important role in quality assurance of the as-built building data: to perform this check, data from all contractors (specified) was compared with the physical as-built situation on site (actual) captured by the laser scanners. Based on the list of deviations, the contractors could set about reworking, correcting and continuing their plans and drawings.

Continued Benefits of Scanning Data

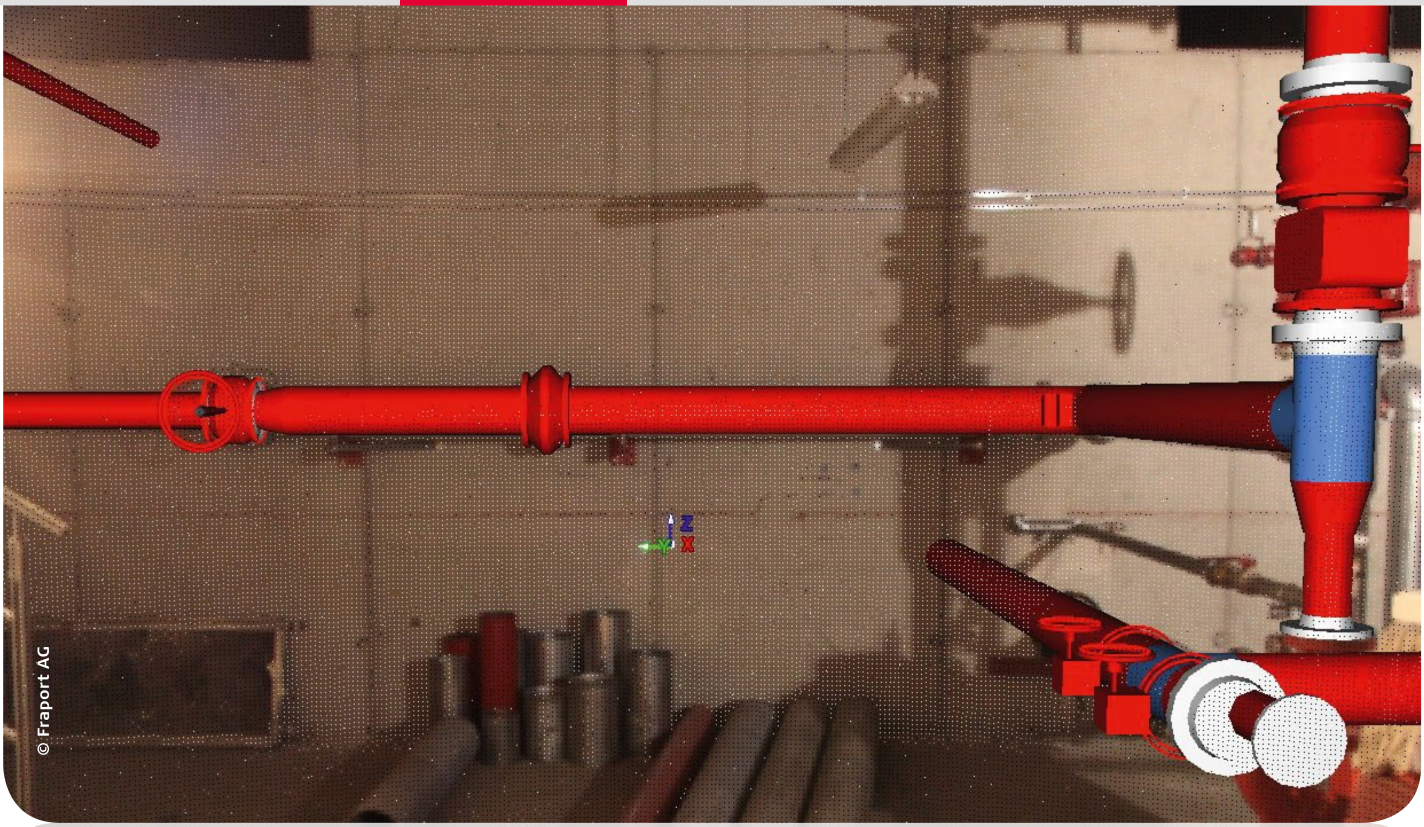
Save for a few remaining tasks, the scanning work on Pier A-Plus is nearly complete. Captured data is used in several different ways: the TruViews produced from them, which allow views and measurements to be made from the scanner station positions in the point clouds, are used in many departments at Fraport AG – for example in case of failures – as well as by the numerous contractors involved. TruViews are perfect for performing as-built data comparison and they provide better orientation than point clouds. Moreover, for the first time scan data is being used in the release of floor areas for retail units in Pier A-Plus, where they augment total station surveys.

Construction in Existing Buildings using meaningful Scan Data

For the most part, Fraport builds within existing buildings, which have to be kept continuously operational because the airport is open 24 hours a day. 3D laser scanners allow all airport operations to carry on smoothly and reliably. This already proved the value of their use on the construction site, where up to 1,700 people were working at any one time. The Building Data Management Team makes laser scanning data available to project managers and specialists working in various parts of the airport to make their tasks easier. Using scanning data they can, for example, check how well their building services equipment fits above a suspended ceiling without having to physically go there and open it up.

Further Development of Leica Cyclone and CloudWorx

In close cooperation with Fraport AG, Leica Geosystems has been able to develop the functionality of



■ **CAD data updated by contractor.**

its Cyclone and CloudWorx plug-in software considerably. With improved import/export routines, plan data can now be read directly into the software. The software adjustments immediately benefitted the scanning project and data evaluation.

The infrastructure management staff at Fraport AG were able to use the knowledge gained to considerably improve their guidelines for scanning services. "The continuously updated guidelines state that we work only with Leica Geosystems products," says Evelyn Happel. "Compared to manual surveys, scanning is considerably quicker, much more accurate and less error prone. For these reasons, we will always use 3D laser scanning for future surveys of existing buildings," explains Evelyn Happel. ■

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Pier A-Plus at Frankfurt Airport

Pier A-Plus at Frankfurt Airport offers capacity for up to six million passengers and is used by Lufthansa and its Star Alliance partners. It provides up to seven aircraft gates, four for the A 380 and three for the A 340-600 or B 747-400, with the ability to accommodate the new Boeing 747-800 aircraft. Passengers are spoiled with exclusive boarding facilities with state-of-the-art interior design. High-tech features include boarding bridges, which not only operate automatically, but are also the first to allow separate boarding of economy, business and first-class passengers.

Frankfurt Airport is Europe's third-largest and the world's eleventh-largest airport. Every day, approximately 1,300 aircrafts take off and land here. Last year more than 57 million passengers used the airport to fly within Germany and to or from around 300 destinations worldwide.
www.fraport.de

Modeling Stairs with Ease

by Anna C. Seidel

In August 2012 group LESCAD from Slovenia faced a challenging project that required new thinking and new equipment. The company that primarily produces technical drawings for yacht interiors, public areas of commercial enterprises, and office furniture was looking for a measuring device that could directly output into CAD. They found what they were looking for in the Leica 3D Disto.

The project they needed this new tool for involved measuring a complex, double winged staircase and providing 3D models and drawings of the structure. The staircase had curved stairs, followed flat walls on the outside and was curved on the inside. In addition, the individual stairs were irregularly shaped.

Completing the measurements using traditional procedures would have involved tape measures, cardboard stencils, and time. Lots of time; for detailed measurements and notes, for input to CAD, and to correct the errors from both. Using more modern tools such as line lasers and laser distance meters would have reduced measurement errors but not the time consuming process of data transfer and input to CAD.

The Leica 3D Disto paid off immediately by allowing the measurements to be taken in just one day by only one operator and with direct data transfer to CAD. Multiple setups were possible to gather the full spectrum of data. By marking reference points with target stickers measurements were repeatable, precision could be controlled, and data from different stations was simply merged together.

Alojz Merela at LESCAD knows from experience "It is much better to start 3D modeling on the basis of accurate measurements. It reduces questions and helps point out critical points on site. Problems can

Leica 3D Disto: Award for "Performance and Innovation"

The Leica 3D Disto recently won the Performance and Innovation Award at the EquipBaie trade fair in Paris in December. This revolutionary tool is able to measure, scan or project to any location in a room independent of a room's geometry or around a building in three dimensions while visualizing and documenting the results immediately.

For more information about the Leica 3D Disto please visit: www.3d-disto-info.com

be solved at an early stage of documentation." All of which saves time and effort.

By automatically generating lines between measurement points on the control tablet in the field the entire survey is visualised on the go. The operator can check the survey and identify possible blind spots or problem areas that need additional measurements before leaving the site.

After just a few hours of measuring, enough data was gathered to generate a complete 3D plan of the staircase – not just of the stairs leading up, but also of the complex underside of the staircase.

In the office the results were transferred from the tablet directly into CAD in DXF format using a USB stick. Processing in CAD soon produced complete 3D models of the entire structure. But that's not all, says Miha Rijavec "We can obtain cross-sections, views, dimensions, details, and notes from the processed model."

After completing the staircase LESCAD went on to measure rooms and to model the interior of the rest of the building. Their Leica 3D Disto proved its worth in more ways than one by not only measuring exact 3D positions and scanning but also because it is able to project CAD data obtained in the office back onto the floor or walls of a structure. The Leica 3D Disto allowed them to perform even the most demanding field measurements quickly and accurately. This process has proven especially useful with curved and irregular shapes.

All these functions were put to good use on this project and will be used in the future as the Leica 3D Disto has found its place in LESCAD's *(www.lescad.si)* toolbox. ■

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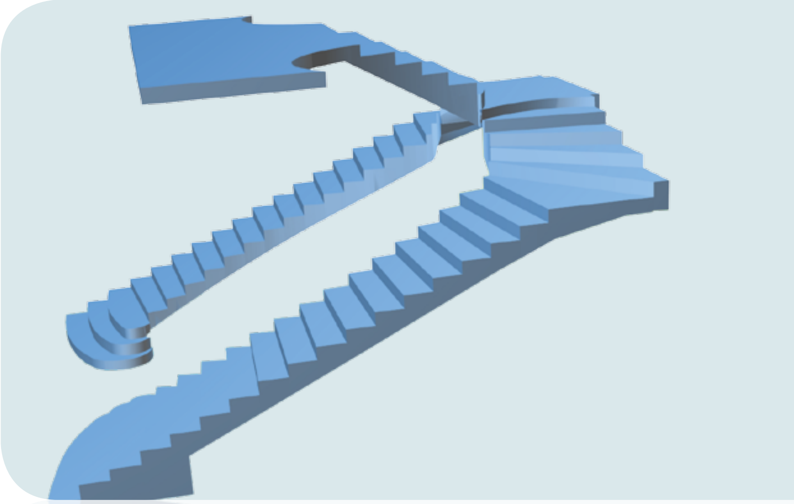


■ **Leica 3D Disto provides modeling data.**

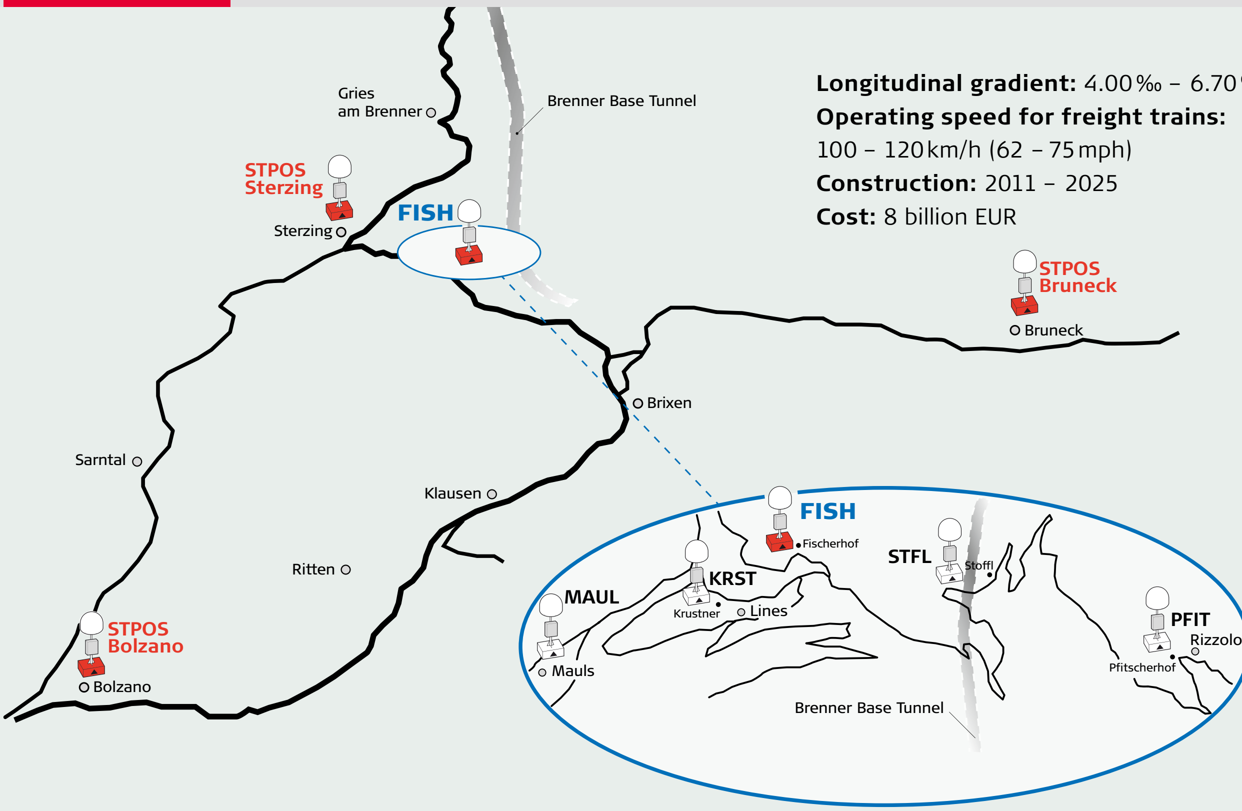
GNSS Monitoring for Safety on the Brenner

by Agnes Zeiner

When it is complete in thirteen years the 55 km (34 mi) Brenner Base Tunnel will be only 2 km (1.2 mi) shorter than the Gotthard Base Tunnel, which celebrated its breakthrough almost two years ago. Leica Geosystems instruments ensured the centimeter accuracy of the Gotthard miners' work and the engineers in charge at the Brenner Base Tunnel have also opted to use Leica Geosystems instruments and equipment for a wide range of tasks, among them the monitoring of a geologically unstable zone on the South Tyrol side of the Brenner Pass. Consulting engineers Trigonos and the European public limited company BBT SE (Brenner Base Tunnel Societas Europaea) are responsible for developing and executing the monitoring work, based on a sophisticated multi-stage continuous (GNSS) monitoring network.

Several sections of the exploratory tunnel for the Brenner Base Tunnel (BBT) are currently under construction. The six-meter in diameter exploratory tunnel will be centered directly below the two single-track main tunnel tubes and will serve as an escape and service tunnel after the BBT is open. The 1.5 km (0.9 mi) "Periadriatic Seam" section of the tunnel, running under the village of Mauls (Community of Freienfeld) in South Tyrol, is particularly precarious. Here the tunnel passes through the Periadriatic Seam – a geologic fault separating the Southern Limestone Alps from the Austrian Central Eastern Alps. The main fault zone is estimated to be about 200 m (656 ft) wide, with adjacent overstressed rock stretching for a kilometer.

The challenge posed by the Periadriatic Seam is well known to the project company – the European public limited company BBT SE, a cooperative venture between Austria and Italy. This section of the works was therefore undertaken with greatest caution. It is being carried out as a separate contract and the underground measurements required during tunnel driving are particularly complex. In addition, the Schwaz-based Tyrolean firm of consulting engineers



Longitudinal gradient: 4.00‰ – 6.70‰
Operating speed for freight trains: 100 – 120 km/h (62 – 75 mph)
Construction: 2011 – 2025
Cost: 8 billion EUR

Products used

Sensors:
- L1 – Leica GMX901 monitoring receiver
- L1/L2 – Leica GMX902 GG monitoring receiver and AX1202 GG antenna
- Leica Viva TS15 imaging total station

Software:
- Leica GNSS Spider, Leica SpiderQC, Leica GeoMoS

Services:
- Leica CrossCheck

Trigonos was commissioned to develop an above-ground monitoring concept: "In close cooperation with surveying engineers of BBT SE, we designed a GNSS monitoring concept and proved its suitability in practice during the baseline measurement and the initial follow-up survey," explains Lienhart Troyer, Managing Director of Trigonos, who is also involved in several other projects for the Brenner Base Tunnel.

Multistage Monitoring Network with 5 + 3 Stations

The above-ground survey has one primary question to answer: is surface settlement occuring during tunneling? The system must run fully automatically, and – should tolerances be exceeded – send text and e-mail notifications to the client and the site supervisory staff.

"We decided to set up a local GNSS network consisting of five points near the village of Mauls, which was then embedded in a higher-order network," explains Lienhart Troyer. The monitored zone covers an area of about two square kilometers, so only a GNSS solution would be able to achieve the required accuracy. The centrally positioned station in Fischerhof (FISH) is used as a reference station for the calculation of the baselines to the other stations in Mauls (MAUL), Krustner (KRST), Stoffl (STFL), and Pfitscherhof (PFIT).

"We wanted to keep the baselines as short as possible to maintain the highest possible accuracy. However, this also means the reference station itself is positioned in a potential deformation zone. Any settlement or movement of the reference station would influence the results of the other four stations. This

BBT SE

Headquarters:
Bolzano, Italy and Innsbruck, Austria
Employees: > 90
Established:
2004 as a European public limited company
Executive Board:
Raffaele Zurlo, Konrad Bergmeister
Responsibles Surveying:
Pierluigi Sibilla, Claudio Floretta, Gregor Windischer

For more information, please visit: www.bbt-se.com

The Brenner Base Tunnel

The Brenner Base Tunnel is the key section of the 2,200 km (1,367 mi) long Berlin-Munich-Verona-Bologna-Palermo high-speed railway axis. This flat trajectory, rail-only tunnel with a length of 55 km (34 mi) will be primarily used for the transport of goods. It consists of two single-track main tubes with an exploratory tunnel running below them. The main tubes will be driven 70 m (230 ft) apart and linked every 333 m (1,092 ft) by connecting side tunnels. Including the existing 7.7 km (4.8 mi) underground freight train bypass around Innsbruck, the 62.7 km (39 mi) base tunnel will be the longest railway tunnel in the world. The tunnel is designed for a maximum speed of 250 km/h (155 mph). In addition to the Innsbruck freight bypass, the line will tie-in to the existing infrastructure of the Innsbruck and Fortezza train stations. Multi-function stations in the tunnel will be located at Innsbruck, St. Jodok, and Trens. *(Source: BBT SE)*

is why the reference station is additionally monitored using data from three stations forming part of the GPS reference service STPOS in the Bozen/South Tyrol province," explains Lienhart Troyer. The lengths of the baselines between the Fischerhof reference station and the three STPOS stations at Sterzing, Bozen, and Bruneck range from 10 km to more than 43 km (6 mi to more than 27 mi). "This hierarchical monitoring network can reliably detect movements of the Fischerhof station, while being able to provide precise local information about possible deformations in the area being monitored."

Installation and First Measurements

Trigonos' contract included implementation of their concept, including baseline measurement and the initial follow-up survey. After several visits with staff from BBT SE, the exact locations of the five stations were chosen. BBT SE conducted the negotiations with the landowners, followed by a construction company erecting the foundations and masts for the antenna communications equipment. Four stations have a 230 V power supply. The Stoffl station was powered by battery for the baseline measurement and initial follow-up survey but will subsequently be operating continuously with a photovoltaic supply of energy. Backup batteries with a capacity of 48 hours will ensure the stations' uninterrupted operation.

The necessary software was installed in the office and included Leica GNSS Spider to operate the network and the individual stations. "The baseline measurement took place in July over a period of 48 hours. We went through the entire GPS constellation several times," says Lienhart Troyer. A Leica GMX902 GG dual-frequency monitoring receiver was used at the reference station, and Leica GMX901 monitoring SmartAntennas were installed at the other four stations. Data transfer was wireless over GPRS/UMTS in real time, with Leica SpiderQC continuously checking data quality. A first follow-up survey, also lasting 48 hours, was performed in August to confirm the baseline measurement data.

Specialists from Leica Geosystems, Heerbrugg were involved with the data analysis, the results of which were incorporated into the BBT frame network. "Because of the length of the base lines and the high accuracy requirements, we relied on Cross-Check, the coordinate calculation service provided by Leica Geosystems, for the calculation of the higher-order network. This meant we avoided purchasing special software for this project and saved a great deal of additional training time. Our expectations of accuracy were completely fulfilled," says Lienhart Troyer, expressing Trigonos' satisfaction with the outcome.

■ A Leica Viva TS15 Total Station monitoring surface movements in Mauls.

Europe-wide Tender

In January 2012 Trigonos was awarded the Europe-wide tender for the continuous operation of the monitoring system issued by BBT SE. This phase of the project will start simultaneously with the tunnel driving in the area of the Periadriatic Seam in April 2012 and will be maintained for at least three years.

In addition to the GNSS monitoring, a terrestrial monitoring system, using a Leica Viva TS15 imaging total station and prisms, was installed in Mauls to obtain reliable and immediate information about ground surface movements, particularly in the densely built center of the 2000-strong community of Mauls. ■

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Trigonos ZT GmbH

Headquarters: Schwaz, Austria
Employees: 21
Established: 1975 as Vermessungsbüro Weiser, restructured in 2008
Managing Directors:
Lienhart Troyer, Christoph Kandler, Joachim Feldes

Projects on the Brenner Base Tunnel include:
Surveying framework contract for the Austrian sector, construction surveying on the Brenner North pilot tunnel, and geodetic level monitoring of the exploratory construction contracts

Leica Geosystems value-added reseller of geomonitoring products since 2009.


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Harvesting Rich Eire Soil

by Nicolette Tapper

The world's population reached 7.1 billion at the end of 2012, and continues to increase by 150 people every minute. More resources are required to nourish the human race. Making the best use of the geographical space we currently occupy and optimal utilization of the untouched land available for agriculture in the future depends on smart, precise and controlled farming technology. A complete agriculture guidance solution increases output, reduces overheads and improves back-office decision making processes. Irish agronomists and farmers are looking to Leica Geosystems' GNSS based auto steering solutions with an integrated service tool and a simple connection to RTK network to increase their yields.

John Arrell, owner of Progressive Agriculture Solutions (PAS), Ireland is no stranger to the world of precision farming. John has been heavily involved with Agriculture Management Solutions since 2002, before establishing PAS. "I started off selling parallel tracking systems and then progressed with the technology, selling my first GPS steered tractor in 2006," John says.

PAS was started in 2012 because John was attracted to the Leica Geosystems Agriculture product suite as they offered a fully supported guidance solution. "I wanted to partner with a company that led the

field in positioning technology and Leica Geosystems was the obvious choice. Their technology was tried and tested in other industries. This gave me confidence to establish my company as a leader in the field."

PAS supplies Ireland's progressive farmers with the full Leica Geosystems Agriculture product suite through tractor dealerships. With no shortage of water and incredibly fertile soil Ireland has the perfect conditions for producing grass, an inexpensive feed for livestock. To maintain these luscious green pastures, a smooth seeding, accurate fertilizing and thorough spraying application is essential. Steer-to-the-line tractor guidance systems such as the Leica mojoMINI provide farmers with even coverage with no overlap, saving money on seed and fertilizer.

For a cereal farmer Real Time Kinematic (RTK) accuracy is imperative for crop cultivation. Leica mojo3D equipped with Leica mojoXact provides sub-inch RTK positioning which determines straight crop lines, pass to pass. Perfect rows no longer come from visual orientation, they're controlled by GPS – much like the one in a car with an in-cab guidance display – connected via a control box to the steering wheel which automatically steers a seven ton machine. John comments "Using these products I am able to engage more with tractor dealers throughout Ireland and I'm able to do this because of Leica Geosystems technology."

Additionally, Leica Geosystems offered John the opportunity to establish his own RTK network. RTK positioning is a satellite-based technology used to provide centimeter level positioning accuracy. An RTK position used by a roving device in the field relies on the data received from a stationary reference source. For John, setting up a permanent network solution means farmers don't need a stationary reference source, as the local area would already have one set up they can subscribe to. "We started the PAS network in an area where there was a demand for high end machinery. By placing base stations in these areas we had something that no one else in Ireland had: our own agriculture RTK Network that worked unlike any of the existing radio bases that were being used."

Positioned only 18 km (11 mi) away from one of John's strategically placed base stations, is arable farmer Liam. Residing in the north west of Ireland

and managing a progressive farm consisting of an array of field shapes and sizes over differing topography, Liam was trialling the Leica mojo3D and Leica mojoXact. Within a month Liam had drilled approximately 100 ha (250 acres) of winter barley, all with the assistance of Leica Virtual Wrench, an invaluable service that is a web based in-field remote support and diagnostics tool. "After initial set up and training on the Leica Geosystems products we supported him through Leica Virtual Wrench, and talked him through any queries he had on set up. We could tune and direct remotely, which he found invaluable, especially when he wasn't sure how to do something. We just logged on to his screen and talked him through it. Within a day he was confidently drilling around sweeping hedgerows using fixed contour and doing the headlands using 'ultimate curve' guidance," explains John.

"Liam found that after a few days of using the steering he became completely dependent on it, using his time to monitor more closely what the implement was doing and conducting business on the phone. The biggest change he noticed is that he gets out of his tractor in the evening not feeling tired or exhausted," says John.

John anticipates a strong future for precision agriculture in Ireland "Partnering with Leica Geosystems has been a great business venture, not just because of the technology that they offer but because of the people within the company and the solutions that they provide me with, like being able to run my own RTK network." ■

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■ **Straight and true crop lines with mojo3D and RTK.**

Smoothness Incentives Achieved

by Daniel C. Brown

For a whole host of reasons, Mike Viehdorfer really likes the stringless control system on his new GOMACO GHP-2800 concrete paver. He works for Manatts Inc., a diversified, family-owned construction company based in Brooklyn, Iowa, USA. Mike is the project manager for the U.S. Highway 71 project in northwest Iowa, his second major stringless paving project.

The 7 million € ($9 million) project involves repaving a four-lane divided highway for a 14 km (9 mi) stretch in Clay and Dickinson Counties. Manatts is placing a 15 cm (6 in) concrete overlay atop the milled asphalt pavement. In the same pass, the GOMACO GHP-2800 paver widens the roadway from 7 to 10 m (24 – 34 ft) with 20 cm (8 in) of concrete on each side.

Strong Incentives

A concrete paver is typically controlled by two stringlines set at precise locations on each side of the lane being paved. 3D machine control, on the other hand, saves contractors considerable time and money by eliminating all of the detailed survey, manual labor and associated transportation costs normally incurred on a highway or runway. Automated 3D control also eliminates the potential for human error

Seamless Integration and Smooth Sailing

With over 13 years of engineering and commercial collaboration between Leica Geosystems and GOMACO, since the first U.S. street was paved by the two partners using 3D controls back in 1999, it is perhaps not surprising how well-integrated the Leica Geosystems controls are on GOMACO equipment. On any GOMACO paver or trimmer, Leica PaveSmart 3D regulates the steering, grade, draft and crossfall of the paver with no need to retrofit complex hydraulics. The system guides the paver in relation to a digitized 3D model of the highway, running on the Leica Geosystems machine computer onboard the paver.

The GOMACO paver is equipped with two prisms, mounted above the machine, as tracking targets for the two Leica Geosystems robotic total stations. The two total stations then follow the movement of the two prisms on the paver and communicate the paver's precise location via radio link to the machine computer. This then computes the differences between the paver's actual location and the digital terrain model. Knowing those differences, the Leica Geosystems machine computer then instructs the GOMACO GHP-2800 to regulate the mold's steering and grade fully automatically.

Two additional total stations are set up, one ahead and one behind the GOMACO GHP-2800, to use in checking the new pavement. As the GOMACO GHP-2800 passes the next total station in front of it, the crew moves the rear station around in front, "leapfrogging" the total stations down the highway. The GOMACO GHP-2800 never needs to stop – a capability unique to Leica Geosystems' technology.

with stringline and its logistical restrictions around the paver.

For this project and others to follow, Manatts' new GOMACO GHP-2800 concrete paver is fitted with a Leica PaveSmart 3D stringless control system. "In the old days, when we were paving on stringline, if you got 50 % of the available smoothness incentive payments on a project, that was good," says Viehdorfer. "Now with our Leica Geosystems paving system, we expect to earn 70 to 80 % of the smoothness incentives on any given project."

And on Highway 71 the Manatts crew was bettering that – earning maximum incentive on about 95 % of the pavement placed. Naturally, Viehdorfer gives a great deal of the credit for smoothness to the quality of the GOMACO GHP-2800 paver and the experience of the crew. Manatts is running the Profile Index (PI) system for measuring smoothness, calculated as the sum of measurements taken at various stations along the surface. The Iowa Department of Transportation says it takes a PI of less than 35 cm of deviation per kilometer (22 in/mi) from a zero blanking band to earn the maximum smoothness incentive. On Highway 71, Manatts has been consistently running between 20 and 24 cm of deviation (13 – 19 in/mi).

Tim Tometich, machine control manager for Manatts, says his company benefits alot from the GOMACO-Leica Geosystems combination. "The value that we have is that GOMACO has built their computer to talk to the Leica PaveSmart 3D computer. The GOMACO computer was built with Leica Geosystems' stringless technology in mind, and the two computers talk really well to each other."

Benefitting the Bottom Line

We asked Manatts' Viehdorfer why he likes the stringless system. "I love the ease of access to the project," he says. "You don't have strings that people are stepping on and tripping over. I think one of the greatest benefits is that we get smoother pavements. When you can do cross sections every 1.5 m (5 ft) on a vertical curve compared to 7.5 m (25 ft) with stringline, you just end up with smoother pavement. And you get finer yield control."

Manatts has two GOMACO GHP-2800 pavers that run stringless with the Leica PaveSmart 3D system. "We also have a couple of GOMACO 9500 trimmers that we can run stringless," says Viehdorfer. "And we have two road mills that also operate with the Leica Geosystems machine control system for profile milling."

■ **A crew member checks elevations on the new concrete surface with a Leica Geosystems total station.**

Manatts also used a PaveSmart 3D system to control the milling machine that re-profiled the asphalt ahead of the paver. Hence the grade and slope of the milled asphalt is set precisely, meaning that actual concrete quantities paved do not overrun the estimated measured quantities by very much at all. The goal is to get a yield close to 100%.

"Before we started stringless milling, our yields were always 110% and greater," says Viehdorfer. "Now that we are using stringless systems for both milling and paving, we are controlling the concrete yields to the 104 to 105% range." Naturally, this material cost saving drops directly through to Manatts' bottom-line, meaning they can bid confidently, and even more competitively, for paving projects in today's tough economic climate.

Plug-and-Play Systems for all Tasks

Leica PaveSmart 3D is fully "plug and play" with the asphalt milling process. "The Leica Geosystems paving system works really well on the milling machine," says Tometich. "We can control line and grade within a couple of hundredths – the same tolerances that we get with the paver. The only thing that you have to be cognizant of is your teeth wear on the mill. The teeth wear changes, so we change teeth more often. And we check grade often with the rover. But the system controls grade really well."

In fact, in 2010 Manatts built an entire project – 10 kilometers (6 miles) of Interstate 35 near Ellsworth, Iowa – with no stakes or stringline whatsoever. The company has Leica Geosystems GPS systems on two bulldozers and one motorgrader, so that equipment did the earthmoving. "Then we used the same GPS dozers and motorgrader to lay the base rock," says Tometich. "We used a stringless GOMACO 9500 to trim the base rock, and a GOMACO paver running on the Leica Geosystems machine control system to pave the Interstate." ■

About the author:
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- when it has to be **right**

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