



# Headstart with Cyrax™



In the last Reporter issue we presented Cyra™ Technologies' revolutionary 3D laser scanning and visualization technologies. Today, I am pleased to inform you that this company and these technologies are now part of Leica Geosystems. As of November 17<sup>th</sup> 2000, the company that developed and made this 3D laser scanning, modelling and visualization technology ready for daily work belongs to Leica Geosystems. We welcome the employees of Cyra Technologies as members of the Leica Geosystems family.

The same welcome goes out to Cyra customers, who can now benefit from the world-wide advice and service net of Leica Geosystems. But of course, in acquiring this California based company, we were thinking most of all, of our loyal Leica Geosystems customers and of all the readers of the Reporter magazine. We are committed to helping you manage your work as quickly as possible by applying the most advanced technologies of the new decade. The advantages are striking. Complex objects, such as the 3D models and 2D plans of a chemical plant, can be completed ten times faster than with conventional methods! The 3D laser scanner, Cyrax™ 2500, the second generation of Cyra products that has just hit the market, measures and documents in a single second spatial coordinates of a thousand points and this within a distance of up to 50 meters with an accuracy of six millimeters or better. Cyclone™ V3 the integrated software transforms the data into 3D models or 2D plans. As stated, more details can be found in the last Reporter (issue 45) on pages 16-17 or at the internet addresses: [www.leica-geosystems.com](http://www.leica-geosystems.com), and [www.cyra.com](http://www.cyra.com).

Over three decades ago we were the first to combine infra-red distance measurement with the angle measurement of a theodolite by creating a mount-on EDM (DI10), two decades ago we introduced the world's first data recording electronic total station (TC1) and over a decade ago we were pioneers of the first GPS surveying equipment (WM101) for centimetre precision from GPS signals. All of these original Leica Geosystems solutions have become standards in surveying and have mostly evolved into automated systems. Today, with Cyrametry™ we are again making history in the field of surveying, and as a loyal customer of Leica Geosystems you will be the first to benefit from this. Nowhere else in the field of surveying will you find such efficient solutions for your various tasks, a more advanced and proven spectrum of technologies and products. Use them to your advantage!

Sincerely

Hans Hess,  
President & CEO, Leica Geosystems

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President & CEO: Hans Hess

**Editorial office:** Leica Geosystems AG, CH-9435 Heerbrugg,  
Switzerland, Fax: +41 71 727 46 89  
Internet: [Waltraud.Strobl@leica-geosystems.com](mailto:Waltraud.Strobl@leica-geosystems.com)

**Editors:** Waltraud Strobl, Fritz Staudacher (Stf)

**Layout and production:** Niklaus Frei

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## Editorial

Dear reader

The meaning of "long-term customer relationship" can be gleamed by the experience of our reporter at a construction site in Vienna. His report is on page 16 of this issue. The companies renovating century old buildings had an even older history, yet they employed cutting edge technologies, such as reflectorless laser surveying equipment. The principle of evolution is not only at work in nature, but is highly effective in technology and human society. Recognizing what is already good and the relentless pursuit of perfection, guarantees improvements. Someone like Hans-Peter Blaha of the Porr Corporation, who decades ago, worked successfully with "Wild-and-Kern" Instruments, today appreciates the efficiency of Leica Geosystems solutions. Those who could rely on each other in building historical monuments to modern industry and architecture, will have a bright future in the new millennium.



Waltraud Strobl

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# Runway construction costs on a controlled descent



“Unique” is Zürich Airport’s new tag-line. An apt choice, describing not only the impressive alpine panorama to which passengers are treated at landing and take-off, but also the remote-controlled technique now in use for constructing new taxiways – truly a world first. Just like the aircraft pilots taking off and landing only a short distance away, machine operator Beat Furrer has his concrete slip-former set to 3D automatic operation. Compared with previous runway construction methods, this technique puts costs on a controlled descent. There are no troublesome guide wires to be found on this site.

Under Beat Furrer’s watchful eye, a Gomaco GHP 2800 slip-former lays a swathe of concrete six metres wide and 36 centimetres thick with a precision of under one centimetre in the horizontal axis and three millimetres in the vertical axis, meeting the demanding tolerances specified for the 5th expansion of Unique Zürich Airport.

## **Novel machine guidance system for easier working**

“It was unnecessary to invest in a new slip-former, we simply retrofitted our existing Gomaco machine with the new Leica 3-D machine guidance system. It simply attaches to the driver’s cab”, explains civil engineer Martin Bänziger of Kloten-based construction company Specogna Bau AG. The cement slip-former receives automatic three-dimensional control commands direct from the Leica system. Measurement engineering support is provided by Schällibaum AG, an engineering and surveying firm appointed to handle constructional survey work by a consortium comprised of Walo Bertschinger AG, Batigroup AG, Specogna Bau AG and Heilit + Wörner. When the Reporter visited the site on a September morning, surveyor David Zimmermann had set up a pair of LEICA TCA2003

## **Construction costs: one million francs a day**

The 5th airport expansion at Unique Zürich Airport (see illustration right) includes an additional terminal (midfield dock), the Airside Centre and a new check-in concourse directly above the railway station, for increased passenger handling capacity and improved services. The project also includes new private and public delivery access and tunnels. The total budget is 2.3 billion Swiss francs, with 403 million francs earmarked for taxiways and aircraft de-icing areas alone. This translates into expenditure of over one million francs a day during the five-year construction period. Follow-on investments will total a further three billion francs.

**Two LEICA TCA2003 total stations track the slip-former position in real time.**





total stations adjacent to a projected section of taxiway, to keep the slip-former precisely on course.

**The perfect edge**

Precision automation allows the machine operator to concentrate on construction site procedures, like ensuring an optimal supply of concrete from the delivery lorries. Beat Furrer: "My work got easier after the Leica system was installed. I can now devote even more time to quality monitoring and improvement. Take the edges of the taxiway, for example: with the machine

under automatic control, I can concentrate more on ensuring that cement is fed right to the outer extremes of the operating width and properly compacted. Just take a look at those edges – perfect!"

**Safety first**

Martin Bänziger of Specogna Bau AG is the man responsible for deploying the system to save time and expense on the gigantic Unique Airport Zürich construction project. It is the 30-year-old site manager's job to see that the clients' and planners'



exacting quality, cost and deadline specifications are met or even exceeded. No mean feat, considering that regular airport operations and construction work must

*A slip-former lays a perfect taxiway at Unique Airport Zürich, thanks to automated 3-D control by a Leica Geosystems machine guidance system.*



**Unique Airport Zürich: building for the future**

The boom in air travel is outstripping all other forms of transport. An expert study predicts a 60 per cent increase in passenger volume for Switzerland over the next two decades, compared to just 30 per cent growth in road and rail travel. Switzerland's largest airport is already of major economic significance, with around 90,000 people depending on it for their income.

Zürich airport has seen phased growth over the past fifty years, and now handles 21 million passengers and 270,000 aircraft movements annually. The 5th expansion currently underway will upgrade existing infrastructure, replace ageing systems and enhance current facilities to establish a modern air traffic hub fit for the 21st century.



*Left: The 5th expansion of Unique Airport Zürich: construction includes an additional terminal with underground access (marked in red on the model). Just like the taxiways, building work is in full swing here as well.*



proceed in tandem, and aviation safety is the utmost priority.

**A big success in the field**

"The first three months of site operations proved that we had made the right decision to construct cement taxiways with the help of a Leica Geosystems machine guidance system", says Martin Bänziger. Despite initial scepticism from some quarters, no one involved with this time-critical site would now want to forfeit the benefits, since everything depends on rapid construction progress.



Martin Bänziger: "We halved the time needed to prepare the site for putting down the cement! And the pace of cement laying is around 20 per cent up on previous performance." Further benefits include better surface quality, coupled with increased precision and reliability. M. Bänziger: "With this new machine guidance system attached to our concrete slip-former, we can transform the project plan into finished work on the ground practically 1:1, with unparalleled speed and precision. A guide wire would never be this exact – not to mention the continual obstruction to construction site logistics."



**Construction manager Martin Bänziger is responsible for maintaining or even exceeding the exacting quality, scheduling and cost specifications. The Leica machine guidance system has been very helpful in producing 50% time savings for site preparatory work, and around 20% additional construction performance.**

### ***Leica 3-D machine guidance system for closed-loop automation***

The Gomaco slip-former was individually adjusted by Schällibaum engineers and Jürgen Maier of Leica Geosystems when the machine guidance system was installed. A one-off calibration procedure compensates for vagaries in slip-former geometry. LEICA TCA2003 total stations, once positioned, deliver a continuous stream of measurement data to the machine guidance system. The system determines the cement slip-former's position in real time, and sends appropriate control parameters to the machine.

The Leica machine guidance system not only stores all the project data, but is also linked with the construction machine controller. Continuous comparison of the current position with project specifications allows cement to be laid within  $\pm 3$  mm of the desired height profile, while guiding the machine along the required horizontal course. All this is achieved with greater speed and precision than a visual/manual approach using conventional surveying and control techniques.

### ***Flat, homogenous concrete surface***

Taxiways for large jet aircraft are among the most demanding surfaces from a construction engineering standpoint. The aircraft wheels bear down with a weight of 30 tonnes at each of three points, and a homogenous cement surface is vital to avoiding large expanses of rainwater and ice. The combination of a slip-former and a Leica machine guidance system delivers first-class results. A laboratory technician working on-site checks every concrete delivery to ensure consistently high material standards.

### ***Site preparation at twice the speed***

What is the reason for the fifty per cent site preparation time savings delivered by the machine guidance system?

Foreman Jürgen Indlekofer, the company's site specialist for highway and civil engineering construction projects: "Previously, we had to stake out and string

**David Zimmermann is responsible for the surveying aspects of the project: "The surface is perfectly smooth and homogenous!" The reflector prism is visible in the right hand photo. Total stations track it automatically, never losing focus.**





up the entire carriageway. Every six metres, or much less with clothoids, we would drive metal stakes into the ground and then level the guide wire at just the right height, with millimetre exactitude – although we knew that this order of precision was practically unattainable, owing to the thickness of the wire itself. Plus, there was always the risk of someone stumbling over it and disturbing the arrangement. Then we needed extra space to accommodate construction traffic entering and leaving the site, and complex logistics to allow incoming and outgoing vehicles to get past each other.” Clearly, the foreman and his crew are far from nostalgic about the „good old days“.

***Making the most of scarce time***

The only thing that frustrates Jürgen Indlekofer about this construction site are operational restrictions during foggy weather. Fog has repeatedly held up work, and caused delays to pilots and passengers. Says the foreman: “Fog is no problem for the machine

guidance system itself – we have already used it in darkness – but it does affect airport safety and quality. And these of course have

***Linked taxiways for faster takeoffs***

Additional finger docks and taxiways with passing places are being constructed for improved aircraft handling and new generations of aircraft. The extended taxiway network will mean that aircraft have less distance to travel to the takeoff runway. Specogna Bau AG and Batigroup AG are working on this portion of the construction site using a Gomaco GPH2800 slip-former fitted with a Leica machine guidance system. Also on-site at Unique Airport Zürich is a smaller slip-former operated by the Walo Bertschinger AG construction company, equipped with the same 3-D machine guidance system.



*Machine operator Beat Furrer is relieved of control chores by the Leica Geosystems machine guidance system (white box) fitted in the driver's cab – not unlike the aircraft guidance systems which pilots now take for granted. Now he can concentrate wholly on the production process: “Our taxiways are absolutely perfect!”.*



*Foreman Jürg Indlekofer is glad about simplified logistics, without stakes and guide wires.*

*No more obstructive guide wires! With a Leica Geosystems machine guidance system running the automatically controlled slip-former, construction proceeds swiftly alongside regular airport operation, with horizontal and vertical precision of  $\leq 1$  cm and  $\pm 3$  mm respectively.*



### ***Applications in road and railway construction***

Leica Geosystems' machine guidance systems have also taken 3-D control of other construction projects. They can be found on Wirtgen track-laying equipment deployed on the high-speed ICE rail link between Cologne and Frankfurt, and on the machines putting down tarmac on a replacement stretch of the Swiss N1 highway between St. Gall and the Unique Airport. Here too, the Schällibaum surveying company is responsible for deployment of the Leica 3-D machine control systems.

priority." Rain, snow and frost also make it impossible to mix cement of the required quality. Jürgen Indlekofer: "Unfortunately, there is nothing we can do about these weather-related glitches during the cold season in our hemisphere. But thanks to the halved survey setup time, in winter, summer and autumn we can make more use of brief weather openings to lay considerably longer strips of cement than before. It all adds up and helps us to stay ahead." Following interruptions caused by the weather, the precision afforded by the machine guidance systems makes for faster and more accurate resumption of work than would be possible with manual control, with seamless continuation of the previously laid section. From a construction and survey engineering viewpoint alone, Unique Airport Zürich is already living up to its name.

*Stf*

### ***LEICA GPS500 also in use***

The company is also using the LEICA GPS500 system for general positioning and planning work on the Unique site. Leica GPS systems were used in 1999 for precise measurement of the existing taxiways, mainly during nightly airport shutdowns, in order to draw up definitive construction plans.



# “Geoinformation for all” at ISPRS-congress in Amsterdam

With over 2500 participants and numerous daily visitors, the ISPRS Congress 2000 in Amsterdam, became one of the largest meetings in the history of the International Society of Photogrammetry and Remote Sensing (ISPRS). The motto “Geoinformation for all”, puts a name to the task that is the most important for the experts of Photogrammetry and Remote Sensing in the new millennium. Even now, through various sensors, digital information flows into GIS-data bases making it possible to select and evaluate various information. More and more, different aspects of life are finding easier solutions based on geographical information systems.

The wave of digitalization has now reached aerial photography. As the first company in the world, LH Systems introduced their ADS40 digital aerial photography system to international experts on photogrammetry and remote sensing. Their system works without film or chemicals, but with high performance optical devices. During overflight, the area is scanned simultaneously by various sensors, and the acquired data is stored digitally. High optical quality, as well as optimized algorithms for photogrammetry and remote sensors, enable different combinations of these data. And all this economically, with high precision and high resolution. At a resolution of 150 pairs of scan lines per millimetre, the performance of the ADS40, developed together with the “Deutsches Zentrum für Luft und Raumfahrt” (DLR), lies between the to date best known digital satellite sensors and the most powerful filmbased aerial photography systems.

Bruce Wald, President and CEO of LH Systems, announced the order intake of two ADS40 systems, by the Japanese company Pasco, at the ISPRS congress. This renown Japanese company will be the first, world-wide to exploit the extraordinary range of this sensor.

**Today digital technologies are standard practice**

Cyra, with its ground based Cyrax system, pursues a totally different approach to digital object data acquisition. Objects, also scanned at high resolutions, are simultaneously measured with laser beams and in a few moments a 3-D model of the object has been digitized - precise to a few millimetres. There are many ways, in which to utilize these models.

But not only data input, but also for data analyses new possibilities are emerging: the data structure of the ADS40 is optimally tuned to LH systems, thus optimizing data-flow during data processing.

Where storage and analyses of data in GIS/LIS data bases are concerned, ESRI is a leading address in the field. One of the latest ESRI products is ArcSurvey Software. Leica Geosystems developed it for experts who want to simplify their work in the field, discover new applications and find new customers for the world of ESRI.

**Leica Geosystems: Freedom of choice**

Even though photogrammetry and surveying are growing closer together through GIS/LIS, beside Leica Geosystems, visitors at the ISPRS could not find

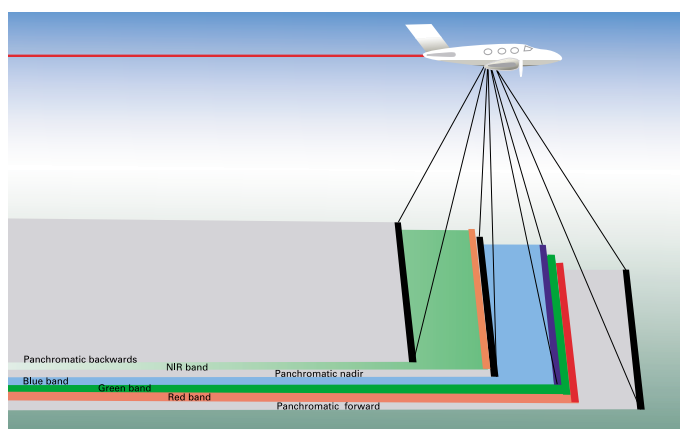


*Leica Geosystems' stand at the ISPRS exhibition attracting visitors: dialogue between man and technology.*



*The world's first photogrammetric digital camera, the ADS40 was first seen at the ISPRS congress in Amsterdam: Bruce Wald, President and CEO of LH Systems, announced the first orders from Japan and Germany.*

*The new digital sensor ADS40 by LH Systems acquires the overflow terrain all at once with various sensors, pointing forwards and backwards. It practically fulfills the functions of three conventional cameras.*





*Reason to celebrate: Hans Hess, President and CEO of Leica Geosystems (middle) is proud of the successful listing at the stock market of Leica Geosystems. Tsuneo Komatsuzaki (left) General Manager at Pasco Corporation, has just ordered two ADS40 systems, thus making Japan the first country in the world to employ this modern technology.*



*Chotinard Ratanasaka from the Thai Ministry of Lands and Surveys (second from left) is at present engaged in creating 4-5000er maps together with her colleagues from the Chulangkorn University and the Asian Institute of Technology. She is familiar with Leica Geosystems instruments and systems from the "Kern-and-Wild" days.*



*Khalil Saleme (left) at the Royal Jordanian Geosystems is using a completely automated system.*

any other major manufacturer of surveying- and GPS equipment at the exhibition. Leica Geosystems pursues with Cyra Technologies and with it's partnerships in LH Systems (50% participation), ESRI (strategic partnership) a future-oriented concept that puts into practice through the slogan "At a touch Leica Geosystems' freedom of choice", unlimited data-exchange compatible to many technologies.

Although Leica Geosystems' stand could not be overlooked at the exhibition, this was not due only to it's position directly in the entrance of the hall and surrounded by LH Systems, ESRI and Cyra products, but also because of a totally new

concept. Erwin Frei, Vice President of Leica Geosystems: "At the ISPRS Congress 2000, we wanted to show how various technologies interact and how this can be used to great advantage in the hands of experts. The potential in our innovative systems and problem solutions should be clearly visible to our visitors."

### **Much noticed Laser World-Premier**

These aims of Leica Geosystems were accomplished very well. Five times daily, laser beams magically projected virtual products into the air - accompanied by two people in a dialogue displaying the symbols of surveying solutions,

describing them and then just as easily letting them vanish into thin air. It was a real and much applauded world premier to the theme of the congress: "Geo-information for all", presented by man and through technology. Who stepped closer after the laser show, could see concrete products: the reflectorless total station LEICA TCRA1803, the GS50 and the GPS500 in the unusual combination with the DISTO laser meter and with bearing and distance designating laser locator Vector, as well as FieldLink, dialogue software field-office including editing and mapping quality.

Those who were interested could have a webpage with a new picture of themselves

*Renlin Zhang – Member of a 50-man ISPRS delegation from China – explores in the old city of Xi'an and teaches photogrammetry and surveying at Northwest University. He has many years of experience with instruments from Leica Geosystems and LH Systems, among which are the digital workstations DWS.*

*The Third World needs special attention in international development: Robert Schöch explains new means of visualization with data in ESRI format, to two ISPRS colleagues from Burkina Faso.*

*Jens Hallund from Sorø in Denmark employs a LEICA GPS500 to lay out gas pipes.*





*And Ahmad Al-Hijaj oversee at Geographic Centre, Ammann, ed chain using LH Systems.*



*Daily a DISTO could be won at the exhibition stand. Waltraud Strobl, who is responsible for international exhibits at Leica Geosystems, is spending her Wednesday as "Lady Luck".*



*Wolfgang Höppl, Graz, had to recently measure a turbine inlet at an Austrian hydro power plant: "With the LEICA TCR1103 this job, exacting down to the millimetre, was done in only a few hours – just a short while ago this would not have been possible !"*

as greetings from the congress in Amsterdam made at the Leica Geosystems' stand, and sent right from there to friends at home or abroad. Lucky visitors could even win a DISTO.

Antonio Celli returned home to Argentina with such a handy laser ranging device. Mr. Abouzaid from Saudi Arabia, John Kamper and Brian P. Olsen from Denmark were also winners. By the time of the next ISPRS Congress to be held in Washington D.C. in 2004, many concepts presented and discussed here by experts, will have been put into practice. Experiences gathered by expert- and work groups will in four years have enabled even more efficient

solutions in countries using geo-information. Leica Geosystems and it's partners will be there again to provide customers with cutting edge solutions for their needs in surveying, remote sensing and photogrammetry.

*Stf*

*Future solutions made visible at Leica Geosystems stand with the help of laser technology. Among other things the dialogue software Field-Link, the GPS500 and GS50 systems, the laser locator Vector as well as the DISTO lasermeter were present.*

*Riznan Zulkufi, Malaysia has questions to Christian Schorr about how to measure DGPS positions in forested areas. With a Leica GS50, even among trees or in cities the accuracy is within 40 centimetres (rms) thanks to ClearTrak™. The GIS DataPro software guarantees in addition, a complete dialogue between sensor and office. DISTO and Vector enable the acquisition and registration of distant objects without having to leave the prescribed GPS path.*



## At last Scandinavia has "bridged" the gap to Europe



As over the Big Belt, the entire planning and construction of the Öresund bridge was aided by Leica GPS- and TPS systems.

Europe is moving closer together: not only politically but also traffic wise. Old borders are being removed. Newest example: the 16km long bridge over the Öresund (picture). Leica GPS systems provided for the entire construction area millimeter precise position data and LEICA TCA1800 total station took on remote monitoring. Together with the bridge over the Big Belt, also projected and measured with Leica Geosystems instruments, 33 km of the most modern infrastructure have been built here in the last decade.

*Sif*



## On the Tsing-Ma bridge of Hong Kong a new era for GPS begins

Even if you now have to do without the excitement of approaching between high-rise buildings, landing at Hong Kong remains thrilling. Now passengers can see the Tsing-Ma bridge, a suspension bridge for road- and rail traffic and, at its construction time, the world's longest unsupported span section. Not only was it constructed using Leica Geosystems surveying equipment, but recently it is being monitored with the latest Leica GPS systems.

The Tsing-Ma bridge, dedicated in 1998 form together with the Kap-Shui-Mun and Ting-Kau Bridges an impressive network of engineering, spanning the straits between Chek-Lap-Kok, which is the new airport of Hong Kong, the city and the New Territories. (Reporter 36)

### Real time GPS monitoring

Though the entire network of bridges is already being monitored with 756 electronic sensors for different parameters – like wind speedometer, thermometer, accelerometer etc. – the board of transportation decided to install a Leica GPS system. By this means, real-time 3-D position monitoring is added and simultaneously a from the other sensors independent system has been put into place.

### Automated monitoring

The project entails mounting and connecting 27 LEICA CRS1500 receivers at the top of the pillars, on the spans and cables of the three bridges. Using RTK correction data received through the glass fibre network of the central reference station, the GPS stations can update their spatial 3-D positions at a rate of ten Hertz. All data are gathered at workstation data services and processed by the Bridge Monitoring Console Software.

### Safety first

The responsible government branch has created a GPS



based monitoring and control system, which around-the-clock monitors the movement due to special environmental changes around the three bridges. Among these are wind pressure, temperature changes, oceanic and seismic activities, as well as heavy traffic and traffic frequency.

*Andy Cheung*

# England: LEICA TCA1700 on ice . . .

**Tough times for a LEICA TCA1700 series instrument: measuring boreholes in a man-made ice cavern at a tunnel construction site at Kingston-upon-Hull in north-west England.**

Positioned right next to a wall of ice cooled to minus 30 degrees centigrade at the tunnel portal, the instrument runs day and night at full stretch. With the help of a guidance system and construction laser, every bore is positioned with millimetre accuracy, measured, documented and analysed directly on site.

## **Tunelling in a freezer**

Equipment failure – even at the most extreme temperatures – would be unthinkable, since conventional techniques would be unable to guarantee the precision required for making approximately 170 horizontal bores, each over 20 metres long. The project depends on maximum precision in positioning the chiller unit that protects workers and equipment at the tunnel drilling face. An incorrectly positioned bore drill could puncture the surrounding ice jacket, with fatal consequences: a sudden inrush of water would flood the tunnel, far below sea level.

*The drilling guide system reports deviations right away. All system components intercommunicate by radio.*



*The LEICA TCA1700 automated total station shows its class even under the most extreme conditions, delivering reliable measurements below sea level at minus 30 degrees Celsius, around the clock.*

## **Millimetric correction**

The drilling guide system was developed specially for this project by Beton- und Monierbau GmbH and Geodigital, a Frankfurt-based engineering firm. Each bore involves using the system to perform up to five separate measurement and work procedures, with the help of specially made prism adapters and calibrated attachments. After each measurement, the drilling engineers have immediate access to current estimates of the projected end position, both on a radio remote-controlled operating terminal and graphically on the process computer display. Millimetric corrections keep drilling operations perfectly on course.

By the way: levelling the laser theodolite proved to be the smallest problem. Tripod stands and brackets iced up solid within a very short time.

*Gerhard Weithe*



*Prisms are used for regular positional checks.*

# *In service 20 hours a day for Vancouver's SkyTrain*



There is some hard work going on in Vancouver, the Canadian Pacific metropolis. Two LEICA TCA2003 total stations with automatic target seeking operate up to twenty hours daily along the route of a new stretch of SkyTrain track. "The beauty of the Leica Geosystems automatic target recognition instrument is that we can also work nights", says Don Murray.

*Above: The overhead erection truss system works its way along the support columns on stilts, spanning them with elements that are joined together on site. Below: LEICA TCA2003 total station operate up to 20 hours a day with survey teams working in shifts. 90,000 track anchoring points need measuring – and that's just part of the job!*



Don Murray and his 21-strong team are responsible for all surveying work on the 17-kilometre SkyTrain expansion. 13 new "stations in the sky" are simultaneously taking shape along the new stretch of elevated guideway that runs primarily through industrial areas, high above existing road and rail corridors.

## *Pace setting elevated guideway*

The key to the success of Greater Vancouver's SkyTrain is the elevated guideway. Just like the construction work presently underway, SkyTrain passengers travel quickly and efficiently without getting tangled in traffic. The SAR joint venture building the elevated guideway uses innovative construction and survey methods, like an overhead erection truss system and target-seeking total stations.

## *Planned for a century of service*

The awesome quality demands placed on the SkyTrain elevated railway are dictated by its design life of 100 years. More than 500 columns are required to support the guideway. The concrete columns are cast in situ about 37 metres apart. Once the columns are in place the guideway beams are assembled using an overhead erection truss system which straddles the guideway columns. The track runs on reinforced concrete beam segments that are slotted together before the erection truss moves on to the next section.

## *Custom casting*

Each segment is individually cast with its own geometry depending on the angle and incline of the guideway at SAR Transit's precast facility. Guideway assembly typically involves hoisting

12 segments, each 3.2 metres long, then drawing them together with steel cables to form a solid guideway span. There are 6,000 segments used in the formation of the guideway.

**Work includes measuring 90,000 anchor points**

Precise measurement is crucial in this densely built-up area criss-crossed by transportation routes. Don Murray: "The first step was to establish a fixed point control network along the entire projected route. We did the job with two LEICA TCA2003 total stations. For more than a year now, we have been using the same instruments to measure finished sections of guideway. This includes 156-212 pairs of as-built inserts per segment, which alone adds up to around 90,000 measurement points!" It is therefore unsurprising that the surveyors work shifts like the rest of the construction crew in order to record this quantity of points and maintain rapid progress. As a result, their LEICA TCA2003 total stations operate for up to twenty hours a day. "Precision is paramount", says surveying specialist Don Murray. "The specified tolerance is just ±3 mm. Furthermore, each measurement must be repeatable with similar precision. And of course, instrument downtime is the last thing we can afford. In short, there were many reasons behind our choice of Leica TCA2003 total stations."

**About one third faster – amongst other benefits**

Asked to compare the benefits of automated target focussing with conventional methods based on his



experience with this project, Don Murray concludes: "When establishing the fixed point network, we were able to acquire considerably more data in the time available. Measuring new control points on the elevated guideway structure required just two-thirds of the time originally scheduled, which corresponds to a one-third saving in work hours and personnel. We could also minimise any positioning errors while marking the control bolts." There is another point which Don Murray feels should not be underestimated: "The automated total stations target-seeking 'eye' stays on top form even after 20 hours' work, which is why this project has not been dogged by discrepancies resulting from observer fatigue, followed by painstaking tracking-down of errors!"

**Train service to commence shortly**

For efficiency and scheduling reasons, the SkyTrain guideway is being built in several areas simultaneously. Thanks to the latest construction and survey technology, the project managers were able to minimise diversions and disruptions along existing traffic routes. After a construction period of just one and a half years, the

first SkyTrains are set to start gliding elegantly along the expansion stretch as early as May 2001, high above regular traffic. *Stf*

*Vancouver's new stretch of SkyTrain elevated railway runs largely alongside existing traffic routes.*



Stephansdom – Prater ferriswheel – Gasometer: these three man-made landmarks of Vienna have, for the past four decades, been prominently visible from afar. The UN City and the Millennium Tower have transported the Danube metropolis' skyline into modern times. The four gigantic Gasometers in the eastern section called Simmering, are being turned into living quarters and commercial centers.

"How well our grandfathers were in the position of building and surveying with incredible accuracy, was manifested at the start of the revitalization work, while re-measuring the Gasometers." says Hans-Peter Blaha, surveying expert at Porr: "The maximum deviation within the enormous Gasometer circular structure of 63 metre in diameter and 60 metres in height was a meager 1,5 centimetres."

**Europe's largest gas power plant**

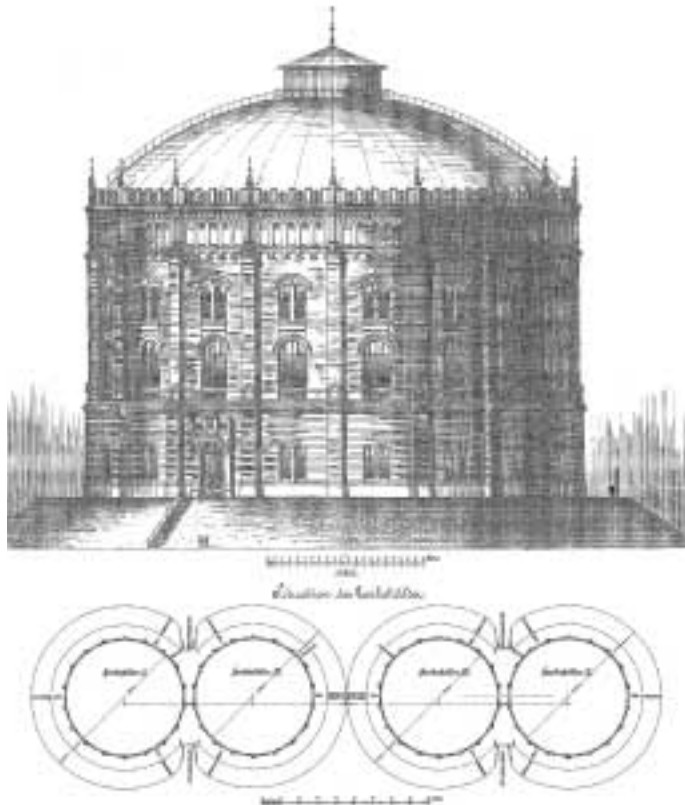
The old Imperial City of Vienna does not only consist of history and culture, even if those traits have been nurtured more consciously than in other cities. Though "Jugendstil" had it's origins here, there are a lot of original modern designs to be seen. Where else for instance, can one find such impressive

gas light and power supply as can still be found at Vienna's four Gasometers? In 1986 after converting to other power sources they weren't just razed to the ground but preserved as trademarks of a culture of industry-based settlements and as a history of energy



*Above: The Viennese Secession-building is as old as the Gasometers but even today still seems modern.*

*Below: The architectural plans shows industrial architecture shortly before the Modern Age. Vienna's Gasometer containers were representatively protected by a tiled wall.*



# High-rises out





*Left: The 160 ton steel dome structures were renovated. With a central scaffolding the pressure ring was placed underneath. Photo: Porr/Gruna*

supply, in a way even beneficial to the people of today and tomorrow.

**A common concept – four individual ideas**

Four renown architects were tasked with coming up with a solution, based on common infrastructure, to turn the four former Gasometers into living quarters, business and office centers. In the summer of 2001 the four Gasometers (A-D), will be filled with urban life in accordance with the ideas of the architectural offices of Nouvel (A), Coop-Himmelblau (B), Wehdom (C) and Holzbauer (D).

**City center and airport equidistant.**

Inside of Gasometers C-D the designated workgroup in which Porr Project and Hochbau AG participate, a 34 storey building with about 90'000 squaremetres of floor area, 235 apartments, 20'000 square metres of garage area, 18'000 square metres of city archives, 10'500 square metres shopping-/business area and 5000 square metres of offices is being erected. The Gasometers will be transformed into "Castelli Gaselli", so to speak "Living and business castles" with high class infrastructure and it's very own subway station. From here one can reach the Stephansdom in the center of the city in ten minutes and in about the same time reach the airport "Wien-Schwechat" on the outskirts of town.

**New buildings inside the Gasometer walls**

Intra muros – within the walls of each cylinder – a high-rise will be built, above which the sky will remain open. After removing the steel tank, only the steel rods with a light-house foundation remains. In order to let light in, 15 metre diameter holes will be drilled into the tiled walls. Three new strong concrete rings will stabilise and stiffen the old walls and at the same time serve as connection between the Gasometers fortification pillar and the core of the new building. Each of the four Gasometers will receive individual interior architecture according to the builder's concepts and architectural plans. Hans-Peter Blaha, who along with his assistant Stefan Götz is responsible for the surveying of Gasometers C and D: "Our primary task is, starting off with the local surveying data, drawing survey points through the two objects to create stable points for detailed surveys."

**Between pressure rings**

The 160 ton dome structure was more problematic. The so-called "lantern" alone weighs 18 tons, and the entire structure had to be preserved, which is why a profound revision was needed. The pressure rings and the 36 main steel girders had to be removed, revised while suspended in mid air by five cranes of 60 metre span and 82 metre lift and then re-inserted. A central girder was erected below the pressure rings. Hans-Peter Blaha: "During removal and reconstruction of these structures, the different forces had to be considered. Measuring and monitoring with the reflectorless Leica TCRA1105 was the obvious way to go as it delivered wonderful results. Based on our measurements, the office of static's FCP could retrace the pressure rings original positions. Simultaneously multiple holes were cut into the

*of the cylinder*



*Photo far left: Stefan Götz measures the dome structure with the LEICA TCRA1105 in automatic reflectorless sensor ranging mode. Left: Gasometer C and D at different stages of renovation. Photo: Porr/Rappersberger*



*High-rises are being built in the cylinders of the largest Gasometer compound in Europe.*



*Coop Himmelblau ventures to set a control point outside of Gasometer B.*

dome. The upper surface shows the tension and the inner the set coordinates."

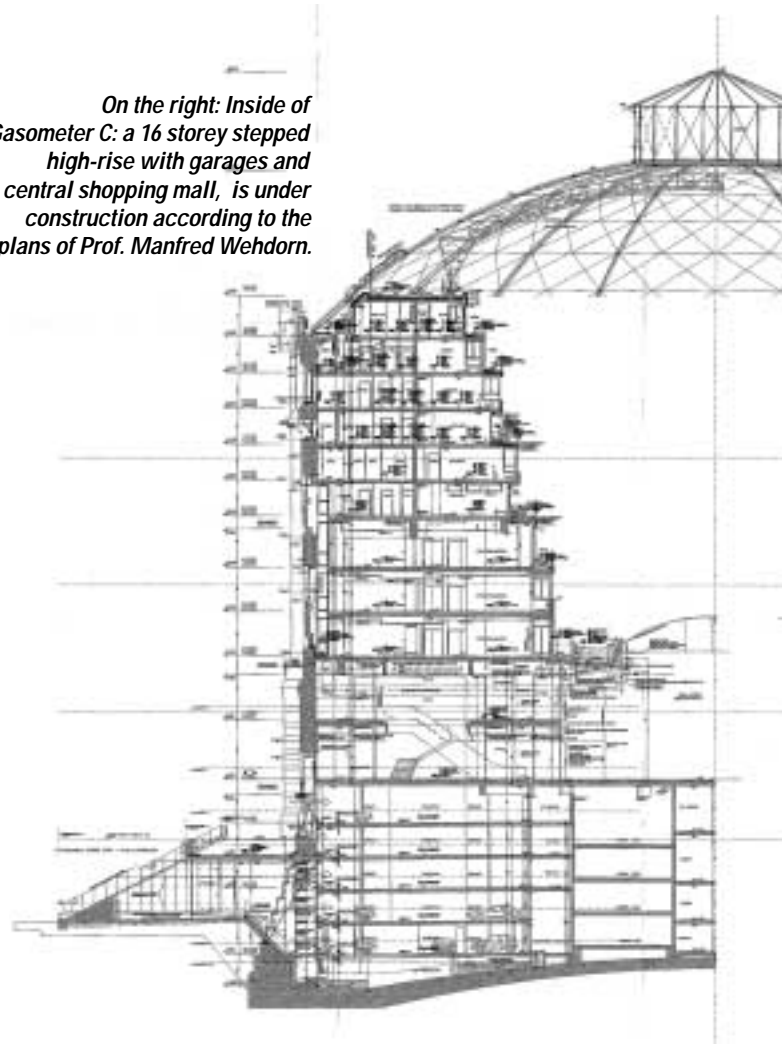
**Method of choice:**

**reflectorless measuring!**

Speed, accuracy and safety were also needed when it came to building a pedestrian bridge between the two buildings, connecting old walls and adjusting the new heights of the concrete levels. The LEICA TCRA1105, with automatic reflectorless measuring and visible measuring points rendered the best of services. Stefan Götz; "Despite of walls without sharply defined edges the LEICA TCRA1105 gave remarkably accurate results. I could directly process the data on the PC and supply exact plans for the statisticians and constructors." Technology of the new millennium in Vienna!

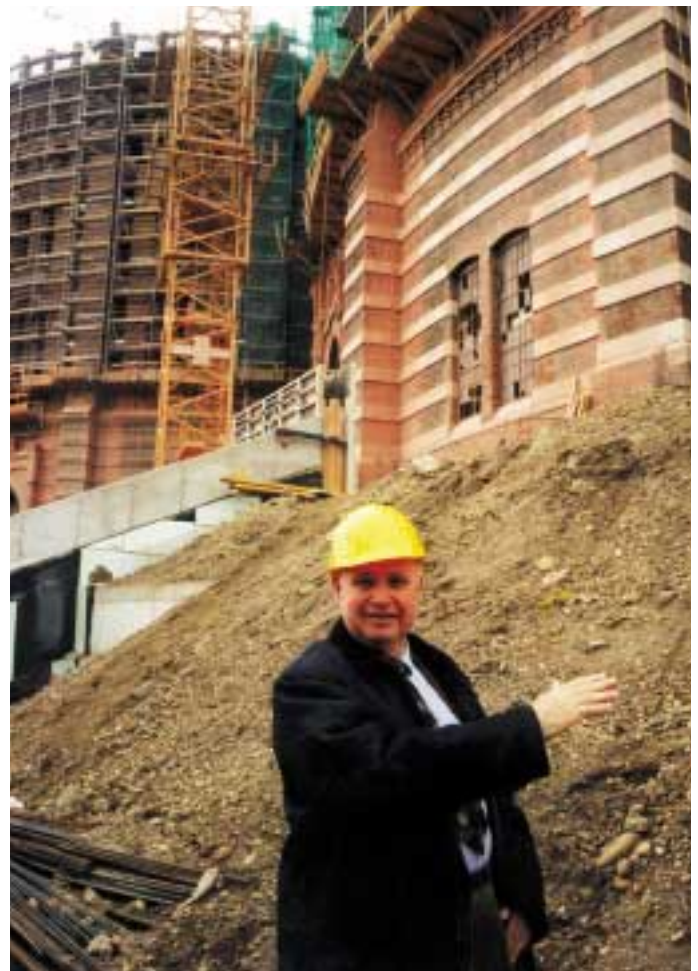
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*On the right: Inside of Gasometer C: a 16 storey stepped high-rise with garages and central shopping mall, is under construction according to the plans of Prof. Manfred Wehdorn.*



**Highly skilled and experienced in customer relations**

"These Gasometers supplied the metropolis of the Danube monarchy, Vienna and her two million inhabitants with electricity for eight decades" says Peter Schlögl (on the right). His grandfather, Rudolf Rost, had constructed in his own workshop surveying instruments for the Gasometers, which were filled for the first time in 1899. Peter Schlögl: "I spent my youth here myself, for my father was a chemist in the then largest gas power plant in Europe." Today, Peter Schlögl has returned to the area after a long time. He is visiting the enormous site along with his daughter, Dr. Michaela Schlögl, Rost Directress, his customers the two surveying experts, Hans-Peter Blaha and Stefan Götz from "A. Porr, Technobau und Umwelt AG." By order of the Porr Project Manager, Martin Schilling, the two surveying experts were recently able to solve a critical problem with reflectorless measurement. The R+A Rost Company, with Peter Schlögl as manager, was able to supply the most powerful surveying instrument, as they were a hundred years ago – this time the LEICA TCRA1105 total station. R+A Rost are representatives for Leica Geosystems in Austria for many years. "Long lasting customer relations are not as unusual in Vienna as in other places" Hans-Peter Blaha explains. That is true, Porr Construction was founded 130 years ago.





*On the left: Porr's leading surveyor Hans-Peter Blaha, using the quick, contactless and reflectorless way of measuring the Gasometers structure. All the way down: Porr's Surveying Engineer Stefan Götz checking*

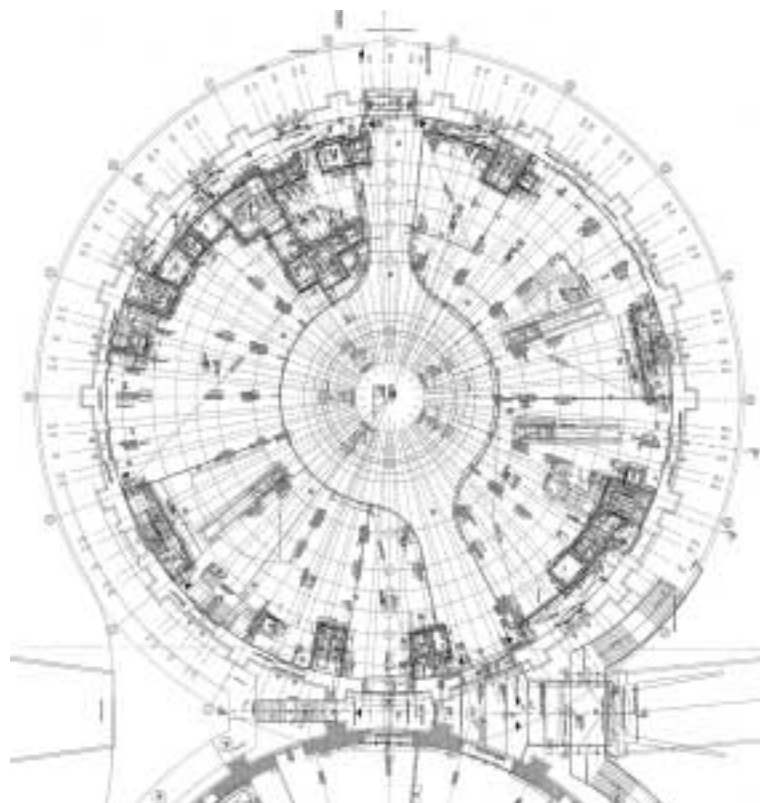
*old and new structures with the LEICA TCRA1105. Below; In the "Castelli Gaselli" C (picture) and D alone, 235 apartments are being built in the inner walls.*

### ***Various surveying tasks at Porr***

The surveying department of "Porr Technobau und Umwelt AG", led by Hans-Peter Blaha is not only responsible for challenging tasks in surveying, but it is also responsible for maintaining and recalibrating all instruments used by the Porr Company. "We have about 200 levels, as well as 100 theodolites and total stations. Among other new Leica Geosystems instruments, we also have numerous "Wild and Kern" instruments, that are even today up the task where precision and high quality is concerned."

The newest and smallest instrument available to the Porr surveyors is the laserimeter DISTO by Leica Geosystems. "With this instrument we can quickly determine all ceiling heights i.e. at highway underpasses. We also solve trigonometric problems easily by combing the DISTO measurements with angle measurements from the theodolite.

To determine the slant of a road, we always need it's width. On a road with much traffic there is no faster, simpler way than with this small handy thing," says Hans-Peter Blaha.



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