



# The fascination of diversity



Glimpses into the many different fields of activity of our customers, and into the astonishing diversity of applications for which they use our technologies, products and systems, make up one of the most interesting aspects of my work with Leica Geosystems. This issue of the REPORTER will show you just a small part of this diversity. Each example presented is fascinating; it is unique in its own way and yet at the same time typical. A flip through the pages takes us from Scandinavia to America, to China and to the Middle East. There are brief insights into shipbuilding, space travel, the oil industry, major construction products and many other topics. Leica customers everywhere are turning great visions into reality, and it fills me with pride to know that our products and services are making their contribution; a small one here, a great one there. This way, our customers can profit from the ubiquitous presence of Leica Geosystems, which has its own distribution and service network in about twenty countries. In more than a hundred additional countries, excellently-qualified representatives, working exclusively for Leica Geosystems, attend to customer requirements. Their task is to provide on-site customer support. In addition to our great range of standard products, we offer solutions that are "made to measure"; this is our motto. In all of these

countries Leica Geosystems also has service workshops, where specially-trained technicians carry out maintenance on our customers' instruments. More and more customers are signing up for attractive maintenance contracts that relieve them of responsibility for their instruments. Trained application specialists are there to provide on-site advice about how to use Leica products more efficiently or how to accommodate them to individual requirements. We all get satisfaction from knowing that we help with your daily surveying tasks. We are also very pleased when we can use the REPORTER to pass on your news to other customers throughout the world. Maybe sometime you will let our readers know about your own project? Meanwhile, enjoy reading about the fascinating projects of other Leica users.

Hans Hess  
President & CEO  
Leica Geosystems

## IMPRINT

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Editorial

## THANK YOU!

**In REPORTER no. 41 – our 30-year jubilee issue – we appealed for your views about the REPORTER. Three Leica cameras could be won as our way of saying, "thank you". We picked the winners at random from your replies. They were: Frank J. Hinsche from Halle (Germany), K.K. Katiyar from New Delhi (India), and Philippe Lortal from Challans (France). Congratulations to you all!**

400 REPORTER readers from around the world sent us their thoughts about our magazine. The results revealed that each copy is read by an average of four people. Multiply this by our circulation, and it emerges that our customer magazine has a readership of approximately a quarter of a million professionals world-wide.

95% of respondents judged the REPORTER contents as "very good / good", while only 5% considered it "not so good / uninteresting". Your assessment of the visual layout was similarly positive. Many thanks for your praise!

REPORTER readers have a wide range of interests, just like the themes we cover. Of primary interest are new products (83%), national

surveys (48%), construction site applications (42%) and geodetic applications (41%). On average, respondents desired four REPORTER issues a year – we publish three at the moment.

Your assessment is a very important benchmark for us. Now that we are more aware of the themes you want to see covered, we will work even harder at meeting your expectations in the coming issues. Concrete reader suggestions arising from this survey will certainly be of additional help in selecting articles for publication. You tell us that you would like to assist the editors with contributions describing your own activities – and perhaps we will manage to publish some reports from the field as early as the next issue.



**Lucky dip: Brigitte Brunner draws the three winners of Leica ZZX cameras from the survey responses, together with Waltraud Strobl.**

Although the reader survey is concluded, we still look forward to receiving your letters and comments. They are a significant contribution towards making the REPORTER interesting and lively to publish – and to read!

Waltraud Strobl

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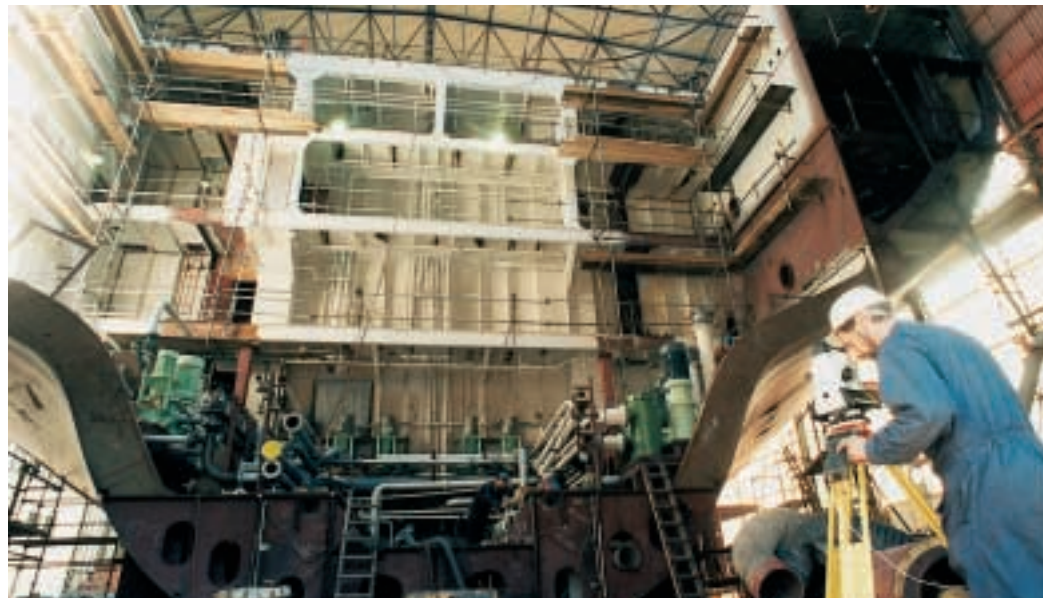
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Levelling the Space Shuttle's terrestrial infrastructure

# Dimensional Control and Analysis at Thyssen Nordseewerke

Thyssen Nordseewerke GmbH, located in Emden on the North Sea coast, has to date built around 500 merchant ships, and 60 submarines and frigates. The latest measurement techniques are used at the yard, which is one of the most modern shipbuilding enterprises in Europe.

There is a long tradition dating back to 1903, when the shipyard was founded as the Nordseewerke Emden Werft und Dock Aktiengesellschaft. Today, a workforce of 1350 produces high-quality container ships, special vessels, icebreakers, frigates and submarines.



## On-site control and measurement

At Thyssen Nordseewerke, ships are constructed on the slipway. Parts and segments of up to approximately 350 tons unit weight are fabricated in the surrounding sheds, before being craned onto the slipway for assembly.

Best-fit construction requires utmost precision in fabrication and measurement at all stages of manufacture. Production and quality control managers have thus opted to use the Leica Geosystems DCA-TPS system for ongoing control and on-site measurement.

## Survey reference system

All measurements within the hull are based on the marked centre line, or a reference line parallel to this, and a predetermined "principle object point" for the second level co-ordinates. Markings on bulkheads, the water line or defined object points within the hollow spaces provide references for level. In submarine construction, the main axis plane or centre plane is used in setting out.

Special navigation or sonar components are set out using a primary reference line.

## DCA-TPS 3-D measurement system – sub-millimetre accuracy

The field equipment is comprised of two TDM5000 sensors and a Husky FS/2 field computer with installed DCP10 software; general dimensional analysis and reporting is performed using DCP20 software. The DCP software is an industry-specific package developed by a specialised Leica Geosystems partner company, A.M.S. of Oulu (Finland).

The TM5000 precision Totalstation measures with sub-millimetre accuracy. The typical distance measuring accuracy is 0.5 mm. Leica Geosystems' Axyz CDM software is used for applications specific to submarine construction, e.g. to compute the roundness of individual segments of the pressure hull, or to verify the cylindricality of the centre section and roundness of the spherical segments at either end of the hull.

## Checking bulkhead positioning with Leica DCA-TPS at Thyssen Nordseewerke

These basic system components are backed up by a range of accessories used for measuring a variety of objects under difficult conditions. They include a hidden point rod, magnetic holder, vacuum holder, various types of standard target, and special tripods for positioning the TDM5000 at different levels.

## Use in merchant ship construction

These systems are used for on-site measurement in merchant ship construction, and also during the fabrication of individual parts and segments. The fundamental measurement task when constructing a new object is to establish a coordinate system on the slipway, with a reference plane to be used for positioning the first double-bottom hull blocks. The fixed points in this coordinate system are permanently marked or

drilled, so that targets and other sighting aids can be affixed prior to measurement. At the setting out stage, measurements are recorded in a polar, tacheometrical system. The program then calculates the transformation to obtain the measured coordinates of the object points in the ship's coordinate system. After setting out, the first double-bottom blocks are positioned. Their centre line and other object points then become the new reference points and are used for measurements inside the hull, where the original



Left: Accessories for targeting points of interest

Right: Precision Total Station TDA5005 with Automatic Target Recognition

reference points, now outside the hull, can no longer be sighted. The measurement systems are applied to each new segment added, to check the relative positions of components and, if necessary, to facilitate remedial action.

## High-precision dimensional control

Bulkhead positioning requires particular attention. Bulkheads are normally incorporated as single sections perpendicular to the ship's length, delimiting the hold at bow and stern and splitting it into several

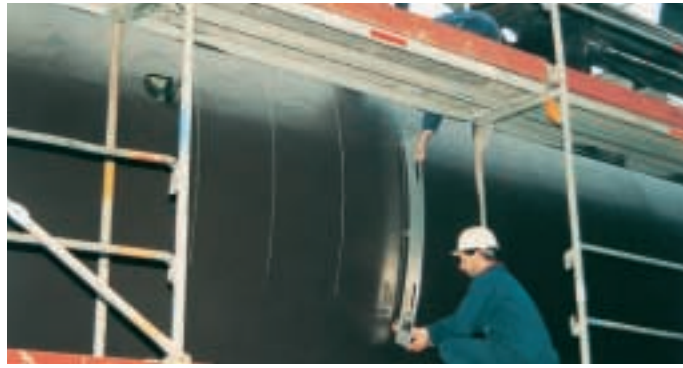
## 3-D measurement values now recorded directly in the Total Station

DCP05 software from A.M.S. is due for release in summer 1999. This new addition to the DCA range integrates 3-D measurement in the Total Station, with the following user benefits:

- Full 3-D functionality with online desired/actual comparison: the operator loads construction data coordinates, adjusts to the reference coordinate system, and the instrument automatically aligns itself on the desired point at the touch of a button. Desired/actual deviations are available right away.
- No additional field computer required: data storage uses PCMCIA compatible memory cards.
- Option for attaching the RCS1100 remote control unit: the one-man system can then be operated from where the information is actually needed during construction – typically the measurement point itself.



The DCA-TPS system in action at Thyssen Nordseewerke



*Above top: Conventional, labour-intensive method for roundness checks using a gauge (1-D measurement). Picture below: Single operator 3D-roundness check using a Leica DCA-TPS Total Station (3D measurement).*



*RCS1100 remote control unit facilitates one-man operation*

*Laser pointer for setting out locations on site according to the design data*



sections for stowing purposes. In the hold area, setting out in line and level of container foundations, and the vertical container tracks used for loading, are all important measurement tasks requiring utmost precision to ensure easy loading and unloading, and to prevent movement of stowed cargo. Steps incorporated in the curved outer sections of the hull to exploit otherwise redundant space are fitted out in the same way as the main part of the hold, to accommodate further containers. Measurements to ensure that these steps are built parallel to the main floor are absolutely critical.

Another important measurement task concerns setting out machine foundations, fittings and drive units, and in particular the checking of shaft and rudder positions.

#### **On-site measurement cuts costs**

In 1995, Thyssen Nordseewerke began phasing in "neat" production methods, i.e. precision fabrication with a minimum of excess material to be trimmed on site.

This method sets out to achieve a high degree of accuracy, within permissible tolerances, at all stages of production from the foundry to the fabrication of sections and blocks – thus eliminating the traditional, yet wasteful practice of incorporating excess material, then trimming/reworking during assembly.

Strict implementation of this test system at all levels of production, supported by the Leica DCA-TPS measurement system, has thus considerably reduced construction times on the slipway.

#### **Use in submarine construction**

The German Federal Armed Forces Procurement Office (BWB) in Koblenz has recently officially approved the LEICA DCA-TPS system as a third method for measuring the roundness of submarines, offering an alternative to gauge and compass methods.

The current U212 series for the German Federal Navy will be the first to be produced at the Thyssen Nordseewerke with ongoing on-site measurement using the Leica DCA-TPS system.

Using a Total Station to measure roundness obviates the need for elaborate scaffolding demanded by traditional methods to ensure safe and accurate handling of the heavy, bulky measuring devices. All the Total Station requires is a small, lightweight (approx. 100 g) target (e.g. reflective tape on a suitable carrier) to be taken to the individual measurement points; one man moves around the object, while another operates the measuring device, positioned at a firm vantage point some distance from the object. The location of the measuring device largely depends on the visibility of the measurement points and site conditions. Flexible system positioning

allows the user to select locations that cause minimum disruption to site operations. Unlike the compass measurement method, which is unusable once the hull has been fitted out, the Total Station has the advantage of allowing partially or totally fitted objects to be measured.

Other operations carried out on submarines at Thyssen Nordseewerke include setting out external fixtures, and measurements for special fittings inside the pressure hull.

#### **New products and enhancements**

The functions of the TDM5000 motorised precision tacheometer described above are also available in the current TDM5005 and TDA5005 models, thus further boosting measurement accuracy. The TDA5005 goes a step further, with Automatic Target Recognition (ATR). The use of prism targets allows automatic adjustment of the reflector and tracking as the reflector moves. Add remote control, and this becomes a single-operator system.

Adaptable DL2 or DL3 diode laser pointers are used to visualise the target line or point on the measurement object, further increasing setting out efficiency.

*Heinz Albers / Jörg Illemann*

## **Constructing the future, reconstructing the past**

Once again, Leica Geosystems is involved in the construction of one of the world's great buildings: the "Sagrada Familia" – the Cathedral of the Sacred Family – in Barcelona. The DISTO™ Pro laser distance meter is helping supervisors to put the finishing touches to Antonio Gaudi's uncompleted architectural masterpiece.

Architect Antonio Gaudi was intent on incorporating a variety of architectures when he started this project in 1882. The style initially tended towards the neo-Gothic, but he subsequently followed a naturalistic-modernistic trend in accordance with an organic structure, creating one of his most important works in the process. Progress on the construction of the towers, which mimic the structure of organpipes, was extremely slow. The horizontal apertures in the towers are there for acoustic reasons, because Gaudí planned enormous bells. The gables at the summits of the towers are among the first examples of abstract sculpture. Gaudí himself lived to see only the completion of the main façade, but work on the cathedral continued unabated after his death. At present, a sub-project is being developed to build a roof for the main chapel; the surface involves irregular shapes and complicated architecture, but it is anticipated that this phase of the work will be complete towards the end of the year 2002.

To ensure precise measurements, the builders are using the DISTO™ Pro hand-held laser meter from Leica Geosystems. This instrument remotely measures distances up to



about 40 metres with an accuracy of 1.5mm, so it is no longer necessary for the operator to go to the other end to measure. Señor Ramón Espel, the building supervisor, notes that the DISTO™ Pro performs well above expectations, giving it applications beyond those aspects of the work that were originally envisaged.

The DISTO™ Pro is being used to check construction results, while simultaneously obtaining information prior to commencing new work. One person can perform measurements far more quickly and accurately than a conventional two-man team. Additionally, the laser can measure to points that would otherwise be inaccessible or dangerous. Señor Espel adds: "Measuring ceiling heights and widths of broad apertures was always a problem for us before, but now we can carry out the work really easily and safely".

*Barcelona's unmistakable landmark: the towers of A. Gaudi's Cathedral of the Holy Family. Building supervisor Ramon Espel values the DISTO™ Pro's non-contact measuring technology when constructing the complex roof for the main chapel (below).*



# Digital levels monitor the Space Shuttle's terrestrial infrastructure



For almost two decades, the Space Shuttle has commanded world-wide attention as the leading resource for manned space research and development. In that time, it has carried more than 600 major payloads totalling over 750 tonnes into orbit, stimulating communication, medical science and space exploration. It is space age technology that is reliable, secure and extraordinarily successful.

Unsurprisingly, success is directly related to those remaining on the ground. From shuttle processing, launch and landing, to routine Kennedy Space Centre (KSC) base operations, it is these people that provide the steady, reliable foundation to explore and exploit our universe.

Much of that foundation is established by a select group of surveyors and precision tools from Space Gateway Support (SGS, Herndon, VA). "The success or failure of Shuttle missions often comes down to a fraction of an inch", says Donald Lanthorne, surveyor for SGS. "We can't afford to make mistakes or experiment with unproven technology. When we select

an instrument for surveying, it's got to perform as reliably as the Shuttle itself. For more than a decade, we've relied on digital levelling technology as the linchpin of our surveying activities".

Beyond surveying, SGS responsibilities include project management, public works, base support services, installation improvement, and engineering activities, both at KSC and the Air Force 45th Space Wing Cape Canaveral Air Station. Lanthorne adds, "With digital levels we have the speed, accuracy and mobility to perform base operations before, during and after Shuttle missions – whether we're balanced precariously several hundred feet in the air, or safely on the ground".

## Shuttle Facilities

Prior to a Shuttle launch, the orbiter is towed from the Orbiter Processing Facility where the payload is loaded, to the Vertical Assembly Building where it is elevated to the upright position. It is then lowered to a Mobile Launcher Platform (MLP) and mated to the familiar bright orange external tank and two white solid rocket boosters (SRBs).

The Shuttle vehicle is supported and restrained on the MLP during assembly, transit and pad checkout by the SRB support/hold-down system. Each SRB unit includes four hold-down posts bolted to a flat pedestal.

It is this mechanism that first prompted the SGS surveying team to invest in digital levelling technology. According to NASA guidelines, each bolt has a nut at each end. The top nut contains two NASA standard detonators that are triggered as the solid rocket motors ignite. Says Lanthorne, "Routine maintenance specifications define that these posts must be refurbished after a certain number of launches. At this time, they must be realigned to an accuracy of 1.5 mm".

The idea, say surveyors, is to position the digital level where it won't interfere with the removal of the post. Then they use a clock face reference system to ensure that the measurements are taken at the same place



every time. He adds, "The digital level allows us to check and adjust the SRB support pedestal surface. After the SRB hold-down posts are bolted down, a special puck is inserted in the top of these posts to represent the SRB attachment point. We check the elevation of this point to ensure that the vertical control dimensions are met". Traditionally, the survey team relied on conventional levelling technology to perform these tasks – but with digital levels, they say, the job is faster, more accurate, and less labour-intensive.

Digital image processing permits height and distance information to be recorded electronically, avoiding errors caused by manual recording and automating data processing. Field tests have shown that digital levelling brings productivity gains of up to 50%.

## Launch Preparation

Once the Shuttle launch system is mated, a massive transporter crawler moves the entire vertically standing structure to Launch Complex 39. Launch Complex 39, not far from the Atlantic Ocean, is a large area of flat land that has been a starting point for space flight since the Apollo missions of the early 1960s. The site consists of two enormous octagonal launch pads, Pad A and Pad B, each covering about 2.5 square kilometres. Pad A is 15 m above sea level, while Pad B is 17 m above sea level.

These enormous concrete pads support the Fixed Service Structure (FSS), a Rotating Service Structure (RSS), and the MLP. The FSS is a 12 metre square, 75 m high steel tower that supports three service arms:

the orbiter access arm, the external tank hydrogen vent line and access arm, and the external tank gaseous oxygen vent arm.

These arms are carefully monitored for deviations that might cause errors when the arms mate to the orbiter at the pad prior to launch. "The close proximity to the salty ocean air", says Lanthorne, "demands that these arms be removed, sandblasted and repainted routinely". Each arm has its own, precisely documented positional requirements. For instance, the Orbiter Access Arm has a white room (clean room) at its end that is used for Shuttle access at the launch pad. During repositioning, the arm is mated and stowed a number of times to make sure it ends up in the right position.

The RSS provides access to and protects the orbiter during changeout and servicing of payloads at the launch pad. The RSS main structure extends from 18 to 57 m above the pad floor and rotates 120 degrees. Within this structure is a cargo bay called the Payload Changeout Room (PCR). This environmentally controlled bay sits some 30 m off the ground and supports cargo delivery to the pad and subsequent vertical installation into the orbiter payload bay. Cargo is removed from the payload canister and installed vertically in the orbiter by a rail system called the

Left: Donald Lanthorne, perched at a dizzying height to check the elevation of the gaseous oxygen vent using a Leica NA 3003 digital level, and (right) measuring the RSS rails with Kevin Beuer.





Payload Ground Handling Mechanism (PGHM). Surveyors must routinely check permanent targets located on the RSS for deformation. NASA demands an accuracy of  $\pm 3$  mm. "This is a fairly simple surveying task", says Lanthorne, "except that we're overlooking the Atlantic Ocean from about 30 m in the air. Naturally, we demand tools that are portable and virtually infallible".

**Maintenance Activities**  
Just prior to launch, KSC onlookers might notice a large white hat seemingly perched on top of the nose of the bright orange external tank. This is called the External Tank Gaseous Oxygen Vent. It's at the end of a 19 metre long mechanical arm attached to the primary launch pad structure. This hat is designed to vacuum liquid oxygen vapours while the external tank is filled with hydrogen and oxygen gases. Just prior to launch (about 2 minutes and 30 seconds) the external tank gaseous oxygen vent arm retracts to a "latchback" position against the FSS.

"Our job is to make sure this 19 m long arm is at the proper elevation to support the stack. Launch pad maintenance crews occasionally remove the

*Shuttle launches at Kennedy Space Centre don't get the go-ahead without rigorous advance checks by Space Gateway Support, using Leica NA 3003 digital levels. The picture shows Kevin Beuer of SGS on the shuttle launchpad. Both height and distance are recorded with high precision and recorded electronically for subsequent calculations and graphical display.*

vent for cleaning, replacing mechanical equipment and testing. We make sure it's put back exactly where it belongs", says Lanthorne.

While standing on the FSS steel tower, around 80 m up in the air, Lanthorne and his partner, Kevin Beuer, set up the digital levelling system. "Once again, speed, accuracy and reliability are essential. Digital technology allows a two-man crew to do the same job more efficiently and accurately than conventional methods. Believe me, when you're standing almost a hundred metres up in the air looking down at the most powerful space vehicle in the world, you appreciate these features".

It's these and many similar activities that challenge SGS to assess and re-assess today's digital technology. "We must have speed, accuracy and mobility from both our people and our tools", Lanthorne concludes. "I've been on-site at Kennedy Space Centre for 20 years, almost as long as the Shuttle program has been operational. In that time, I've sent back one theodolite for some adjustment. That's the kind of reliability we need to manage the next era of manned space activity".

*Vicki Speed Hasenzahl*

## On March 10, 1999, paving history was made

On March 10, 1999, world construction history was made at a site in Northport, Alabama (USA). For the first time ever, slipformed curved kerbs and gutters were laid string-free, with millimetre precision. A Gomaco GT-3600 paving machine created the structures automatically, according to a predefined plan. Control data was received from a Leica Geosystems 3-D machine control system able to precisely control also position and height of other types of Gomaco machines.



Gomaco is a world leader in concrete construction equipment with headquarters in Ida Grove, Iowa (USA). The company's equipment will slipform concrete streets and highways, airport runways, curb and gutter, bridge parapets, irrigation canals, safety barriers, and other construction elements made of concrete. Gomaco's innovative machines are in use world-wide, serviced by an international sales and maintenance network. Gomaco teamed up with Leica Geosystems to stage a world premiere in automated slipforming of kerbs and gutters on March 10, 1999, at a Northport AL site contracted to the Shirley Concrete Company.

### Integration in various types of machine

Gomaco's Network Control Systems technology allows easy integration of the Leica 3-D control system with the company's various machines. The Gomaco Network Controller receives its input from the Leica machine control system. CAD-generated site data is stored in a Leica control computer fitted to the construction machine.

### Automatic construction machine control with millimetre accuracy

The Leica machine control system on board the construction machine consists of an industrial PC running a software package from Leica Geosystems, plus a target prism mounted at a high vantage point. The same software controls a Leica TCA Total Station, positioned some distance outside the construction path. The Total Station automatically optically tracks the prism, while sending real-time distance and angular information to the machine control system via a radio link. The 3-D control centre compares the construction project data with the machine's current position, and immediately sends the necessary control commands to the machine controller to ensure continuous, uninterrupted operation.

### Complex shapes are no longer a problem

The machine can reproduce the most complex profiles, radii and routes specified in the project data, automatically compensating for the terrain and forming the concrete with millimetre accuracy. Not only does this new construction technique offer extraordinary precision, it also brings higher quality, greater safety, and speedier construction. Creating purpose-built areas like large car parks becomes cheaper, while boosting the contractor's competitiveness.

Further advantages include:

- No stringline installation and maintenance costs
- Stringline no longer obstructs construction site logistics
- No stringline errors caused by damage or displacement
- High reliability in the tough world of the construction site
- Arbitrary positioning of the Total Station
- Continuous machine control along lengthy sections possible by setting up a simultaneous pair of Total Stations

*A Gomaco GT-3600 linked to a Leica machine control system forms concrete kerbs precisely according to the site plan. The target prism attached to the yellow Gomaco slipforming machine is clearly visible, likewise the machine control system (the white box behind the operator). The Leica Total Station (at the right in the background) continuously tracks the machine's position and allows uninterrupted 3-D navigation with vertical and lateral precision of 2 and 5 mm respectively.*

# 130 kilometres of desert highway in Yemen – with the Leica TCA1100

A new highway has been constructed between Baidah and Baihan. "Work is faster and more enjoyable with the Leica TCA1100 automatic tacheometer", reports H. Juma'ah of Nasher Engineering. "The TCA1100 is first-class!"

Road surveying operations are proceeding with minimum fuss and maximum precision in this difficult, mountainous and remote area of the Arab peninsula. The TCA1100 performed well along the 130 km stretch, even in Yemen's hot climate.



## LH Systems introduces DSW500 for top performance scanning

LH Systems has introduced the DSW500 Digital Scanning Workstation, the latest in a line of scanners that began with the DSW100 and developed through the DSW200 (1994) and DSW300 (1996).

The new system shares the design principles and goals of the DSW300: cut or roll film, positive or negative, physical resolutions of 4-20 µm, top speed, high geometric accuracy and radiometric fidelity – but intelligent innovation has made it simpler, more reliable, more economical.

Customers have a choice of three digital cameras: the Kodak Megaplug 4.2i digital camera used in the DSW300 remains an option in the DSW500; the three megapixel 6.3i offers even higher

throughput and remarkable scan times, breaking the two minute barrier for a standard black and white aerial photograph; at the other end of the range, the 1.6i results in a very economical scanner indeed, still capable of fine performance.



More subtle improvements include state-of-the-art strobe illumination, a smaller integrating sphere and improved optics. The amount of light is controlled very accurately and scanning is more consistent. A filter wheel allows faster colour scanning. Crucial components are lower cost, more reliable, and the lamp is easier to replace. These benefits are multiplied by an earlier LH Systems

introduction, announced at the ASPRS Conference in Portland in May 1999 – a Windows NT version of the SCAN software. The DSW500 is available for both Windows NT and Sun Microsystems' Solaris. Users now have a choice of hosts: a high performance PC, the extremely economical Sun Ultra 10 workstation, or the high-end Ultra 60.

Users can thus specify versions of the DSW500 to match their requirements and budgets. The latest model in a renowned scanner product line tempers leading edge performance with a healthy respect for market requirements. Scanning professionals will love this system!

## Big order from the Dutch Land Registry

About one and a half years ago, the Dutch Cadastre Office issued a tender for the acquisition of up to 65 self-tracking Total Stations, shortly followed by a second tender for a further 135 instruments. After thorough deliberations, the Land Registry concluded that the Leica TCA1100L would meet

their demands, and both tenders were granted to Leica Geosystems. Contracts were signed on January 7 and September 4, 1998. More than 153 instruments have since been delivered. Leica Geosystems B.V. developed NEN1878, a custom coding program for the Dutch Land Registry.

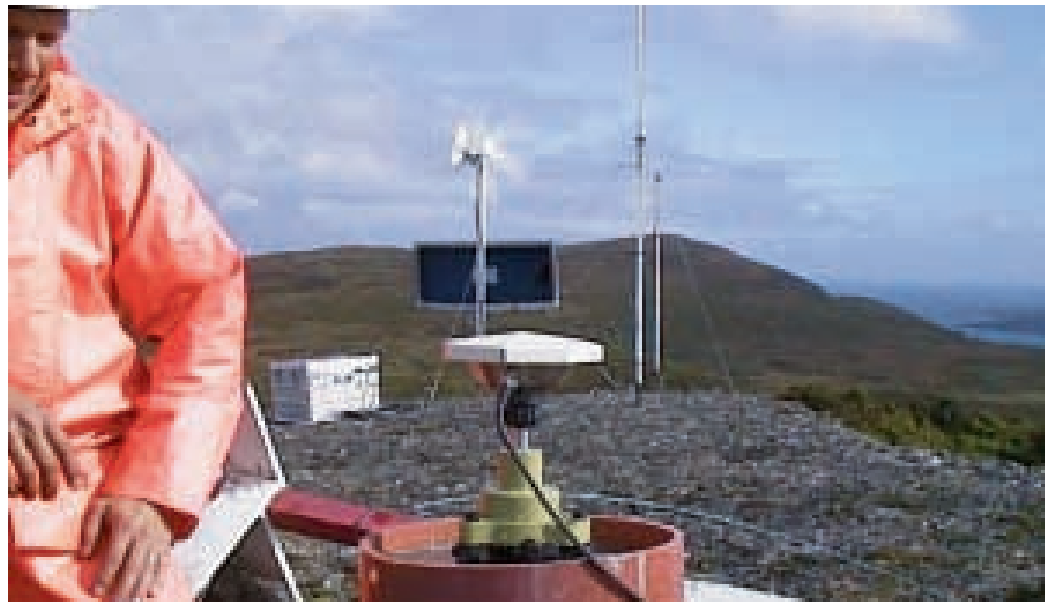
The software was adapted to meet specific Land Registry requirements. All Cadastre Offices throughout the Netherlands are now working with the TCAs; most are also equipped with the EGL guiding light. Reaction from the field has been very positive. Once again, the TCA1100 has proved to be an excellent time and money-saving instrument for digital mapping.

Marjo van Wordragen



Signing one of the contracts for two hundred Leica TCA1100L Total Stations (from left to right): Harry Vos, H.G.F. van Holthoorn, Ir. P. van der Molen (Dutch Cadastre Office), and André Wevers

# Leica GPS for the biggest Gas Pipeline Project in Norway



Four Leica MC1000 GPS base stations transmit real-time data in RTCM format via a radio modem.

completion, we felt compelled to adopt innovative methods right from the start." No tachometers have been used on this project, only GPS instruments. Four Leica MC1000 GPS receivers have been installed as base stations. Three of these base stations are self-powered by their own small wind generator and a system of solar panels. The base station coordinates and the parameters for transforming these into the local Norwegian coordinate system were defined by static measurements to nearby reference points. The base stations transmit real-time data in RTCM format via a radio modem with a power output of 0.5W. The GPS rover units can select measurements from different base stations by setting the corresponding radio channel. After

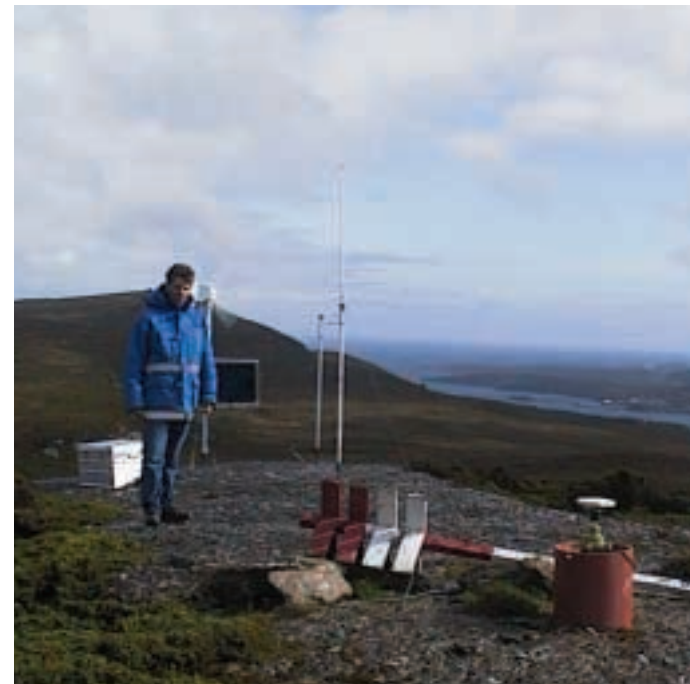
In the midst of harsh terrain, surveyors in astronaut-like garb stake out the route for a new gas pipeline. Determining their position in real-time with the aid of satellites and the Leica MC1000 and SR 9500, they perform the groundwork for one of the largest-ever land based pipeline projects.

**Åsgard and Europipe II.** Åsgard is the name of the new gas pipeline that will run from Kalstø to Kårstø, where it will join Europipe II to carry gas via the Bokn islands to Germany. The steel pipeline, with a diameter of 105 cm and wall thickness of 4 cm, will be buried on land at a depth of 0.9 to 2.0 metres below the surface. Statoil chose the joint venture Kårstø Pipeline Contractors as the prime contractor for the stretch from Kårstø to the western side of Vestre Bokn. Selmer ASA has a 50% stake in the joint venture, with the remainder shared between two German companies, Ludwig Freitag and Bohlen & Doyen, and a Danish company, Per Aarsleff AS. The contract is worth 100 million EURO, making it one of the largest onshore contracts ever awarded. Not only are the costs enormous, the joint venture also faces some mammoth challenges. The pipeline will be laid not only on land, but also under four sections of sea. In total, an approx. 40 km stretch needs to

be completed in 22 months. Once construction is complete, the landscape must be restored to its original state.

## Real-time surveying with GPS

Trond Pettersen Valeur of Selmer is responsible for surveying and GIS: "Given the project's magnitude, and the vital importance of surveying to its successful



Solar and wind generators provide electricity.



initialisation (determination of phase ambiguities), the rover operates with centimetre accuracy. Precision is affected by factors such as the number of satellites, satellite geometry, multipath signal propagation, etc. Five or more satellites with good geometry are needed for effective, precise working. Positioning precision is typically 10 mm ±2ppm. Height precision is somewhat lower (by a factor of approximately 2). To verify results after resolving phase ambiguities, a known point is often used to perform a calibration, then the coordinates are compared. Two initialisations are normally performed with data from two different base stations. A total of seven Leica SR9500 rover units are deployed on the project. Transformation parameters allow work to be performed directly in the Norwegian NGO48 map system (height = 54 AMSL). The field computers are equipped with routing software that provides

information on the current position with respect to the pipeline at any time. Detailed surveying knowledge is not necessary to be able to mark out pipelines using this method. However, some experience with satellite-based surveying is advantageous.

"In practice, this is not a big problem for us as our 'shore leave' is limited anyway. Also, we need to know in advance when we will be needed so we can prepare ourselves appropriately", says Bjørn Willy Larsen of GEFO AS, responsible for quality management on this project. Trond Pettersen Valeur estimates that the time needed for surveying and marking out can be reduced by 50% compared to traditional methods. However, he emphasises that the area around Karmøy and Bokn are particularly well suited to GPS surveying because the terrain is open, without obstructions from tall trees or buildings.

*Some forty kilometres of 1.05 m gauge steel piping will be buried up to 2 m deep or routed across straits. The entire survey effort makes exclusive use of GPS technology; the picture shows a Leica SR9500 in action.*

Norkart V/G software is used for checking and documentation. All surveying is performed using GPS; the surveyors send their field results directly to the V/G system software via the databank manager on a daily basis.

Torleif Algeroy

## Another big Chinese GPS order from Daqing

Daqing Geophysical Exploration Corporation (People's Republic of China) has just confirmed a purchase of twelve dual-frequency Leica GPS SR9500 systems. The decision in favour of Leica Geosystems came in the wake of a public tender and exhaustive evaluation of various systems.

In addition to the Leica system's high performance, the customer's earlier experience with several vendors' systems and service played a pivotal role in the final decision. Eight Leica GPS sets had already been sold to Daqing in October 1996, so there was ample evidence of Leica's quality and dependability in the field. Leica Geosystems nation-wide service coverage was a further plus-point for ensuring that support would be available whenever and wherever it may be needed.

Daqing deploys Leica GPS technology in numerous projects: in the Liao river, Xinjiang, Qinghai and inner Mongolia regions, a joint project with a US partner, and for overseas exploration.



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