Speed Sailing

Two Quakes

Scanning a Power Station

Reviving the Past

Conserving Land and Wildlife
Welcome to the latest issue of Technology&more!

Dear Readers,

Each issue of Technology&more gives our readers the opportunity to learn about the unique and exciting projects surveyors, engineers and geomatic professionals are involved in around the world today. Each of these projects—and many others—demonstrate the maximum efficiency and productivity gained through the use of Trimble® technology. In this issue you can read about the quick response by the scientific and geodetic community to the Haiti and Chile earthquakes earlier this year. You can also learn about some of the many projects completed in South Africa for the 2010 FIFA World Cup—or underway in New Zealand in preparation for the 2011 Rugby World Cup.

Read further to find out about conservation efforts in the scenic northeast region of the U.S., as well as preservation efforts in progress on the Mediterranean island of Crete. And finally, read about a different kind of efficiency: speed sailing. Discover how several elite speed sailing teams around the world have sliced seconds off their records with the help of GNSS technology: it may not be pure surveying or mapping, but we thought you’d enjoy going along for the ride!

Now in its fifth year, Trimble Dimensions International User Conference will be held November 8–10, 2010 at the Mirage Hotel in Las Vegas, Nevada, U.S. If you don’t get the chance to attend, you can read about the conference in the next issue.

As always, if you have an innovative project you’d like to share, we’d like to hear about it: just email Survey_Stories@trimble.com.

We hope you enjoy reading this issue of Technology&more.

Chris Gibson

Published by:
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Cover photo: Helena Darvelid.
Making the World Cup Pitch-Perfect

Much of the world was captivated by the FIFA 2010 World Cup tournament earlier this summer. With 32 teams playing 64 matches at 10 stadiums in 9 cities throughout South Africa, the quadrennial event was truly spectacular.

For the World Cup tournament, FIFA (Fédération Internationale de Football Association) required that all ten pitches (fields) had to be geometrically consistent so that every match was, in effect, played on the same pitch.

HL Wattrus and Associates, a Land and Engineering Surveying firm in Johannesburg, got the job to set out permanent reference marks at each stadium so that the grounds-person could re-mark each pitch in precisely the same place for each game.

The goal posts at either end of the pitch were housed in sleeves that were permanently embedded in concrete below the playing surface. These sleeves could not move, so the playing field had to be marked relative to them. The field also had to be centered with respect to the stadium’s axes, so that the half-way line coincided with the center of the players’ tunnel from the dressing rooms and the center of the pitch was aligned with the center of the stadium.

Setting up in approximately the center of the field, Wattrus and Associates used the Trimble S6 Total Station with Trimble TSC2® Controller running Trimble Survey Controller™ Software to compute a multiple-point resection from pertinent features within the stadium. These included the center of the goal post sleeves, the stadium’s central axis, and the center of the players’ tunnel, as well as other points from around the stadium to ensure a solution that was not biased towards one side of the stadium.

The final resection was used to set out the playing field. Each pitch is elevated above ground level for water drainage, and the permanent reference marks were set out in the concrete retaining wall surrounding the pitch. These reference marks were then used by the stadium groundsperson to re-mark all future fields of play.

The World Cup is consistently the most-watched sporting event on TV worldwide. For the first time in its history, the 2010 games were filmed and broadcast in 3D. Host Broadcast Services (HBS), the FIFA-appointed broadcaster, required Wattrus and Associates to set out to various tiers in the stadium for the accurate placing of both the 3D and high-definition cameras along strategic extensions of the playing field, such as the goal lines, the half-way lines and the center lines.

“This task was simplified tremendously by the Trimble S6,” said Wattrus and Associates Partner Grant Reid, PLS. “In robotic mode, the S6 tracked the prism throughout the stadium with ease, enabling extended field of play lines to be set out anywhere within the stadium.”

So if you were lucky enough to see some or all of the matches, either in person or on TV from home or a local pub, you experienced a pitch-perfect view with the help of Wattrus and Associates and Trimble. Whether or not your team advanced may be another story.
Hardly a day goes by that Tim Daddo, head of Macquarie Innovation’s record-breaking sailing team, isn’t thinking about speed. Speed sailing, that is. The Australian-based sailor races yachts in an attempt to break world speed sailing records. Last year his team reached a new milestone as the first sailboat to exceed 50 knots on a 500 m (547 yds) run (yachting’s equivalent to a 4-minute mile in running).

Daddo knows that accuracy is critical when timing a race. When hundredths of a second can make the difference between success and failure, it is critical to use the most accurate timing system available. Up until 2002, the Macquarie team had installed a synchronized and calibrated video camera onboard the Macquarie Innovation to measure position, elapsed
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Opposite page: l’Hydroptère
Above: Vestas SailRocket, crew of l’Hydroptère, and Macquarie Innovation all pursue speed sailing records.

Time and speed. The camera was heavy and awkward and required two surveyors to install. So when the Royal Melbourne Institute of Technology (RMIT) and Australian distributor Ultimate Positioning approached Daddo in 2002 about trying the Trimble 5700 GPS System to record time, the benefits were immediately clear: increased accuracy and elimination of cumbersome video equipment.

RMIT formed a research team to test the Trimble 5700 in tandem with the video camera system. Both the Trimble 5700 and the camera were fitted to the yacht to record 73 x 500 m (547 yds) runs. The testing was done on land and on the water (most race craft have limited sailing opportunities due to changing operating conditions at sea). RMIT then analyzed the data from the runs and incorporated it into a technical analysis which identified the error magnitude of each device. The results confirmed the superiority of GPS over the cameras, Daddo says.

The Macquarie team gathered the information and in 2003 presented it to the World Sailing Speed Record Council (WSSRC), which sanctioned the immediate use of the Trimble 5700. It still remains the only GPS equipment in the world sanctioned to time short-course speed sailing.

“One of the driving principles behind our initial research into the Trimble system was to find a product that would not only satisfy the technical requirements of the WSSRC, but also be a system that was available as an ‘off the shelf’ product, and was robust and reliable enough to survive the rigors of speed sailing,” Daddo says. “ Somehow, I can’t imagine that the original design brief for the 5700 included being strapped to an experimental sailing craft and surviving saltwater, sand and spray ingestion at over 100 km/hr (62 mi/hr)—but I’m happy to report that not once, over some eight years of use, have we ever had a problem with the data acquired by the Trimble system.”

Installing the GPS proved simple. The crew first determined a location on the shore for the base station before mounting the base unit on a clip underneath a weather shield attached to a 90-mm (3.5-in) diameter post. The antenna was then mounted on top of a 750-mm-long (29.5-in-) extension pole and the rover and its antenna mounted into a custom carbon fiber housing on the boat. This housing was sealed by the WSSRC into a fixture in the beam that attaches the crew capsule to the rest of the boat. Logging is activated and deactivated using push buttons on the carbon fiber housing that mechanically activates the logging and power control buttons on the face of the Trimble 5700. A data cable from the data port on the system connects to the Trimble Recon Controller that’s mounted inside the crew capsule and provides real-time speed display. The velocity data coming from the Trimble 5700 is interpreted
by custom software, which produces an alarm when the threshold speed (set by the boat's design team) is exceeded. That information is fed in real time to the crew cockpit. The world speed sailing record is set by taking the average speed of a craft between any two points in the recorded data greater than 500 m apart.

According to the International Sailing Federation World Sailing Speed Record Council (the governing body of the WSSRC) Rules 2010, the GPS survey equipment receiver logging rates must be set at 10 hertz, which results in a GPS position every 1/10th of a second. The GPS must also provide a time stamp with each position accurate within .001 second. The data needs to be so precise that a horizontal position error (hpe) of greater than 0.10 meter (one sigma) will not be accepted.

Since its sanction by the WSSRC, two other record-breaking speed boats have added the Trimble 5700: the 60-foot "D" Class French l’Hydroptère, which claimed the title of outright fastest boat from Macquarie Innovation last fall by reaching an average speed of 51.36 knots (59.1 mph); and Namibia-based Vestas SailRocket, emerging in 2008 as the fastest boat in the world and now holding the Class "B" world record in its sail area.

“The advantage of using the Trimble system is that it allows us to take the fastest 500-meter stretch from any high-speed run, rather than just a time between two fixed points,” says Paul Larsen, Vestas SailRocket’s team leader. “Using the 5700 means we can simply look at the GPS data for the day and pick out the fastest 500 meters wherever it happened.”

Though the three boats compete, they compete in different categories. From a sailing perspective, however, they are all designed to go fast. l’Hydroptère uses hydrofoils to lift its hulls clear of the water, minimizing drag and increasing its speed, while Vestas SailRocket and Macquarie Innovation are variations of planing craft (the main hull skims across the surface of the water, rather than pushing through it like a conventional yacht).

l’Hydroptère is the largest of the boats and was initially built to sail long distances—not break speed records. But when the WSSRC sanctioned the use of GPS-based survey equipment in short-course speed racing, it opened the door for larger yachts, which were previously denied from the “timing canals” because of size, to compete.

In 2007, l’Hydroptère decided to attempt to break the world speed record, and looked for the best device to measure speed and distance that would still meet industry standards—and chose the Trimble 5700. “It is the only GPS with the accuracy and ruggedness recognized by WSSRC,” says l’Hydroptère’s Damien Colegrave, who oversees measurement solutions for the team.

While the original l’Hydroptère is a trimaran (three hulls), a catamaran (two hulls) l’Hydroptère.ch will be launched this year on Lake Geneva. The new boat will serve as a laboratory boat to test new geometry and systems. Data from both boats could conceivably lead to building a l’Hydroptère maxi. The Vestas SailRocket team is also preparing to unveil an evolution of its original boat, “but faster and more suitable for the challenges to come,” says Larsen, who was part of the crew to break the 24-hour world record in 2002. Vestas SailRocket uses the Trimble 5700 to assist in accurate data-capturing; Larsen says the system was key to interpreting test runs so they could refine and repair the boat design to better establish speed and reactions to conditions. Though the Macquarie Innovation has already exceeded its 50-knot target, the designers are now determining whether it is the best craft to meet future goals. These goals are currently being identified and developed, Daddo says.

What the sailing industry will have when these three crafts are complete is a world-class fleet, fit to dominate speed records for years to come.
Wisconsin’s Interstate 94 (I-94) North-South Freeway Project almost perfectly fits the definition of “stimulus.” Initially divided into numerous separate sections, the 56-km (35-mi) infrastructure project had a start date of 2011. The American Recovery and Reinvestment Act (ARRA) changed that. To financially secure the $60-million reconstruction project with stimulus funds, the Wisconsin Department of Transportation (WisDOT) combined the independent projects and advanced the start date to mid-2009. The project restructuring nearly halved the construction time for some portions; it would also make it difficult to accurately interpret construction plans and have a comprehensive view of the entire project.

However, project managers with the Walsh Group, the lead construction contractor, and Collins Engineers Inc., the engineering firm representing WisDOT on the I-94 project, developed a plan to handle these issues. They commissioned Kapur & Associates to transform the integrated plan sets into two “shovel-accurate” 3D models for earthworks, design and construction, ultimately providing crews with a foresight advantage.

Kapur used Trimble Terramodel™ Software to build digital models of the project before starting construction so that managers could “pre-plan operations and rectify any plan discrepancies to avoid build mistakes in the field,” said Survey Manager Daniel Kucza. “That removes any assumptions or misinterpretations in the field regarding the accuracy and quality of the survey data, allowing them to construct more quickly and confidently from day one.”

As the two finished grade and sub-grade 3D models were created, a survey team used Trimble R8 GNSS Rovers and Trimble S6 and Trimble 5600 Total Stations to cross-section the entire project corridor for accuracy of the existing survey data. Once in the field, crews set ground control using Trimble R8 GNSS Rovers and WisDOT’s WISCORS RTK network of 35 permanent Trimble NetR5™ GNSS Reference Stations and Trimble VRS™ technology, providing teams with RTK GPS data in real time to within 2-cm accuracy. Using a Trimble DiNi® Digital Level, Kapur’s team ran a 13-km (8-mi) circuit to establish a vertical calibration accurate to two hundredths of a foot for the control network and for grade and ground profiles.

With the combination of Trimble’s VRS and GPS technology and the 3D models available in Trimble TSC2 Controllers and Trimble GCS900 Grade Control Systems, earthworks teams moved approximately 3,000 m³ (4,000 yd³) of dirt a day to prepare the construction footprint on schedule. The high-precision Trimble S6 and Trimble 5600 helped surveyors stake out more than 45 lane km (28 lane mi) of concrete pavement to within a quarter of an inch vertically for the bottom stone.

Using the Trimble Connected Site™ solution, field data was continually integrated into the portable TSC2 Controllers, connecting the “back office” to the front lines and helping managers to maintain a well-orchestrated assembly line of mini projects; it also helped them monitor work in real time and adapt to needed changes. With the core 3D construction blueprint grounding everyone on the same path, and the advanced survey technology keeping crews on course, field teams successfully completed the first phase of the I-94 project on time, opening the new four-lane southbound corridor to traffic in December 2009.

Construction on the northbound section began in March and is scheduled to be completed by the end of 2010.

See feature article in POB’s July issue: www.pobonline.com
Double Duty

Major earthquakes present challenges and opportunities for scientists and surveyors. Things get even more interesting when the earthquakes come in pairs.

On January 12, 2010, a major earthquake hit the city of Port-au-Prince in Haiti. The magnitude 7.0 temblor caused widespread destruction in the city and surrounding region. Hundreds of buildings collapsed, with more than 200,000 casualties. Five weeks later, on February 27, an even stronger quake (magnitude 8.8) struck off the coast of the Maule region in Chile. Nearly 500 people were killed in the Chilean quake, most victims of the massive tsunami it generated. Each earthquake set into motion enormous rescue and recovery efforts.

In addition to the immense human needs, the quakes demanded immediate action by scientists and surveyors. Dr. Eric Calais, professor of geophysics at Purdue University, had conducted geophysical research in Haiti in 2003. “I know a lot of people from my previous visits and I wanted to help them,” Calais said. “From the scientific standpoint, it’s important to capture the coseismic ground motion, such as how much the ground moved during the earthquake.” Calais also described the need to measure the post-seismic motion, in which the earth’s surface recovers from the large quake and readjusts to a steady state.

Framework for Measurement

Both countries had measurement infrastructure in place prior to the earthquakes. Calais’ 2003 work in Haiti established more than 30 markers for geophysical positioning. In Chile, American, German and French researchers had established networks of survey and continuous GPS (CGPS) stations to monitor tectonic plates. The Chilean Military Geographic Institute (Instituto Geográfico Militar or IGM) had incorporated these and its own stations into a national geodetic network that contained approximately 500 survey markers and a modest number of CGPS stations.

In both countries most survey markers survived the quakes, but the ground and buildings they sat on had moved. It was a big problem: at the time they were needed the most, the geodetic reference frameworks in Haiti and Chile were unusable. “It’s not only of interest to science,” said Dr. Mike Bevis, a geophysicist at The Ohio State University, “it turned out to be a geodetic or surveying catastrophe because most surveyors in Chile relied on the survey markers, not CGPS stations, to realize the national reference frame. They no longer knew where the survey markers were.”

Working independently and more than 3,000 miles apart, Calais and Bevis had similar objectives: They needed to measure the effects and after-effects of the two massive earthquakes as quickly and accurately as possible. To do so, they first needed to rebuild the geodetic reference systems for the affected areas.

Moving a Mountain of Equipment

Calais and Bevis would need a small mountain of GPS equipment. Soon after each quake, the researchers contacted Jim Normandeau, engineering project manager at UNAVCO, a consortium that provides GPS and GNSS equipment and expertise to universities and research organizations. Normandeau quickly agreed to provide equipment from UNAVCO’s inventory as well as technical and logistical support. In addition to the gear from UNAVCO, Trimble provided additional equipment for both countries. Six Trimble NetRS® GPS Reference Stations with Trimble Zephyr Geodetic™ Antennas were supplied for Calais in Haiti, and nine Trimble NetRS Systems were provided for the work in Chile. Other companies supplied GPS equipment as well. Both quake projects were funded through U.S. National Science Foundation “RAPID” grants, which provide research funds quickly when rapid scientific response is key.
One of UNAVCO’s roles was to test and configure the GPS receivers, and then put them into kits with the necessary cables, batteries, hardware and communications equipment. “The big problem is getting equipment to the country and then moving it around within the country,” Normandeau explained. “You need small, compact systems.” Standard rover kits included Trimble 5700 or Trimble R7 GPS Systems and contained solar panels to enable long-term, unattended operation.

For the teams in both countries, simply getting to the affected areas was difficult. In Haiti, Calais found a cockpit ride on a cargo flight from Miami directly to Port-au-Prince. His colleagues had to fly to Santo Domingo in the Dominican Republic and travel by truck to the Haitian border. Bevis, who was in Peru when the Chilean earthquake struck, took multiple flights and an overnight bus to reach Santiago, where he met up with Chilean colleagues.

While Calais could travel to Haiti with his GPS receivers, the gear for Chile faced more problems. “Space on air freight for non-humanitarian cargo was not available,” Normandeau said. “We sent two people to Santiago with 25 systems, each weighing roughly 40 pounds (18 kg) apiece. They called the airline and made arrangements to take the equipment as excess baggage. It was literally a ton of equipment.”

**Recovery, Measurement and Results**

When Calais’ group reached Haiti, they installed a Trimble NetRS Reference Station in Port-au-Prince at the central hub for Voilà, a major cellular service provider in Haiti. The group then divided into three teams, led respectively by professors Dr. Andy Freed (Purdue University), Dr. Glen Mattioli (Univ. of Arkansas), and Calais; each team was assigned to recover and measure a subset of the points established in 2003. At each station, they set up the Trimble GPS equipment and collected data at 15-second intervals. They occupied each point for at least three days, visiting the receivers daily to download data. In less than two weeks, they completed observations at 35 locations around the country. Shortly after Calais’ group left Haiti, UNAVCO Field Engineer Sarah Doelger arrived in Port-au-Prince. Doelger worked with the Bureau of Mines and Energy and the State University to set up five additional Trimble NetRS CGPS Stations.

The work in Chile focused on installing CGPS stations to collect both immediate and long-term data for the geophysical analysis. With Bevis coordinating the work, researchers (including Dr. Jeff Genrich from the California Institute of Technology and Dr. Eric C. Kendrick and Dana J. Caccamise II from Ohio State) and IGM staff installed 25 CGPS stations in less than a month. Next, the work turned to calculations.

Using the GPS data from Haiti, Calais developed three-dimensional displacement vectors for the 35 locations. Near the epicenter, they measured displacement of approximately 1 m (3.3 ft). At sites 200 km (120 mi) from the epicenter, displacement vectors were less than 1 cm (0.03 ft). By analyzing the vectors, the geophysicists found that the quake included both lateral and vertical shifting. That was an unexpected result, as the Haitian quake occurred close to a known strike-slip fault. Without GPS, there would have been no way to discover the complex motion.

The GPS data from Chile went to Dr. Ben Brooks at the University of Hawaii, who computed baseline vectors and positions. At Concepción, Brooks’ results showed that the earth’s crust had moved by more than 3 m (9.8 ft) in a few seconds. Near the city of Lebu, about 100 km (60 miles)
south of Concepción, the crust moved upward by 1.5 to 2 meters (4.9 to 6.6 ft), leaving boats stranded far from the new shoreline.

In the coming months, the researchers will use the newly installed GPS receivers to study post-seismic deformation. Calais has worked with the U.S. Geological Survey to create hazard maps for Haiti, which will assist in planning and reconstruction there. The results from Chile went to research groups in the U.S. and Canada, where they were used to make preliminary predictions about future post-seismic deformation. The analyses also guided the siting of new geodetic reference stations.

Because of the GPS infrastructure in place in Chile, Bevis believes it will be the most carefully studied mega-earthquake in history. “It’s important to realize how the needs of the nation and the survey and engineering community are in parallel with the needs of the scientists,” Bevis said. “The reference frame in Chile is now bigger and denser than it was before the quake. In the face of the disaster, that was a positive outcome.”

See feature on Haiti quake in American Surveyor’s Issue #6: www.amerisurv.com
See feature on Chile quake in POB’s September issue: www.pobonline.com
Known locally as “The Big Build,” Sacramento County Airport’s Central Terminal B project is the largest capital improvement project now underway in the Northern California area. Expected to be completed in 2012, the $1.3-billion project includes a new central terminal, a new automated people mover, new parking lots and access roads, and dozens of significant improvements to runways, taxiways, a 21-gate concourse and support areas. Andregg Geomatics has provided surveying and mapping for the project from its beginning stages in 2006, starting with control, aerial, topo and design surveys, and continuing with staking and as-built surveys. The firm is now working for the county and three main contractors, and has set or recorded many thousands of points. Working efficiently in a highly secure environment and keeping massive amounts of data organized has been a challenge, but the firm says that Trimble Access™ Software and the Trimble Connected Site solution have been keys to success.

Establishing an accurate control network was the first critical challenge. There are significant subsidence issues in and around the airport, and existing benchmarks were unreliable. The Andregg team performed simultaneous observations of three federal base network control stations and several stations in the proposed airport network. Using four Trimble 4000SSI dual-frequency GPS Receivers, Andregg crews performed 20- to 90-minute fast-static observations over three days, with each station occupied at least twice. All post processing was done using Trimble GPSurvey™ Software.

A two-person crew then performed level loops with a Trimble DiNi Digital Level. A total of 37 km (23 mi) of backwards and forward loops were run over three weeks, with balanced backsights and foresights and daily closing of loops. After more processing and least squares adjustments, Andregg achieved an average vertical precision for all lines to all stations of less than 0.991 ppm, an average horizontal error of 0.0037 m, and an average vertical error of 0.0023 m for leveled stations.

Airport security was another challenge. “The link between field and office was important,” said Andregg Project Manager Michael Farrauto, “because security procedures make it time-consuming to enter and exit the airfield.” But with the cellular link to the office via Trimble Connected Community™ Web Service and Trimble Business Center Software, Andregg crews could get needed data without leaving the jobsite. "For example,” Farrauto noted, “to get new point calculations crews would transmit points and measurements as needed to the office. After calcs were finished, the new points would be downloaded right into the party chief’s controller without him even breaking down his instrument setup.”

Robotic instruments with Direct Reflex (DR) capability, including Trimble’s S6 Total Station and Trimble VX™ Spatial Station, have also helped to minimize trips in and out of secure areas. Since most survey work is accomplished with one-person crews, fewer Andregg employees have had to go through the lengthy security clearance procedures, which include background checks, extensive orientation, and issuance of SITA badges that have to be worn at all times.

Long-lasting projects are a boon in tough economic times, and Andregg Geomatics has made the most of this airport project by using advanced technology that keeps quality high and delivery times low.

See feature article in POB’s August issue: www.pobonline.com
During the third and second millennia BC, the Mediterranean island of Crete was home to one of the most remarkable ancient civilizations and the oldest European culture that knew how to write. Starting excavations at Knossos in 1900, British archaeologist Sir Arthur Evans called this culture the Minoans, after their legendary King Minos.

The Minoans were the first to construct monumental public buildings, traditionally called palaces, and decorate them with beautiful wall paintings, colorful stonework, light wells and porticoes; the Minoan culture often surprises archaeologists because of its freshness, beauty and sophistication.

Still, numerous excavations over the last 110 years have not succeeded in clarifying who the mysterious Minoans were and how their society was organized. Many of the early excavators were only interested in pretty objects and did not pay enough attention to contextual associations.

This is why a new archaeological project was initiated in 2007 at a place called Sissi, a village on Crete’s north coast. The project is called Sarpedon (Sissi Archaeological Project: www.sarpedon.be) after the king who is said to have ruled this part of the island until he was exiled by his brother Minos.

During the last three years, excavations were conducted by an interdisciplinary team led by Prof. Jan Driessen, professor of Archaeology at the Université Catholique de Louvain (UCL) in Belgium. The team included archaeologists, anthropologists, topographers, paleobotanists, geoarchaeologists and other specialists from UCL, in collaboration with the Katholieke Universiteit Leuven, also in Belgium, and other researchers from France, Greece and Britain.

The project’s target is the 3.5-hectare (8.7-acre) Kefali hill, 20 m (66 ft) high, situated on the coast about an hour’s walk east of Malia, one of the major palace centers of Minoan Crete. The Minoans chose the hill at Sissi for strategic reasons. With steep slopes on three sides and the sea on the fourth, the hill could be defended easily. Its location on the only road between Malia, in central Crete, and the eastern regions of the island must also have given it specific commercial advantages. Three excavation campaigns have revealed an extensive cemetery, used between 2600 BC and 1750 BC, and a settlement, occupied between 2600 BC and 1250 BC.

Contextual association is everything in archaeology. In the old days, archaeologists mapped everything by hand, usually with a measuring tape that was often floating in the wind or stretched across irregular terrain. Errors were common and plans rarely fit together. In addition, the use of a separate level or even simpler means for absolute height measuring introduced mistakes and frustration.

The team’s topographer, Nicolas Kress used a Trimble VX Spatial Station, supplied by Couderé Geo Services in Belgium. The Trimble VX is well suited to the needs of archaeological projects. With its Windows interface, it is simple to use. It can be used as a total station to provide the necessary coordinates (north, east, and elevation), allowing the rapid recording of both topographical and archaeological features, and to georeference plans and aerial photographs that are subsequently rectified and redrawn.
“The Trimble VX allows us to shoot numerous points very quickly and accurately and prepare a pre-contour plan of points of the excavations,” said Professor Driessen. It is easy to switch color codes for each encountered feature; the archaeologist can print out the pre-plan and easily complete it by hand afterwards by connecting the dots. These are then digitized and imported into a GIS environment and associated with the objects and features found during excavation.

The team is also starting to use the 3D scanning function of the Trimble VX to cover the entire hill as well as specific rooms in which the architectural phases and archaeological stratigraphy are extremely complex. “A 3D visualization allows us to re-construct the sequence of excavation and to offer more convincing hypotheses as to the events that caused the complexity,” said Driessen. “We are also experimenting with 3D scans of some complex objects. Since all material remains in Greek museums, the 3D scans allow us to revisit the object and to better understand it afterwards.”

The quantity of data retrieved during an excavation is enormous: not only the composition and nature of the earth layers encountered are noted, but also all specific features and objects and their associations. “Using the Trimble VX, we can easily tie topographical work to a GIS environment in which all the data are integrated by our spatial data manager, Piraye Hacigüzeller,” said Driessen.

“All these data elements are entered in a database on our field computers.”

The actual work of digging is accompanied by taking copious notes, digital photographs, filming and drawing. Additionally, features encountered through surface reconnaissance before excavation, during the ground penetrating radar (GPR) survey or in aerial photographs all need to be integrated within a single GIS environment.

The link between all these data is their topographical association. This allows the team to create plans and to interpret the plans and hence the data. Behind each point is a feature or an object with photographs, drawings, descriptions, dates—a life. Simply entering a specific time frame within the search function allows the reconstruction of all features and objects that date to a particular period. This enables the team to identify concentrations of specific features and hence to suggest specializations or particular functions (such as workshops where specific objects were manufactured). For a functional reconstruction of the site, such work is of extreme value.

The assimilation of these data and their relationships provides a dynamic, diachronic view of life on this windswept hill some 4,500 years ago. Gradually, a Minoan landscape is being constructed in which nature-made and man-made features are integrated in ways that were not possible before.
I

n preparation for the 2010 FIFA World Cup, South Africa initiated numerous large construction projects across the country. While the new stadiums, transportation and infrastructure projects have attracted the most attention, a project in Limpopo Province plays an important role in the country’s long-term growth.

The Medupi Power Station, owned and operated by South African utility company Eskom, will provide reliable electric power to Eskom customers in northern South Africa. The coal-fired plant uses supercritical boiler technology to operate at higher temperatures and pressures than conventional boilers. Medupi will have six generating units and overall capacity to deliver 4,788 million watts (MW) of power to the South African grid. To reduce demand for water, Medupi will utilize dry-cooling technology as part of its generation cycle. When completed in 2015, Medupi will be the largest dry-cooled plant in the world, and will provide greater efficiency and improved utilization of coal and water than similar plants that use conventional technologies.

Covering 883 hectares (2,180 acres), Medupi’s size and complexity called for expert surveyors. Trail Surveys (Pty) Ltd. of Pretoria was selected to serve on the project’s quality control team and to represent Eskom in all survey matters on the site. “We conduct verification surveys on work done by surveyors from the various construction subcontractors working on the project,” said Trail Surveys CEO Philip Schalekamp. “We also do contour and detail surveys, volume verification, height analysis on earth works and blasting, as-built surveys and other ad hoc surveys and reports.”

One of Trail Surveys’ tasks was to verify the construction of the lift shaft for the boiler on Medupi’s Unit 6. The boiler lift shafts, which are key structures in a generating unit, are erected early in the construction of each unit. Not only must each shaft be in the correct location, it must also be constructed to specified dimensional and vertical tolerances. Built of concrete using slip form construction, the shaft at Unit 6 is roughly 7.6 m (25 ft) on each side and 120 m (394 ft) tall. To ensure that it was built to plan, Trail Surveys combined precise surveying with laser scanning.

**Straight and Narrow**

Confirming that structures are built correctly is a critical part of any construction project. At a new power station in South Africa, Trimble technology makes quick work of a tall order.
The first step was to establish control for the scanning. The Trail Surveys crew used a Trimble S8 Total Station and Trimble CU™ Controller to establish four new instrument stations around the lift shaft at Unit 6. They made multiple measurements to each new station from Medupi's network of geodetic control pillars. The fieldwork for the control took less than half a day. The team downloaded the measurements to Trimble Geomatics Office™ Software and completed the calculations to produce coordinates for the new stations. With the control in place, the scanning work began.

Using the survey workflow in the Trimble system, the surveyors set up their Trimble GX™ 3D Scanner on the new points and oriented the scanner into the project control network. From each point, they scanned an entire face of the lift shaft. Trimble PointScape™ Software “was an important part of the work,” said Trails Survey surveyor Danie Roelvert. “We were able to limit the scans to only the areas of interest, which speeds up the work in the office.” The Trimble SureScan™ technology allowed the crew to “achieve a more regular grid of points,” he said, “which was a tremendous help in cleaning and processing the data.”

Each setup required roughly one hour, and all of the scanning work was completed in about four hours. To avoid the congestion (Medupi employs more than 8,000 construction workers) as well as heat shimmer and dust, the team conducted the scanning early, beginning at 3 a.m. and working until 7 a.m.

In the office, it took about four hours to process the scans using Trimble RealWorks® Software. The registration of the scans went quickly, with residuals as small as 8 mm (0.03 ft). The technicians filtered the point cloud to produce a 10 cm (0.3 ft) spatial grid on each face of the shaft.

With the scanning results in place, the surveyors used the Surface to Model and 3D Inspection tools of Trimble RealWorks to compare the measured data to the lift shaft’s design. Each face of the shaft was analyzed independently as a complete 120 m (394 ft) surface, and also broken into 15 m (49 ft) sections. By color coding the differences between the design and as-built shaft, it was easy to identify deviations from the design.

The Trail Surveys team delivered the data to Eskom in Trimble RealWorks format. By using Trimble RealWorks Viewer, Eskom engineers could inspect the results and access the data for further analysis. Trail Surveys also provided inspection color maps of each face, plus cross sections and 3D views of the shaft. Schalekamp said that his clients were pleased with the deliverables. “The scan is very helpful to analyze each side of the shaft at any given point,” he said, “and also to visualize the shaft in general. The ‘heat plot’ made the data user-friendly so that any person can understand the report.”

According to Roelvert, the project could not have succeeded without the combined Trimble technologies. The Trimble S8 Total Station provided accurate control, and the Trimble GX took over from there. “If we had used only a total station, we would only be able to determine whether the top is within tolerance,” Roelvert said, “and that would have required a surveyor to access the top of the shaft to place a prism. The scanner allowed us to analyze all four sides of the structure, from bottom to top. There were no access issues as the shaft is remotely surveyed. In terms of positioning, you can see exactly what happened during construction.”
As rugby teams around the globe prepare for the 2011 Rugby World Cup in New Zealand, engineers in Auckland, the country’s largest city, are preparing motorways for the 70,000 overseas visitors expected to flock to the city to watch the event. Held over seven weekends starting in September 2011, the World Cup will culminate in October at Auckland’s Eden Park.

To prepare for the increased traffic, Auckland engineers are analyzing stresses in one of the city’s major thoroughfares, the Newmarket Viaduct, to anticipate any problems while the structure is dismantled and replaced with a new viaduct. Central to the analysis is monitoring the structure’s movements with changing load conditions while it is still carrying traffic.

The 700-m-long (2,297-ft) Newmarket Viaduct was built in 1966 as a twin, cast-in-situ, balanced cantilever bridge. This elevated stretch of motorway today struggles to accommodate Auckland’s ever-increasing traffic patterns, leading the NZ Transport Agency to decide to demolish and replace it in stages with a stronger, wider structure. The task of achieving this, while still keeping the motorway open to 160,000 vehicles a day, has been entrusted to NGA Newmarket—an alliance in which the NZ Transport Agency is working with seven private enterprises.

New Zealand has a unique location on the boundary of the Pacific and Australian tectonic plates, and almost every two days an earthquake rattles part of the country. Because of the age of the Newmarket Viaduct, and the possibility that its foundations may have moved as a result of these earthquakes, engineers were concerned about the structure’s seismic resistance as it is slowly dismantled.
To assist with the engineering analysis, project surveyors installed nearly 100 prism targets on the motorway’s piers so movements could be monitored as traffic loadings and air temperatures change. These targets will provide valuable data from which the engineers can base their calculations.

Cherry pickers were used to install the prisms, which are mounted on a bracket bolted to the viaduct and oriented so they are visible from at least two of the six survey stations established along the route. Surveyors used a Trimble S8 Total Station to record target positions in 3-D and store the data.

At each station the Trimble S8 was set to operate automatically for about 3.5 hrs, running through the programmed sequence of prism positions approximately 100 times, with a backsight and foresight to each prism each time.

Before starting its sweep of the targets, the total station initializes by checking that the angles and distances it measures to several permanent survey markers match those measured previously. The Trimble S8 then swings silently, at 115 degrees per second, to the programmed location of each target. At each position it looks for the target, automatically locks to the target and takes readings before swinging to the next target. The Autolock™ feature works from distances of just under a meter to 700 m. The sweep of targets is repeated about 100 times at each survey station, with angles measured to within 1 second and distances to within 1 to 2 mm.

Though the total station has the capacity to record and relay data to an office in real time, the results from the viaduct are not needed immediately so the data is being post-processed. Recorded with the Trimble S8’s data controller, the data is exported in XML file format back at the office into Trimble’s 4D Control™ Software; the software locates the new files, processes the new data and adds it to the existing database for each prism position. The Trimble 4D Control Software provides surveyors and engineers with several options on how to display data.

Only three surveyors are needed to manage the site survey work, which includes setting out beds for the precast bridge sections of the viaduct—the precast yard is 20 km (12 mi) away—and onsite setting out for formwork, new pier construction and the placement of precast bridge sections. A second Trimble S8 and a Trimble S6 are used for this work.

Head surveyor Arthur Waddell said they are very fortunate that the Trimble S8 can do most of the monitoring automatically. “It’s extremely economical on survey time,” he said. Project surveyors will monitor through the demolition to ensure that the movement of the structure as it is dismantled is in accordance with the engineers’ predictions.

New Zealand’s progress in preparing and implementing plans for the 2011 Rugby World Cup’s arrival has earned it an A+ rating from the International Rugby Board’s chairman and chief executive. Auckland’s new viaduct will score yet another victory for the country as it increases Auckland’s motorway capacity well before the opening game.
The University of Northern Iowa (UNI) recently installed a new wood floor in its McLeod Center, an arena dedicated to basketball and volleyball. New to the McLeod Center, that is: the “new” wood floor was actually slightly used and had historic significance for fans of the UNI Panthers men’s basketball team—it had been previously installed in St. Louis in 2009, when it served as the stage for the UNI Panther’s first-ever appearance in the National Collegiate Athletic Association (NCAA) basketball tournament’s “Sweet 16.” (Sweet 16 refers to the final 16 teams in the NCAA Division I Basketball Championships each year.)

“We are going to think back to that great run last year every time we are on this floor,” said UNI Athletic Director Troy Dannen. “How many teams can say they have been to the Sweet 16, let alone actually have the actual floor in their building?”

But there was a downside to the new floor installation. The McLeod Center is only four years old, which means that the prior floor had needed replacing about five years sooner than anticipated. And since wooden floors represent an investment of up to $140,000, university officials really wanted to know what happened. “We suspected that there might be some areas where high or low spots in the concrete subfloor forced the wood floor to bridge gaps,” explained UNI Engineering Planner Doug Lovejoy.

“That’s bad for two reasons: it causes dead spots in the floor that affect play, and it makes floors wear out sooner.”

But suspecting and knowing are two different things. To be sure there was a problem, and to pinpoint its location, Lovejoy needed a way to find very subtle grade changes. Specifications for the concrete floor called for no more than 3.2 mm (1/8 in) rise or fall within any 3-m (10-ft) section. Using manual methods to find exceptions, in an area as big as an arena floor, seemed nearly impossible.

Fortunately, and coincidentally, Lovejoy had received a visit from two consultants, Dan Corbin, CP, and Gary G. Brown, PLS, CP, just two months prior to the removal of the old floor. The pair (they own Dan Corbin, Inc., and GB Consulting, respectively, and team on scanning projects) had demonstrated the capabilities of their new investment, a Trimble GX Advanced 3D Scanner. When he considered the scanner’s capabilities, Lovejoy said to himself, “that might be just what we need.”

Photo by Dan Corbin

Photo by Gary G. Brown

Many Challenges
Corbin and Brown are both certified photogrammetrists, and say that experience helps when getting into 3D scanning. “It’s one thing to have a lot of data,” says Corbin, “but it’s another thing entirely to have intelligent data. Point clouds generate a lot of data, but more is not necessarily better—you need the right amount of shots, spaced properly, on the areas of interest.”
The pair faced several challenges on the McLeod Center floor project. For one thing, the resolution needed was extraordinary: ultimately, they wanted to produce accurate 6.4-mm (1/4-in) contours of more than 465 m² (5,000 ft²) of subfloor. And to do this, they couldn’t set up on the floor itself; if they did, the oblique angles might make it hard to space shots properly and could create problems in the data.

They also had a short time window in which to work. The McLeod Center gets 370,000 visitors a year, and has a nearly full schedule—in fact, one of the events they had to work around was a visit by the Dalai Lama.

One early decision helped resolve all these challenges. The day before their scheduled window, they were able to get into the center for a few hours and set control. Working on assumed coordinates, and using the Trimble GX’s survey mode to traverse, they set just two points on opposite sides of the arena’s mezzanine. This gave them good angles when scanning the entire floor. They also decided to scan all the visible floor area from each point, so that most of the floor was scanned from two points. This gave them plenty of redundant data, and by separately color-coding the points in Trimble RealWorks Software, and using the software’s routines to compare point sets, they were able to manage and analyze points with very high confidence. “We were accurate to about 1/8-inch,” says Brown.

The Trimble GX comes with an optional shooting mode called SureScan, which makes a big difference according to Corbin: “SureScan lets us define the shot spacing we want—two inches (five cm) in this case—and then calibrates shots on the fly to guarantee accurate, even spacing over the entire area of coverage. It was just what we needed on this job, with the big area that we had to cover, and it’s one of the things we like about the GX.”

With all the approximately 800,000 evenly placed points collected in a matter of minutes, Corbin and Brown were able to work with enough accuracy and precision to answer the university’s questions about the floor—and they did find a problem.

“When we produced a 1/4-inch contour map,” says Brown, “it was obvious that there was a high spot centered on one of the free throw lines, and this jibed with what the facilities manager and the players had been saying about dead areas. In an area 9 m (30 ft) across there was a two-inch drop, more than four times the amount called for in project tolerances, and more than enough to affect floor performance.”

Deliverables for the project included a contour map, a plot of points used with x,y,z coordinates, and also the entire point cloud which university staff could view with the free RealWorks viewer. Relevant information was passed on to flooring contractors and should result in much longer floor lifespan—which means the cost of scanning will be repaid many times over.

**New Business Directions**

“We think 3D scanning is the market’s next wave,” says Corbin, explaining the investment in a new kind of survey work. “Especially as BIM [Building Information Modeling] becomes standard, there’s going to be a huge market for intelligent data that defines the built world.” To take advantage of this trend, Corbin and Brown chose the Trimble GX Advanced for its versatility and ability to undertake a variety of projects. “The GX’s combination of speed and versatility is unmatched,” says Brown, “and it will do everything from plant interiors to paved intersections—it’s certainly the right scanner for us.”

Finding scanning projects has proven to be surprisingly easy. “We just got the word out to friends and associates in surveying industry, and visited existing clients, like UNI,” says Corbin. “We find that a lot of surveyors have the need for scanned data, but haven’t made the investment in a scanner yet. We fit in well as subcontractors.”

Scanning continues to be used in compelling new ways, years after it has become a mature technology. Proving that a floor is not quite flat may not seem dramatic to some. But for facilities managers who may save hundreds of thousands of dollars by acquiring the knowledge, it’s downright thrilling—and certainly worth paying for.
Laying the Foundations for GIS and Land Management in Guatemala and Cambodia

With its main office in Helsinki, Finland, FINNMAP (FM-International) is an independent consulting company with major activities in all areas related to mapping, surveying and aerial photography. Over its 50-year history, FINNMAP has successfully carried out projects worldwide in more than 25 different countries, working in both public and private industries.

Today owned by Japan’s PASCO Corporation, the company often contributes to large-scale public GIS efforts, partnering with agencies such as the United Nations, the Commission of the European Union, Development Banks and other international organizations. Throughout the last decade, FINNMAP’s client projects have been relatively focused in Southeast Asia, Asia, Northern Africa, Eastern Europe and Latin America.

Measuring Guatemala

One of the company’s most successful and longest client relationships has been with the Republic of Guatemala. In close collaboration with an extensive group of public and private contributors, in 2005 FINNMAP was selected to produce and deliver digital aerial photographs and maps for the Republic of Guatemala.

The overall goal of this project was to deliver highly accurate aerial photography for the development of base maps and hazard maps, which would be integrated into the country’s developing GIS. The FINNMAP team worked in tandem with the Guatemalan Ministry of Agriculture, Livestock and Food (MAGA) and the International Cooperation Center for the Pre-Investment and Agricultural Diversification.

From 2005 to 2008, FINNMAP used the Trimble INPHO Photogrammetric System package to collect aerial imagery and produce orthophotos for the entire Republic of Guatemala, which spans 108,900 km² (42,046 mi²). The team used Trimble MATCH-AT™ for aerial triangulation, Trimble MATCH-T™ DSM Software for digital elevation model (DEM) production and Trimble OrthoMaster™ and OrthoVista™ Software for orthophoto production.

For phase one of this massive project, FINNMAP successfully delivered digital aerial photography in color (1:20,000) with ground resolution of 40 cm (1.3 ft) for the entire area of Guatemala. The team also processed digital visual and near-infrared (NIR) images (approx. 33,500 images x 2), directly georeferenced by airborne GPS+Inertial technology.

Digital orthophotos with ground resolution of 0.50 m (1.6 ft) were also produced. Digital Terrain Models (DTMs) with 15 m (49-ft) interval were created as well, ultimately giving government officials access to the accurate geographic...
information needed to make informed, thoughtful decisions about fundamental city and land planning initiatives.

“With Trimble’s advanced geospatial technology, our team can efficiently and successfully develop accurate and reliable GIS data in a digital format,” said Timo Sääski, managing director for FINNMAP. “Trimble’s INPHO software has been critical to the first phase of this important project.”

Phase two of the project was orchestrated by MAGA and the National Geographic Institute (IGN). FINNMAP was responsible for providing consulting and technical guidance in orthophoto and aerial image storage and management. Using Aerial Photogrammetry software from Trimble in conjunction with other geospatial technology, FINNMAP produced 259 digital map sheets (scale 1:50,000) to cover the total area of Guatemala.

These aerial images and sophisticated DTMs will be used to aid in the development of a modern cadastral system in the country. Experts agree that the creation of a digital mapping system and GIS is an essential foundation for an effective economy where private landowner rights are monitored, regulated and protected. These digital map sheets will aid in primary land titling efforts which in turn will play a central role in the developing economy of Guatemala.

Meanwhile, in Cambodia . . .
FINNMAP is helping to meet the far-reaching goals of the Cambodian Land Management and Administration Project (LMAP). These goals include:

- Development of national policies, the regulatory legal framework, and institutions for land administration
- Assurance and registration of titles in urban and rural areas
- Establishment of an efficient and transparent land administration system through digital cadastral mapping and land registration based on geodesy and presented through modern tools by GIS

For the initial phase of Component 3 of the LMAP, “Land Titling Program and Development of a Land Registration System,” FINNMAP is helping to facilitate and manage the collection of accurate GPS information, aerial photographs and orthophotos for 46 villages in 4 of Cambodia’s 24 provinces: Kandal, Takeo, Kampong Thom, and Shihanoukville.

Land ownership data was collected by systematic land registration using Trimble equipment in addition to other mapping and GIS technologies. Working in tandem with agency staff, GIS field data was collected by traveling from village to village. The team captured aerial imagery parcel by parcel for the adjudication, demarcation and surveying in the fields.

FINNMAP is also working to create links between legal land registration data and parcel maps, which will be used to secure land, promote land ownership, stimulate business and community development, and to minimize land disputes.

Sääski and other contributors to this project believe the results for the initial land survey phase have been extremely successful. In fact, from 2002 to 2008 this project delivered 1,012,512 title certificates and publicly displayed 1,096,242 parcels. In total, the group has surveyed and adjudicated 1,306,487 parcels. The work is expected to continue into 2012.

“Trimble photogrammetry and laser scanning software empowers our team to more efficiently manage these complex and multi-dimensional projects that involve many moving parts from digital mapping and modeling, to aerial photography and land titling to remote sensing,” said Sääski. “Comprehensive orthophoto production capabilities, the ability to efficiently collect survey data, combined with our expertise in processing geographical information, are all elements that allow us to best serve our clients.”

The Cambodian imagery was publicly displayed.
Modern railway systems require frequent inspection to prevent encroachments along the train tracks. A new technique developed in Germany uses Spatial Imaging to speed the work and reduce costs.

With more than 34,000 km (21,000 mi) of rail lines, DB Netz AG (DB) is one of the largest rail systems in Europe. A critical safety requirement is to maintain clearance between trains and objects adjacent to the tracks. DB relies on surveyors to provide precise location data on the structures and installations of the railway system. All measurements must meet DB’s requirements for accuracy, quality control and compatibility with existing databases.

In congested areas such as urban corridors and train stations, surveyors commonly use photogrammetry to create cross-sections along the track alignment. To provide reference information, a measuring frame is placed on the tracks while the photos are collected. The method produces good results, but the measuring frames are heavy, awkward and require frequent calibration.

Led by Prof. Dr.-Ing. habil. Michael Möser, a team from the Geodetical Institute at Technical University of Dresden (TU-DD) developed a new method for measuring encroachments. The team uses a Trimble VX Spatial Station with Trimble CU Controller to capture information about encroachments and clearances along the tracks. Similar to photogrammetry, the method uses the Trimble VX to capture digital images. In addition, it uses the instrument’s positioning capability to streamline field and office work.

To demonstrate the new process, Möser’s team conducted a survey at a railway station at Glashütte. The team set up the Trimble VX near suspected encroachments and used free stationing to orient the instrument into the DB coordinate system. They placed a small target at two points a few meters apart on one rail and measured the locations using the Trimble VX DR measurement. These points defined the X-axis for the local stationing.

Next, the team measured directly to the suspected encroachment. “The DR capability lets us measure objects that are difficult to access,” said Dipl.-Ing. Mandy Kolb, Möser’s student at TU-DD during the project. “We used the station and offset function in Trimble Survey Controller Software to compute the station value of the encroachment relative to the rail.”

Using the stake out by station function in Trimble Survey Controller, the team then set out two reference points, one on each rail, at the same stationing as the encroachment. The software’s overlay function made the work go quickly by providing a visual reference of the setout point in the Trimble VX video display. The team placed the target at the new points and measured...
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Take a quick Technology&more survey and you could win an Apple iPad!

Möser said the Trimble VX Spatial Station is well suited for the complex work. “The approach is fast and delivers complete, concise data without specialized equipment,” he said. “The speed of the process reduces the amount of time that survey teams must spend on the track or in hazardous areas.”

See feature article in POB’s October issue: www.pobonline.com
Conserving Land and Wildlife with GPS and GIS Technology

The Western Penobscot Bay region of Maine is one of the most scenic areas in the northeastern U.S. and a favorite destination for travelers during the summer tourist season. With abundant water resources and forestland, the region is a natural haven for numerous wildlife species including eagles, seals, nesting sea birds, dolphins and more.

Coastal Mountains Land Trust (CMLT) has been working since 1986 to permanently conserve land to benefit the natural and human communities in 15 towns in this region. The organization has worked cooperatively with landowners to conserve more than 3,237 hectares (8,000 acres) of land and now manages 58 individual public access preserves and monitors 53 conservation easements that sustain agricultural, forestry, scenic and wildlife resources.

Additionally, it manages more than 37 km (23 mi) of wild, scenic trails on the properties it protects.

Support from the Norcross Wildlife Foundation and Trimble have recently provided CMLT with a Trimble GeoXM™ handheld, as well as Trimble’s TerraSync™ Professional and GPS Pathfinder® Office Software to better manage and maintain data about its properties.

“Maintaining a stewardship GIS database is now a key part of the work we do; having accurate data informs our management decisions,” said Ian Stewart, stewardship director at CMLT. “We’re extremely grateful to the Norcross Wildlife Foundation and to Trimble for support that allows our organization to be more efficient and impactful.”

“When we first received the GeoXM handheld, we loaded it with GIS shape files, some of which we had in our existing GIS database and some of which we acquired from the state,” said Stewart. “This put detailed location information about rivers, streams, contours, parcel boundaries and other landmarks right in the palm of our hand.”

The GeoXM handheld came equipped with TerraSync Software for quick and easy data collection and was also loaded with aerial photos of the region, which CMLT obtained from the state of Maine. Now, when the organization acquires new land, staff members use the unit to develop the baseline documentation necessary to plan for the property’s future stewardship.

“When we first get a new piece of land, we take thorough notes so we can carefully monitor the state of the land over time,” said Stewart. “We start by visiting the property with the GeoXM handheld to mark its boundaries, take photos, geolocate the photographic points and take note of streams, weeds, animal habitats and other land features.”
Back in the office, the data is imported into GPS Pathfinder Office software for postprocessing. The software’s powerful GNSS postprocessing capabilities ensure that the data is reliable, consistent and accurate within 1 to 3 m (3 to 10 ft). Once postprocessing is complete, GPS Pathfinder Office exports the data as a shapefile so that it can be edited, analyzed and maintained in ESRI’s ArcView GIS software.

In addition to collecting and managing data about newly acquired land, the Trimble GeoXM handheld is also a key component of the organization’s stewardship program for existing land. Its uses include:

**Ecological inventory studies:** The GeoXM handheld is used to complete detailed inventories of CMLT’s land preserves, including collecting data about sensitive areas that need to be restored and creating maps of different types of communities on each property, such as wetlands, pine forests or grasslands.

**Management plan development:** CMLT creates a five-year plan for each of its properties, including trail development, ecological development, and restoration. According to Stewart, having such plans enables the organization to better manage each property and its workload; it also helps bolster public support and fundraising.

**Public access management:** Accurate information collected in the field and stored in the GIS helps the staff determine where to build bridges, implement landscaping to prevent erosion or clear debris from roads and public access points.

**Trail development:** Each hiking, biking, and scenic trail is mapped using the GeoXM handheld, which makes it easy to see where trails intersect and where they are in proximity to boundaries or natural habitats; the data also helps with trail maintenance and planning.

**Boundary maintenance and monitoring:** Aerial photos and parcel data in the GIS database are loaded onto the GeoXM handheld to help CMLT monitor and maintain boundaries between their land and neighboring properties.

**Habitat management:** Managing the natural habitats of local plant and animal species is another important responsibility. For example, more than a third of one preserve is protected as open space for grassland birds. Staff members use the GeoXM handheld to map a rotational mowing cycle to help protect the birds’ natural habitat. At another site, more than 25 stands of invasive plants have been mapped to help manage weed control.

According to Stewart, CMLT saves money by using Trimble’s solutions to complete tasks internally that otherwise would have to be contracted out, such as surveying and drafting legal documentation about deeds and boundaries. Stewart estimates the organization completes much of its field work in half the time because workers can navigate to a specific location and, once at the site, basic data collection and orienteering becomes much easier.

“From getting new land into our system to managing our stewardship program for existing land, Trimble GPS and GIS technology is making us a better organization,” said Stewart. “We simply couldn’t do many of the things we’re doing today—linking photos to geographic points in a database, mapping trails, implementing long-term, spatially accurate plans—without it.”

“We will definitely be using GPS and GIS technology into the future,” said Stewart. “Our goal is to continue to find new ways to use this technology and to be more proactive at managing our land and our GIS database.”
This issue's Photo Contest winning images may evoke some responses: Golf in Hawaii, anyone? Visit a Dinosaur Park in Connecticut, view the wildlife in the Ukraine, or gaze at the Auckland Skyland in New Zealand? First place—and a Trimble 4-in-1 all-weather jacket—goes to Grant Reid of HL Watrous and Associates in Johannesburg, South Africa, for his shot of the Soccer City World Cup 2010 Stadium. You’ll see the photo on page 1 and the back cover.

This issue’s Honorable Mention winners will each receive a limited-edition Trimble watch:

**Hawaii Hole in One**
Surveyor Doug Flath of the Korte Company sent this gorgeous shot while conducting an as-built survey of the recently rebuilt cart paths at the Kaneohe Klipper Golf Course at Marine Corps Base Hawaii in Kaneohe, Oahu, HI. The Kaneohe Klipper is an 18-hole championship golf course where the Ko’olau Mountains frame the front nine and the Pacific coastline spans the back nine. In this picture, the 13th hole is just to the right and the 14th tee is to the left as one looks down the 14th fairway. “Since this work was taking place on an active golf course, I had to be quick in my work,” said Flath. “After dodging many golf balls, I thought why not use the continuous topo feature in Trimble Survey Controller and quickly drive the paths in between golfers teeing off. So with my safety in mind, I was able to complete the project without getting hurt and much quicker than anticipated with our Trimble 5600 Total Station.”

**Auckland Skyline**
Surveyor Mike Fleming with Harrison Grierson Consultants in Auckland, New Zealand, submitted this stunning image of the Westhaven Marina against the Auckland City Skyline. Harrison Grierson used 4 Trimble R8 GNSS Receivers in their Victoria Park Tunnel topographical survey project in Auckland, which is currently under construction; the image shows the Trimble R8 GNSS base station set up over one of the control benchmarks for the pre-construction topographical surveys. The surveys involved the detail surveying of 2.5 km (1.6 mi) of motorway and surrounding areas, which included the use of digital levels and robotic total stations for the required higher-vertical-accuracy areas. Regarding the Auckland Sky Tower visible in the background, Mike says, “Our company was involved in the set out of this tower during 1995–1997, which included as part of the set-out procedures the use of Trimble 4000 SSI RTK GPS, tilt sensors and customized Trimble software to maintain verticality of the tower during construction.”
The Snake That Liked Yellow
These fun photos were taken by Igor Toropa of Navgeotech PB in July 2008 in the Kherson area of Ukraine. Igor was initializing a Trimble R3 GPS Receiver for an observation session when he noticed a grass snake had quietly climbed up the receiver during initialization. He put the Trimble Recon Controller on the ground to get the snake; when the snake was lowered to the ground, it promptly climbed on the controller. “In our opinion he liked the yellow color of the instrument,” said Ukraine Trimble distributor KMC’s Vitaliy Gluschenko, who sent in the images.

Dinosaur State Park
Professor James (Drew) Hyatt, PhD, at Eastern Connecticut State University has perhaps the dream project: he just started scanning Eubrontes tracks at Connecticut’s Dinosaur State Park. (Eubrontes is the name of the fossil tracks found in the area in 1966; most scientists agree that the trackmaker was a carnivorous dinosaur similar in size and shape to Dilophosaurus.) There are approximately 2,000 tracks in the park, of which ~600 are available for viewing inside the park’s domed interpretive center, with the remainder having been reburied for preservation purposes. The tracks range from 25 to 41 cm (10 to 16 in) in length and are spaced 1.07 to 1.37 m (3.5 to 4.5 ft) apart. “The plan is to use the Trimble VX Spatial Station to characterize the forms, to build phototextured overlays and rectified maps for school groups, and to eventually perform form analysis on prints to determine whether individuals can be distinguished from one another,” explains Hyatt. The unique park, which attracts more than 50,000 visitors annually, is one of the largest dinosaur track sites in North America. The park’s museum presents a bird’s-eye view of the preserved Mesozoic floodplain covered with tracks, dioramas of Triassic and Jurassic environments, collections of fossils, and interactive exhibits.
The winners of the Trimble Photo Contest receive Trimble prizes and the photos are published in Technology&more. This issue's first place winner is the World Cup Stadium photo submitted by Grant Reid of South Africa's HL Watruts and Associates. Honorable mention winners are published on pages 24-25. Send your photo at 300 dpi resolution (10 x 15 cm or 4 x 6 in) to Survey_Stories@trimble.com. Make sure you include your name, title and contact information.

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