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REPORTER 45

The Magazine of Leica Geosystems

Leica Geosystems

Leica Geosystems – Capture new dimensions.

Capturing new dimensions – that is Leica Geosystems' goal for the new millennium. Not only with help from our large repertoire of instruments, systems and industry know-how, but also through our company's financial infrastructure, by broadening corporate ownership.

A few weeks ago, Leica Geosystems published successful results for the previous financial year. 15% higher revenue and sustained earnings growth, accompanied by notable increases in market share, indicate that Leica Geosystems is on a very positive development course and has created significant added value for all stakeholders: customers, shareholders and employees alike. Spurred on by this success, Leica Geosystems went public on the Zürich stock market a few weeks ago. This move established the prerequisites for Leica Geosystems to implement strategy even faster in its endeavour to continue delivering the latest technologies and broad-based, world-wide sales and support services, and secure its long-term position among the leading companies in our industry.

We feel a historic commitment to customers who use our instruments and systems. Reporter readers already know the degree to which Leica assists customers in achieving better infrastructure and carefully documenting our environment, be it through surveying, cartography, GIS/LIS management, industrial measurement, national defence or navigation. We intend to keep things this way, by remaining the leading force for innovation and the premier vendor within the industry. What we did for EDM and GPS will repeat itself through the nurture of promising technologies that translate into products which get the job done effectively. Our investment position in Oakland, California-based Cyra Technologies Inc., the world's leading laser scanning and 3D visualisation company, is a typical example of our intent.

Should you wish to benefit from Leica Geosystems' continued development not only as a customer, but as a shareholder, the opportunity is now yours. "Capture new dimensions" – I am certain that Leica Geosystems' declared mission will also be reflected in its share price.

Yours

Hans Hess,
President & CEO, Leica Geosystems

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Editorial

Dear Reader,

Our cover page shows one of the last century's best-known structures. The Sydney Opera House is a veritable art palace of nearly a thousand rooms. More than that – it has become a symbol not only for a city of four million inhabitants, but the entire continent "down under", not to mention a 20th-century architectural classic. It also marks a milestone in surveying technology. A generation ago, the architects, engineers and surveying professionals involved in its construction were pushing the limits of their respective disciplines. As early as 1970, the Sydney Opera House was the first in a series of high-profile international projects where a reducing infrared tacheometer – the Wild DI10 – was deployed in the closing phase of shell construction.

The building faces a tough climate. Its effects must be monitored, and any damage repaired. In this respect, the opera house is no different from the giant cathedrals of the middle ages, or the Eiffel tower. Today's technologies may be relative newcomers, yet keeping an eye on such large-scale buildings would now be inconceivable without the help of lasers – from Vienna's St. Stephen's Cathedral to the Sydney Opera House.

Waltraud Strobl

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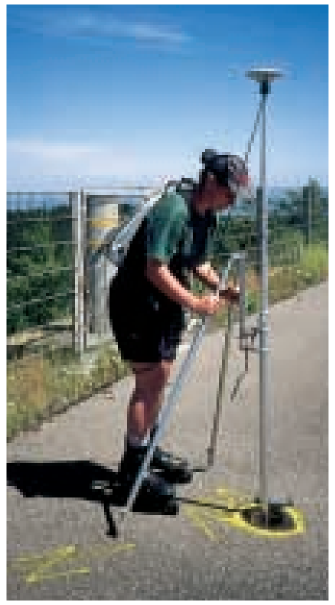

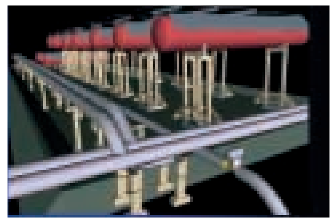

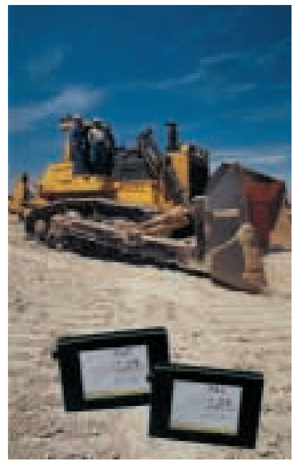

Welcome to Sydney's "Stadium Australia" sports arena

Distance measurements in record time

February 2000 marked the dress rehearsal, with 1250 athletes competing at the Australian Open Athletics Championships held in the newly-built Olympic stadium. Leica Geosystems total stations were deployed to measure jumping and throwing distances in Sydney's new "Stadium Australia". At the meeting, athletes were for the first time able to realistically assess sporting conditions in an arena with a seating capacity of 110,000. The stadium managers also made good use of this opportunity to test the efficiency of proceedings, and see how state-of-the-art measurement and transmission technologies could work together.

Foto: David Madison/Stone

To measure athletes' jumps and distances, Swatch-Timing has deployed, for the very first time Down Under, a new generation of laser surveying instruments developed by Leica Geosystems, Heerbrugg, Switzerland. These instruments focus automatically on the exact landing point and measure the distance at the speed of light. One Australian discus judge said, "With this new laser equipment we were able to determine the distances significantly faster, more accurately and more reliably. Now we won't have to worry about sagging tape measures and unclear calls any more!"

"Just a few seconds after the measurement had been taken, our jury had the result in digital form to the nearest centimetre." This will please television audiences in September – and during the finals we are talking about more than a billion people following the competitions on their screens.

A bold sports arena in the huge Olympia Park

Conditions in Stadium Australia are ideal for TV transmissions: maximum overhead coverage is possible and cameras can be set up in the optimum locations for all the different types of event. For example, the glass panels in the two curved roofs over the side stands have four different layers of tinting, ensuring that the light and colour temperature are balanced for TV transmissions and that spectators are protected through filtering of ultra-violet light. Lines have been laid in the stands, enabling individual spectators in 85,000 seats to be connected to electronic equipment. Stadium visitors are struck by the excellent view of the various competition areas which are available from every seat position. On the intermediate tiers, which are conveniently accessible, there are areas specially designed to accommodate wheelchairs, not just for the Paralympic Games in the second half of October, but for all events held in Stadium Australia.

Sydney's Olympic Park is twenty kilometres from the city centre. Over the last ten years, additional large training centres and competition areas for tennis, basketball, hockey and track athletics have simultaneously been erected around Stadium Australia on the same site in Homebush Bay. As well as the covered SuperDome with its 20,000 seats for sporting and entertainment events, the Olympia Park's Aquatic Centre is also very impressive. It is one of the largest covered swimming pool and water sports complexes in the world. World records fell here even before the Olympic Games.

Stadium Australia is the most state-of-the-art athletics competition venue of our time. It can seat 110,000 spectators. The enormous roofs over the side stands are covered with four layers of tinted glass panels aimed at optimising the television picture quality.

A gold in architecture before the first Olympic gold

Both Australian athletes and spectators were thrilled by the atmosphere in this projecting stadium building, which has already had architectural and ecological prizes conferred on it. Stadium Australia could also turn out to be a sporting venue where new records are broken – not just in running but also in the Long Jump, High Jump, Pole Vault and Triple Jump, the javelin, hammer and discus disciplines, the shot-put, heptathlon and decathlon. The first major Olympic test before the Summer Games takes place in the middle of August when the national Olympic selections are announced in Stadium Australia. Athletes from Australia and other countries as well will also be pushing themselves to the limit here once they have overcome their jet lag. When the Olympic flame is lit in Stadium Australia in the second half of September it will spur them on to yet greater feats.

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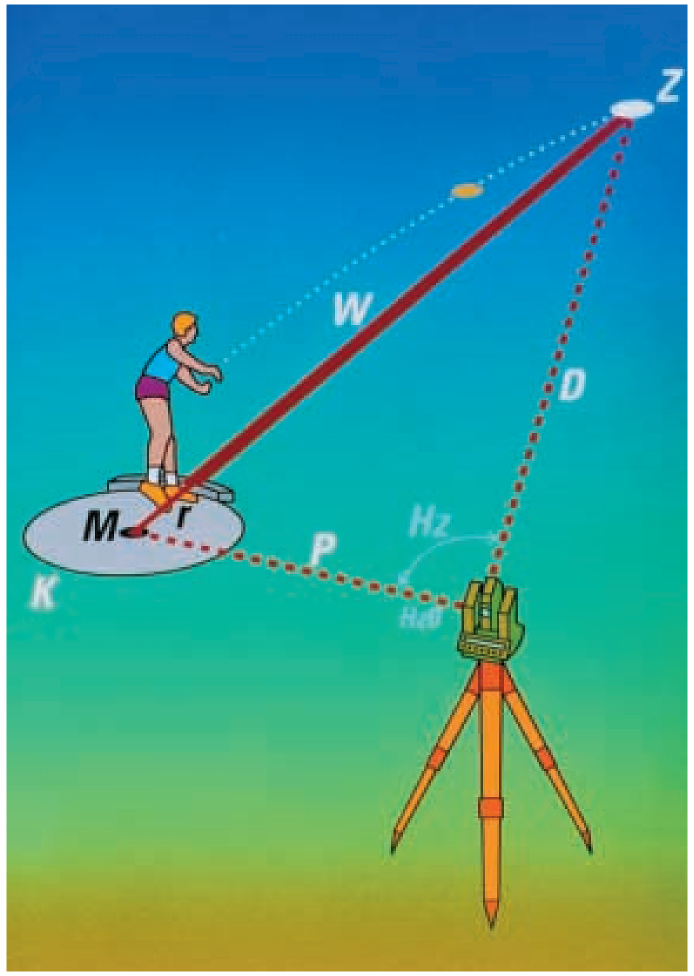
Setting sights on the 2000 summer Olympics at Stadium Australia: SwatchTiming keeps track of times and distances, with help from Leica Geosystems instruments.

Thanks to high-precision chronometry, 75 metre throws can be measured at the speed of light to an accuracy of one millimetre!

Time is the single most accurately defined and reproducible variable in modern physics. The distance measuring technology which is being used in Australia is also based on high-precision chronometry combined with laser technology. With laser distance measurement, quartz crystal oscillations are used to determine the time it takes for a laser light pulse to travel from the start line or throw line to the spot where the athlete or the object thrown lands. Such an invisible "infra-red light flash" covers almost 300,000 km in just one second. The outbound and return paths of a 75 m throwing distance are covered in just half a millionth of a second (0.0000005 sec.). But the speed at which the light pulse travels is also affected by temperature, humidity and brightness. Hence the Leica laser tacheometer, which automatically performs hundreds of such measurements simultaneously within 1-2 seconds, takes these parameters into account. It uses these measurements to compute the exact distance to an accuracy of 2 mm. Yet the measuring software stored in the Leica TCA views the results only" as a rough input: at the same time an oblique distance laser measuring capability also determines the angles opto-electronically. These values are combined with the results of distance measurement by geometry. The combination of these two methods means that a 75 m throwing distance can today be resolved to an accuracy of 1 mm with a single key press. But because the impact point of the object thrown can only seldom be defined so accurately, distance measurements are generally rounded to the nearest centimetre at athletics competitions.

The laser triangulation principle used to measure distances in Sydney.



In the disciplines which involve throwing from a throwing-circle, such as discus, hammer or shot, the automated Leica TCA tacheometer is set up before the start of the competition in a location near the throwing-circle (K). The centre of the throwing-circle (point M) is then determined and angle Hz 0 and laser distance measurement are used to measure its relative position (P) from the instrument midpoint. The competition can now begin. The discus flies through the air and lands in the marked sector. At the point where the discus strikes the ground, the judge lightly places the target mark (point Z) in the ground. The competition surveyor roughly aligns the telescope and presses the start button. The automatic system now seeks the midpoint of the target mark, activates millimetre-precise laser beam measurement of the distance (D) between instrument and target mark (Z), and determines the horizontal angle (Hz) between the centre of the throwing-circle (M, Hz 0) and the target (Z). The software calculates the first throwing distance (W) by trigonometry, deducts the radius of the throwing-circle and rounds the result to the nearest centimetre. A few seconds after the start button has been pressed, the validated distance appears on the judges' screens automatically. All they have to do is press a button to confirm the result and the distance is automatically transmitted to the ranking lists, stadium display boards and television screens.

Projecting side stands, spiral-shaped multi-tier access ramps and the magnificent curved roof structure over the side stands are the distinguishing architectural features of Stadium Australia which visitors notice as they arrive.
In this picture building surveyor Neville Thomson is checking the positions of the huge concrete abutments. Their anchorings were determined in 1998 using Leica Geosystems' measuring technology.

Neville J. Thomson: "It was great to be part of the project!"

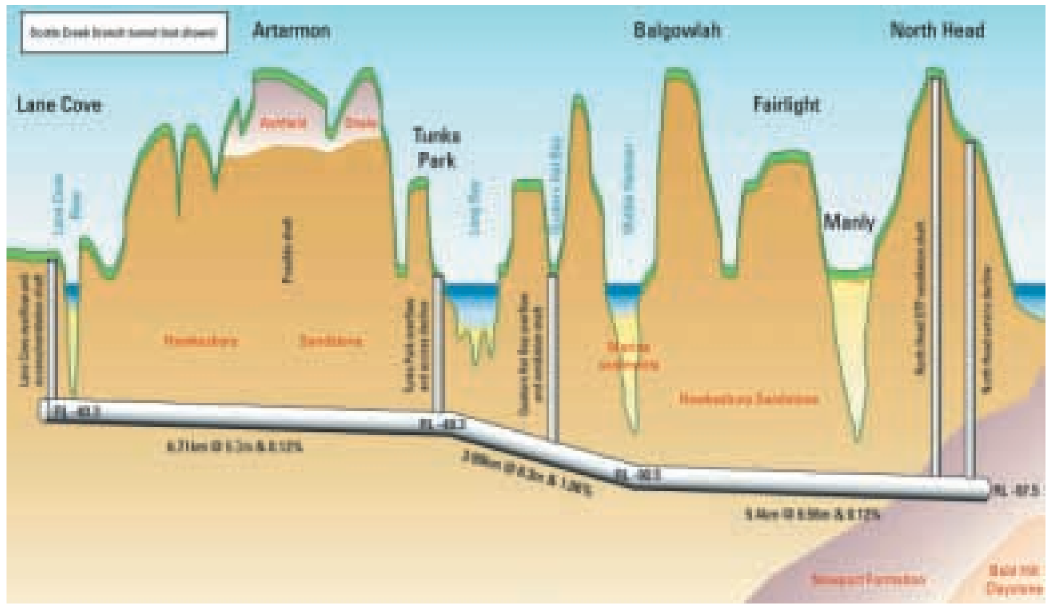
The 2000 Olympic Summer Games began early for surveyor Neville J. Thomson – in 1996, to be exact. That was when De Martin & Gasparini awarded Thomsons Construction Surveys Pty Ltd a constructional survey contract for Stadium Australia's entire foundations and concrete structures. Neville J. Thomson says: "For two years, we had a couple of surveying teams on-site, plus occasional visits by our quality control measurement team. We used our software to electronically transfer the plan data directly to our four LEICA TC1010s with GRM10 Rec Modules." According to Neville, the most demanding measurement challenge from a technical standpoint was pinpointing the anchor points for the gigantic steel suspensions supporting the roof structure. With a tight schedule, on a hectic construction site, reliability and precision are what matter. Says Neville: "I have gained experience with instruments from various vendors over the years – which is why we now use only Leica Geosystems kit." Thomson also used Leica instruments for surveying Sydney's Aquatic Center and the SuperDome for Abigroup Ltd. ***Stf***

Below: Speed, leaping power and take-off angle are the critical factors. In September 110,000 spectators and over 5000 media representatives will be following the results in the stadium live. Billions of people will be doing the same on television broadcasts.

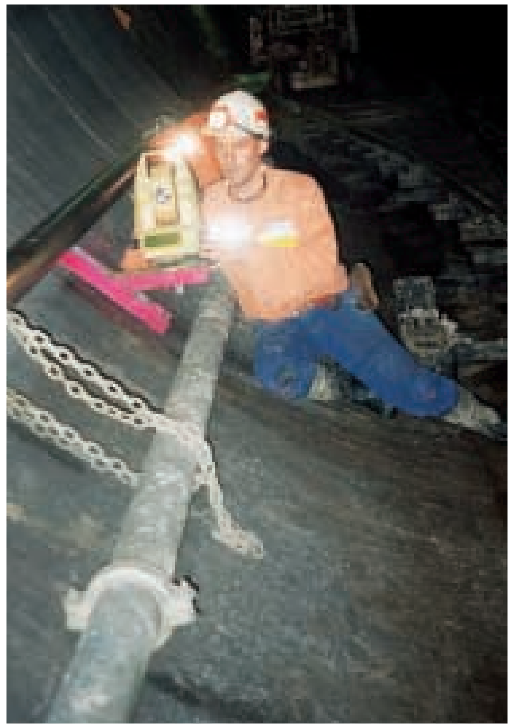
Leica survey instruments in Sydney also used underground on major environmental protection projects

From marking out of the entire Olympic Park in Homebush Bay through to completion of building work on Stadium Australia, Australian surveyors used the same Leica laser survey instruments (type TCA) as SwatchTiming is now using in the stadium to measure distances during athletics events. Australian surveyors from Hard+Forester supervised the surveying activities involved in creating Sydney's Olympic Park on behalf of the Olympic Coordination Authority. Surveyors from Hard+Forester have previously assisted construction engineers with positioning and orienting concrete immersed tube units for the Sidney Harbour Tunnel using instruments from Leica Geosystems. They also surveyed the vast underground Opera House car park adjacent to the harbour.

Right: The Northside Storage Tunnel collects rainwater from the northern Sydney district, with a population of over one million. The entire tunnel complex is around twenty kilometres long.



Below: 28-year-old surveying engineer Cameron Mills (left) is responsible for all the survey work involved in the project. Bruce Forester (right): "These young lads have certainly got what it takes!". When it comes to instrumentation, Bruce Forester has trusted Leica Geosystems for decades.



Left: For control and monitoring, targets are set up in the tunnels at precise, known coordinates. Working in dust, wet and darkness stretches both men and machines.

Centre: Various tunnel construction techniques were used, including four large tunnel boring machines with 6.3 m / 6.57 m diameter.

Bottom: Cameron Mills with his LEICA TCA1800 equipment in the cavern at Scotts Creek, where site access and tunnels from four directions converge. Excavated material is transported above ground in barges – the work is virtually inaudible to residents of nearby Tunks Park.

16-kilometre Northside Storage Tunnel

For the past two years, 28 year-old Hard+Forester employee Cameron Mills and more than a dozen survey specialists have been guiding four giant tunnel boring machines on a route that follows the northern foreshore of Sydney Harbour and passes below Middle Harbour to the coast at Manly. The machines are excavating through sandstone to create a wastewater retention tunnel 16.1 kilometres long and 6.30/6.56 metres in diameter. The project is important for environmental protection in the Sydney Harbour area.

Bruce Forester says, "I am happy for the athletes that these laser devices will be used to take the measurements at the Olympic Games in Stadium Australia. As the best athletes in the world, they deserve that the best measuring instruments should be used. Only in this way can their accomplishments be determined accurately, quickly and fairly". Bruce Forester knows what he is talking about: just a few months before the Summer Olympics get underway, a team led by Cameron Mills used exactly the same instruments to steer four giant tunnel boring machines from various directions over kilometre-long curved paths at precisely defined inclinations up to 80 metres underground, with centimetre precision. Now, the water in Sydney Harbour remains clean even after a cloudburst. ***Stf***

Sydney's landmark: built and monitored with Leica instruments

Millions of people have seen it in books and on post-cards; millions more have seen it at first hand during a visit to Australia. Survey engineer Steve Denning also knows it from above and below: a quarter-century after the Opera House was inaugurated, his know-how was needed to assess the effects of weather and sea-water on the structure, and fix the wear and tear. The initial task was to restore the granite promenade surrounds and sea wall of the Opera House.

Above: Classic Wild T3 and T2 theodolites were used in constructing the Opera House, seen here in a picture from 1966. Steve Denning: "It is amazing that the experts of the day were able to build something this complex in the pre-electronic era." A Wild DI10, the world's first infrared tacheometer, was used in the completion stages of the shell.

Left: Steve Denning uses his Leica TCR703 to verify the roof positions and the modular scaffolding elements in the background. Everything must be in perfect order in time for the Summer Olympics!

Deep down…
Positioning new piles required Steve Denning and his staff to survey the existing promenade decks at sea level. From there they co-ordinated a team of divers for placement of the new piles. After piling, the divers assisted the survey team to locate and record the final position of the piles.

…and high up
Steve Denning also had to scale the Opera House, reaching areas that are normally the preserve of roofers and seagulls. The Sydney Opera House is a masterpiece of architecture and engineering. Steve Denning: "We needed to measure and record all of the building's constructional details, in order to spot shifts and deviations in good time, and facilitate repair work." As with any large building, running repairs are a necessity: given the millions of visitors each year, nobody can afford to take risks.

Three-dimensional recording
Closer examination of the Opera House roof reveals that it is covered in thousands of light grey, textured ceramic tiles that trace the contours of the three-dimensional building structure like a skin. They have differing shapes, meaning that each one must be individually identifiable in order to effect a custom-made replacement. Yet gaining access is a tricky business: the surrounding space is no longer adequate for cranes, and regular scaffolding is out of the question.

Therefore, Steve Denning made a three-dimensional tacheometric recording of the outer skin and fascia beams for the roofing and fitting company. A multi-segmented scaffolding system was then developed, which could also be combined in a way that would allow work on the overhanging front façades – only highly experienced extreme climbers would be able to gain access otherwise.

Theodolite and LEICA DIOR
Steve Denning: "We also needed to identify the existing holes in the fascia beams for securing the modular scaffolding and hoist platform. The LEICA DIOR 3002 distance measure, with its visible target point, proved unbeatable: we would sight the theodolite telescope on a securing hole to determine its position, and the mount-on DIOR 3002 gave us the precise distance. Its beam ran parallel to the theodolite's, but landed five centimetres above the hole, meaning that it was reflected from the concrete surface. A combined angle and distance measuring telescope of the kind found in our LEICA TCR703 would have measured right to the bottom of the hole, and hence always a little too far. It's one of those rare cases where a separation of angle and distance measurement instruments is superior to an integrated solution."

Service is crucial
Steve Denning has other large-scale projects under his belt, for example the constructional survey for the Anzac Bridge (previously known as the Glebe Island Bridge):
"All these projects demand a lot of adaptation to circumstances. I use Leica Geosystems instruments, because I get the accessories I need as well as first-class service right here in Sydney – even when I have to work deep underwater, at dizzying heights, or target holes that begin exactly where I want them to, regardless of their depth."
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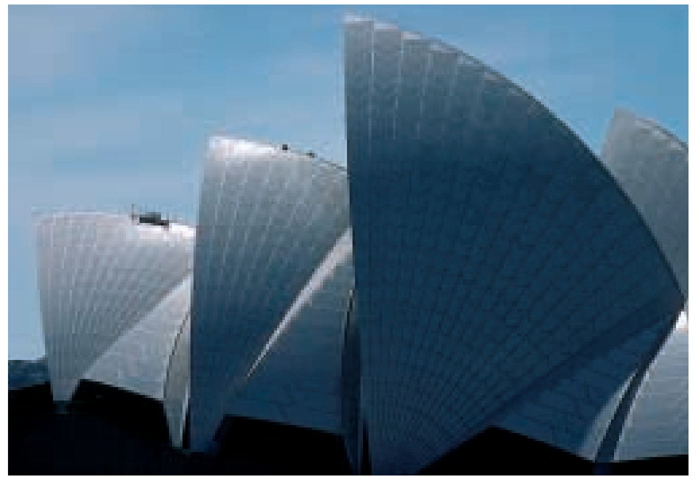

Above: Sydney Harbour Bridge and the Opera House – international symbols of an exuberant, multi-cultural, world-class city. The most beautiful route from the city centre to the Olympic park is by water, passing beneath the "coathanger", as Sydney-siders have dubbed the harbour bridge.

Center: The Opera House's spherical elements each have their individual forms. The Swedish ceramic tiles are finely textured.

Below: Here, the ceramic tiles have just been stripped off. Steve Denning records their exact coordinates using remote measurement with a theodolite and a LEICA DIOR 3002.

No change in the height of the Matterhorn

One of the points used in the survey was the cross at the peak of the Matterhorn, shown here with an SR500 lashed to it.

The Matterhorn is precisely 4477.54 metres high – and remains at 4478 metres according to the maps. In the September 1999 re-survey featured in a recent "Reporter", Italian geology professor Giorgio Poretti was the first to position a GPS surveying system on the peak, with LEICA GPS500s at reference points in the valleys on either side. All points were additionally measured using optical laser triangulation.

Left: The measurement setup at the peak of the Matterhorn: LEICA GPS500 and reflectors for the tacheometers in the valleys on either side.

The Matterhorn is the world's third mountain, after Mt. Everest and Kilimanjaro, to be re-surveyed using the latest technology based on GPS, the Global Positioning System. The height of the Matterhorn is now known with centimetre accuracy, allowing height and position changes of this prominent Swiss-Italian landmark to be precisely tracked. It is apparent that this part of the Alps will continue rising faster than the annual rate of erosion.

27 centimetres between countries

According to Urs Marti of the Swiss Federal Survey, the height of the Matterhorn was originally determined in the 1920s. Back then, Zermatt's local landmark was measured at 4477.50 metres and declared on official Swiss maps as being 4478 metres above sea level. Yet as Zermatt-based geometrician Klaus Aufdenblatten points out, "the measurement uncertainty of the cumbersome opto-mechanical triangulation methods then in use was several decimetres at these distances". In addition to greater precision, such cross-border surveying projects have also provided evidence of discrepancies between national geoids, which could be reconciled over the medium term. Poretti detected a "border step" of 27 centimetres between Italian and Swiss geoid data.

Ancient African rock

Confirmation of the 4478 metre height means that the Matterhorn, formed of rock originating from what is now Africa, has been spared the numerical indignity recently suffered by Kilimanjaro (see Reporter 44).

The highest mountains on the six continents

Continent	Highest mountain	Height above sea level
Asia	Mt. Everest	8846 metres *
America:	Aconcagua	6959 metres **
Africa:	Kilimanjaro	5892 metres *
Antarctica:	Mt. Vinson	5140 metres **
Europe:	Mont Blanc	4808 metres **
Australia:	Mt. Kosciusko	2230 metres **

* Surveyed using LEICA GPS 300/500 during the last decade;
** Surveyed using Leica Geosystems theodolites during the last century

Measurements from the valley on the Swiss side (Zermatt) were taken simultaneously with a LEICA GPS500 and TCA2003.

In October 1999, an expedition led by Eberhard Messmer also used LEICA GPS500 systems to determine a new height of 5892 metres, superseding the earlier figure of 5895 metres. And eight years ago, Giorgio Poretti and Yun-Jong Chen used a similar measurement configuration – with instruments on the peak and in the Nepalese and Tibetan valleys – to redefine the height of Mt. Everest at 8846.10 metres above sea level. Problems with metre-high layers of snow and ice covering the peak of Everest were not an issue on the Matterhorn.

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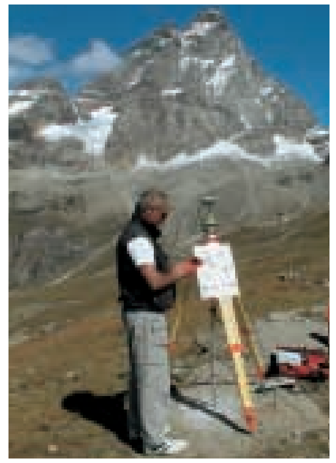
Taking up position at the peak of the Matterhorn.

The Swiss Federal Survey map was used to pinpoint the precisely defined station point in Zermatt for the Matterhorn re-survey.

A century of surveying history

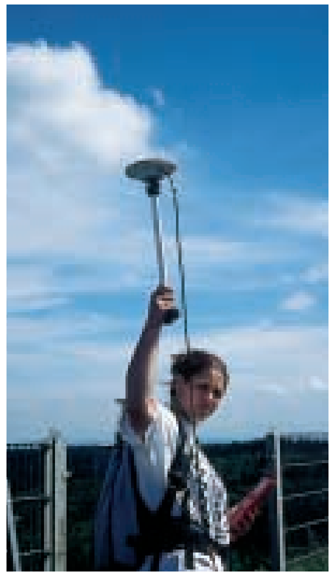
Experts with an eye for surveying history saw the Matterhorn measurement as symbolic of a technological revolution. It was here in canton Valais, within sight of the Matterhorn, that Heinrich Wild, topographer and later instrument designer, used an enormous, mechanical repetition theodolite on the Dents-du-Midi to chart the lower Valais in 1902. Struck by the laboriousness of this method, he went on to develop lighter, opto-mechanical instruments like the Wild T2 is the forerunner of the modern electronic tacheometer – give or take little extras like laser technology, electronic angle measurement and sophisticated software.

Giorgio Poretti took a WILD T2 along with a LEICA GPS500 to the peak of the Matterhorn and used it to sight down to the valley, where further GPS500 systems were complemented by LEICA T2002, LEICA DI3000 and LEICA TCA2003 electronic theodolites and infrared distance measurement equipment. Giorgio Poretti was also interested in comparative measurements as a means of determining whether, and by how much, rays in various parts of the electromagnetic spectrum (GPS microwaves, DI3000 infrared laser light, T2 visible light) were affected by the atmosphere at great differences in altitude as they travelled to and from a prominent and isolated mountain like the Matterhorn, and whether these effects could be used to indicate meteorological changes.



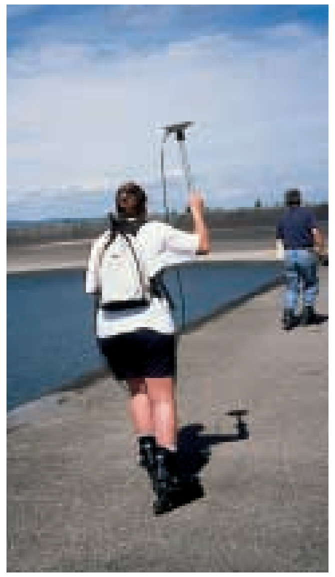
A LEICA GPS500 in the valley on the Italian side. The "Cervino", as the Matterhorn is known in Italian, looks completely different from this viewpoint.

Drifting continental plates caused ancient African rock to tower up into what is now the Matterhorn.



No, not the Olympic torch: student Stephanie Walter holds the GPS500 antenna.

The dams and water reservoirs in the German province of Baden-Württemberg are resurveyed every five years as part of an ongoing monitoring programme. One of the sites being checked is the Hornberg reservoir, located in the southern Black Forest on a mountain peak 1050 m above sea level. The reservoir feeds the Wehr hydroelectric power station, 630 metres further down and operated by Schluchseewerk AG. A study by the Geodetic Institute of the University of Karlsruhe set out to determine whether GPS measurements using Leica Geosystems' new System 500 might be an economical and sufficiently accurate alternative to conventional terrestrial methods.



Millimetre-precise GPS reservoir monitoring on wheels

The existing control network at the Hornberg reservoir is designed for classical survey techniques, with reference points chosen primarily for good line-of-sight conditions. This kind of network does not meet the requirements of a well-reconnoitred GPS network, so three additional reference points were created.

Getting around on inline skates

Setting up and levelling the reference points took half a day. Thereafter, four LEICA GPS System 500 receivers were deployed for two days to take intentionally complex measurements: two rapid-static measurements (observation rate 10 seconds, persistence 30 minutes) at 21 points, and six stop&go chains with an observation rate of two seconds and persistence of one minute at 12 points along the dam. Measurement conditions on the dam were ideal, not just because of clear sight-lines in all directions, but also because the operators could carry the light-weight mobile gear around on inline skates.

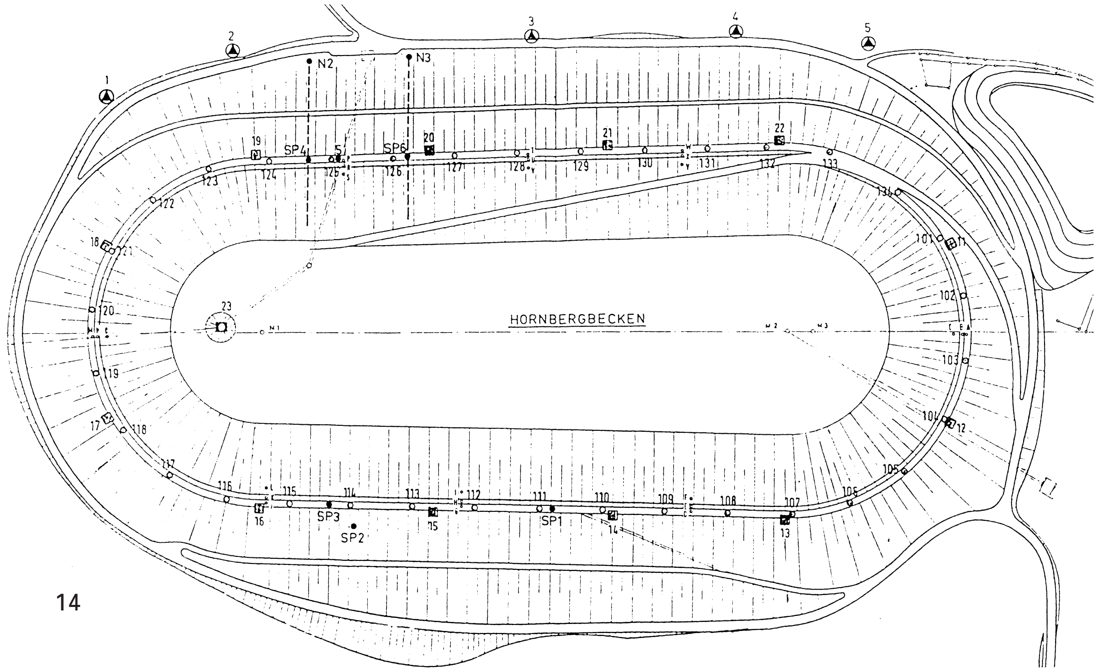
Median point error just 1.3 mm

The new SKIPro software was used for pure GPS analysis, with further GPS position and height data processing by software developed at the Geodetic Institute. Integrating session results of all observations at 17 points (problems were found with four reference points in satellite shadows) gave an overall solution after network compensation with a median point positional error of 1.3 mm (max. 2.1 mm). The rapid-static measurements alone provided similar 1.3 mm median accuracy (max. 1.6 mm). Analysing the six stop&go measurements in isolation gave a median point error of 2.5 mm (max. 3.3 mm).

High GPS precision

A Helmert transform of the coordinates for the GPS overall solution against the National Survey coordinates confirmed the high precision of GPS, with residual deviations between 0.2 mm and 1.6 mm.
This comparison was possible because the National Survey made terrestrial network observations of superior accuracy using a LEICA TCA2003 tacheometer (median point error for unrestrained network compensation: 0.6 mm) immediately after the GPS measurements.
The table below shows individual residual discrepancies for seven identical points.

The survey control network around the Hornberg reservoir.



The Hornberg reservoir: surveying this vast structure in the southern Black Forest using the GPS stop&go technique.

Ident. Points	Residual deviations (mm) Y	X
7	0,7	-0,6
12	1,1	0,2
14	-0,4	-0,9
16	-1,4	1,0
18	0,5	-0,6
20	-0,7	1,6
22	0,2	-0,3

Residual deviations in position for identical points from the Helmert transform

Median height error 1.8 mm

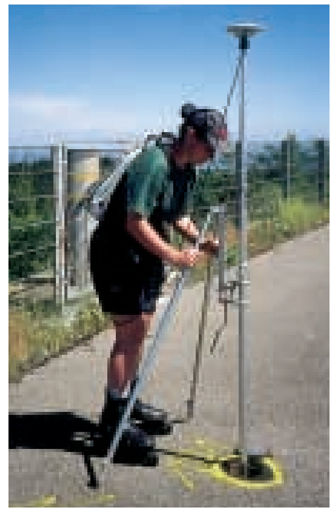
Analysing the heights of the dam points gave a median height error of 1.8 mm (max. 2.4 mm) with unrestrained compensation of the overall solution. The rapid-static solution resulted in 2.1 mm (max. 3.1 mm), while stop&go measurements gave 2.8 mm (max. 3.7 mm). With a compensating plane positioned through six of the twelve dam points for height integration, the remaining points indicate a maximum deviation of five millimetres compared to the levelled heights obtained by the National Survey's LEICA NA3000 digital level.

Manning levels and surveying time required for the National Survey measurements were just marginally higher; however this does not take account of time-consuming preparatory work to clear visual obstacles. From an economic standpoint, as well as the achievable accuracy, GPS measurements appear to offer a genuine alternative to conventional terrestrial techniques.

Michael Illner, Stephanie Walter, Wolfgang Zick

Point number	Difference (mm)
12	1
14	-2
16	0
18	1
20	0
22	-1
101	-2
107	-5
113	-3
118	2
123	3
129	0

Height differences between NA3000 levellings and GPS measurements



Rapid-static with a LEICA GPS500

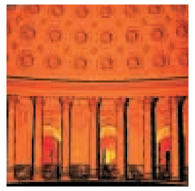
Stephanie Walter and tutor: mission accomplished.

Leica Geosystems takes investment position in Cyra Technologies, Inc.

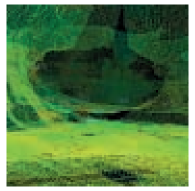
The history of modern surveying is in many ways the history of Leica Geosystems. Whenever new technologies made it possible to simplify the work of surveyors and engineers, the company came up with breakthrough solutions: the electro-optical tacheometer, infrared laser distance measurement and GPS are all witnesses to this pioneering role.

Example ***Chevron LNG plant: creating an "as built" model of the facility***

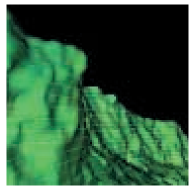
Example ***Renovation of San Francisco's historical City Hall***



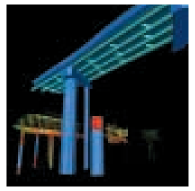
Example ***Starship Troopers™ cavern: visual effects***



Example ***P&M Coal: mining industry***



Example ***CalTrans freeway: bridge checks***



Example ***East Bay district municipal works: water treatment plant model "as built"***

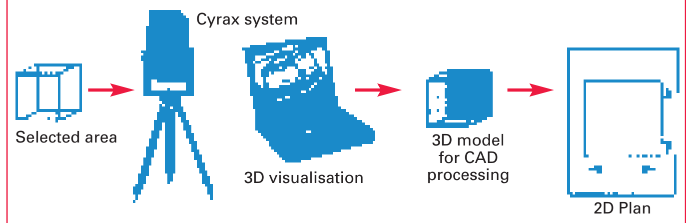
The principles established in the last century will endure into the new millennium. For this reason, Leica Geosystems decided on 20th March 2000 to acquire a financial minority position in Cyra Technologies, Inc. (Oakland, CA, USA). The significant capital investment from Leica Geosystems will enable Cyra to accelerate product development and marketing programs. Cyra™ products such as the Cyrax™ 3D Laser Scanning System ideally complement and enhance the Leica Geosystems range. Cyrax melds the benefits of state-of-the-art laser technology and 3D software for digital remote capture, visualisation and analysis of solid objects.

A technology with great future potential

"Leica Geosystems' decision to invest in Cyra is very important to us in two ways", said Cyra CEO Ben Kacyra. "First, the significant sum being invested will allow us to realise our product and marketing plans even faster and more comprehensively. This makes excellent sense, given the highly encouraging market response to our basic technology. Second, Leica Geosystems' involvement sends a clear signal to the professional community about an up-and-coming technology that is set to grow in importance. After all, Leica Geosystems is synonymous not just with surveying and measurement, it is also a byword for high quality, innovation and professionalism."

Cyrax™ makes digital laser measurement and visualisation easy

Cyrax is a portable, auto-scanning laser system including a laptop PC and software. It measures, visualises and models large structures and sites with an unprecedented combination of speed, completeness and accuracy. Simply orient the scanner toward the scene, select the desired area and measurement density via the laptop, then auto-scan. Complete surface geometry of exposed structures and sites is remotely captured in minutes in the form of dense, accurate "3D point clouds", ready for immediate use.



Cyrax 3D point clouds are a valuable, new "deliverable". They represent a highly detailed, instantaneous 3D "virtual model" of an existing site or structure, complete with survey-grade measurements. As soon as Cyrax has scanned a structure or site, integrated software lets you use the 3D point clouds to rotate and fly around an existing site or structure to view it from any perspective and to dimension between any points. You can also use the 3D point clouds to create wire meshes, 3D models, and 2D drawings for export to popular CAD, rendering or other software.

Capturing growth markets

"This investment reflects the shared vision of Cyra and Leica Geosystems about the upcoming fundamental change in the survey and measurement industry, a change that will require the industry to move rapidly from being tool centric to becoming information technology centric", said Leica Geosystems CEO Hans Hess.

"Leica Geosystems believes that the 3D laser scanners and the capabilities of Cyra's integrated suite of software will become a main catalyst in the upcoming change. These new technological breakthroughs bring very advanced and value-adding solutions to our customers and represent a significant opportunity to open new markets", added Hess. "Cyrax features high added-value software content, with promising extensions into web-based and enterprise-based solutions. This investment fits very well with the mission statement of Leica Geosystems and our dedication to bringing innovation and adding value to our customers."

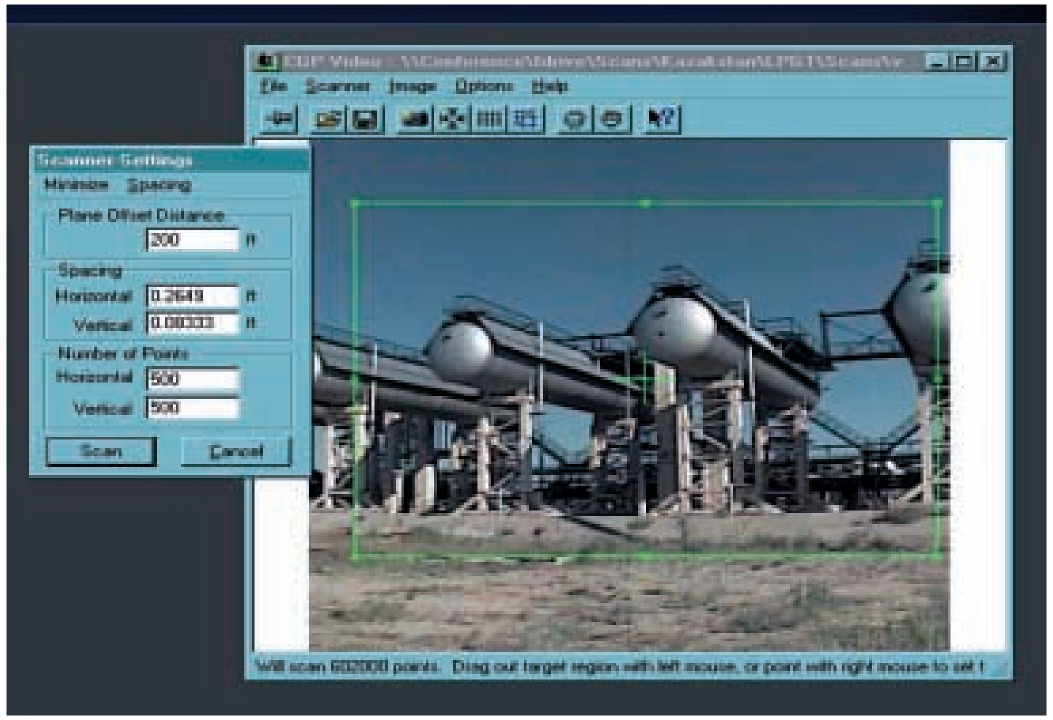
Enthusiasm for the new technology goes beyond Cyra's customers and Leica Geosystems. It has been recently heralded by several survey industry editors as the next major breakthrough in the surveying, mapping and CAD markets, and has been cited as opening up significant new markets for professionals in these areas. Many have compared Cyrax with such technological breakthroughs as EDM (Electronic Distance Measuring), GPS (Global Positioning System), CAD (Computer Aided Design), or even the invention of photography.

Representative examples of typical Cyrax applications

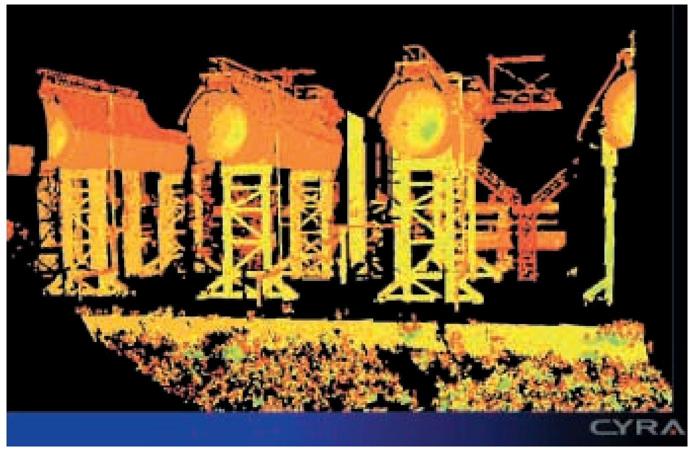
(see also: www.cyra.com):

Cyrax systems are already deployed on numerous projects, e.g.:

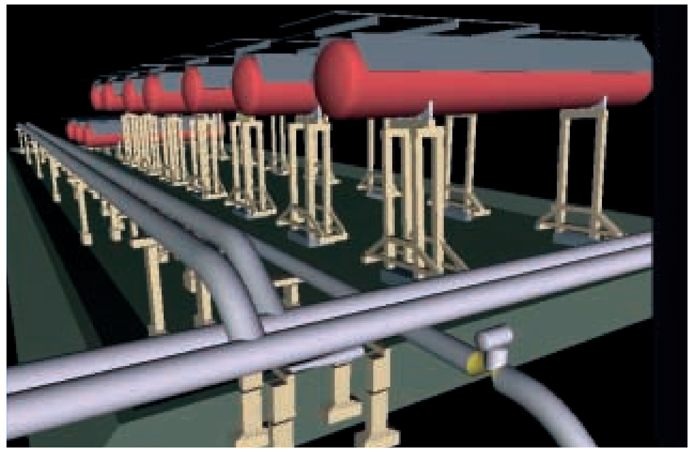
- **complex construction site and control measurements**
- **monitoring and comparing construction progress with plan specifications**
- **2D and 3D cartography and modelling for architecture, constructional and plant engineering**



With Cyrax, the first step is to select an area of the scene. It then takes just a few seconds to scan-in the associated surface points.



The scanned-in points appear as a "cloud" of variously-shaded pixels, which render individual objects visible.



Objects can then be rotated and viewed from various angles.

Already a multiple award-winner

Rapid availability of all-digital 3D representations brings numerous user benefits: low cost, rapid project execution, increased safety, and effective enforcement of building regulations. Since the first product launch nearly two years ago, Cyrax has won various innovation and technology awards sponsored by prominent industry magazines and associations associated with laser technology, computer graphics, chemical plant design, construction, CAD, 3D construction and visualisation.

Leica GPS selected for the Xian-Ankang Railway Project

A detailed introduction and systematic training in operating theory and practice ensured that Railway Ministry engineers were thoroughly familiar with the Leica SR350.

China's railway system is developing fast – and precision instruments are playing an increasingly important role throughout this major construction undertaking. The Leica GPS SR350 sets deployed on the Xian-Ankang Railway Project are an excellent example of the trend.

Under the terms of a construction loan agreement between the Ministry of Foreign Trade and Economic Cooperation of the People's Republic of China and the Overseas Economic Cooperation Fund of Japan, China's National Technical Import & Export Corporation (CNTIC) was authorised to issue an international competitive tender for the equipment. Following extensive tests and bidder evaluation, Leica Geosystems won the order for 16 SR350 sets, not least because nation-wide service coverage meant that support would be available whenever and wherever needed.

Leica SR350s were delivered to the Ministry of Railways: the Professional Design Institute, the First and Third Survey & Design Institutes, and the Bridge Construction Bureau. These organisations will use GPS to perform a wide range of surveying and mapping tasks, accelerating construction of this important railway link while boosting measurement reliability.

Training Chinese Leica Geosystems service specialists in Guangzhou

In order to continue providing Leica Geosystems customers in the People's Republic of China with the highest possible standards of service, the company is making massive investments in ongoing training of service personnel, and their equipment. Here, Anton Schneider of the Service and Training Centre in Heerbrugg instructs Chinese service specialists in Guangzhou about the GPS500, TPS300 and TPS1100 systems.

Leica GPS machine guidance systems boost Texan brown coal mining productivity

Thanks to a new GPS-based machine guidance system supplied by Leica Geosystems, The North American Coal Corporation has achieved significant savings in annual operating costs at its San Miguel Lignite Mine in South Texas.

The San Miguel Lignite Mine, south of San Antonio, has served as one of several test sites for Leica's new Dozer 2000 GPS machine guidance system. The Dozer 2000 is a satellite-based, machine guidance system that permits a bulldozer operator to control the vehicle and blade precisely without the need for survey stakes.

Investment amortised in under one year

According to Doug Darby, Operations Manager for North American Coal at the San Miguel Lignite Mine, the company expects to save as much as $200,000 annually. These savings are generated by eliminating the need for survey staking in pond, road and drainage construction, reducing rehandle in spoil grading, subsoil and topsoil respread, and improving dragline bench height control. "We estimate that we can save some $56,000 on each machine by achieving a 5% reduction in rehandle caused by cutting too deep," said Darby. "We expect to save as much as $72,000 per machine by reducing dragline rehandle by 3% due to better control over bench height. The Dozer 2000 system is an excellent investment. We project to have payback in less than 24 months on the initial four units. As we investigate other uses of the grade control and guidance system, the payback could well drop below one year."

Graphically unambiguous, easily understood information

The Dozer 2000 system uses signals from the U.S. Global Positioning System (GPS) to determine the position of the vehicle with centimetre-level accuracy in real time. Position data from a vehicle-mounted Leica GPS receiver is fed to an AutoCAD-based engineering software package running on a ruggedised touch-screen computer in the vehicle's cab. The computer clearly displays the vehicle's position and movement in relation to a predetermined design surface and guides the operator with graphic instructions for left/right steering and cut and fill values.

"Dozer 2000 is designed to assist the operator by providing real-time navigation information and easy-to-follow instructions for steering and blade control in the cab," stated Rod Eckels, business director for Leica's OEM GPS systems.
"The system uses intuitive graphic displays to show cut and fill values between actual position and design surface. The operator can select cross-section and forward/backward views, plus other useful displays."

Darby reports that the system has been very well received by machine operators at the San Miguel Mine, due to its easy-to-follow graphic displays and its proven accuracy. "We are accomplishing finish grade work that is accurate to within ±2 inches with a machine that has a 13 feet high and 25 feet wide blade – all without the use of survey stakes," he said.

Leica Geosystems' Dozer 2000 steers the bulldozer simply and precisely. The driver has a real-time graphical display of all control data, e.g. cut and fill differences.

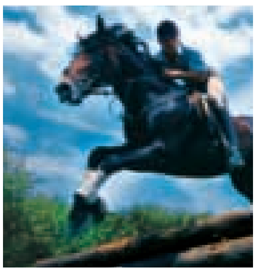
21 systems already in the field

"The Falkirk Mining Company, a wholly owned subsidiary of The North American Coal Corporation, installed two Dozer 2000 systems for evaluation in 1998. We now have 21 systems in service throughout North American Coal managed mines," said Darby. "We will continue expanding our use of this advanced technology in 2000."

The San Miguel Lignite Mine is the lowest cost supplier of lignite in the state of Texas. The company produces over 3 million tons of lignite annually.

North American Coal is the eighth largest coal mining company in the United States, with seven mining operations in 5 states and 1000 employees. It is a subsidiary of NACCO Industries, Inc.

TPS700 Performance Series



The cleverest workhorse: With the TPS700 Performance Series from Leica Geosystems you will leap over all obstacles - faster, more skilfully, and without a reflector. Just think about what you can measure without a reflector - frontages, interiors or profiles, for example. And, with a coaxial distancer that needs no reflector, the clever new TPS700 Total Stations make this all possible. Of course, you can also use the TPS700 to perform all of your other survey tasks; rapidly, conveniently and with the usual Leica Geosystems quality. There is a large display and an alphanumeric keyboard, and a laser plummet for quick and precise centring. See for yourself. Go right ahead now and ask for more information about the new TPS700 Performance Series.

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