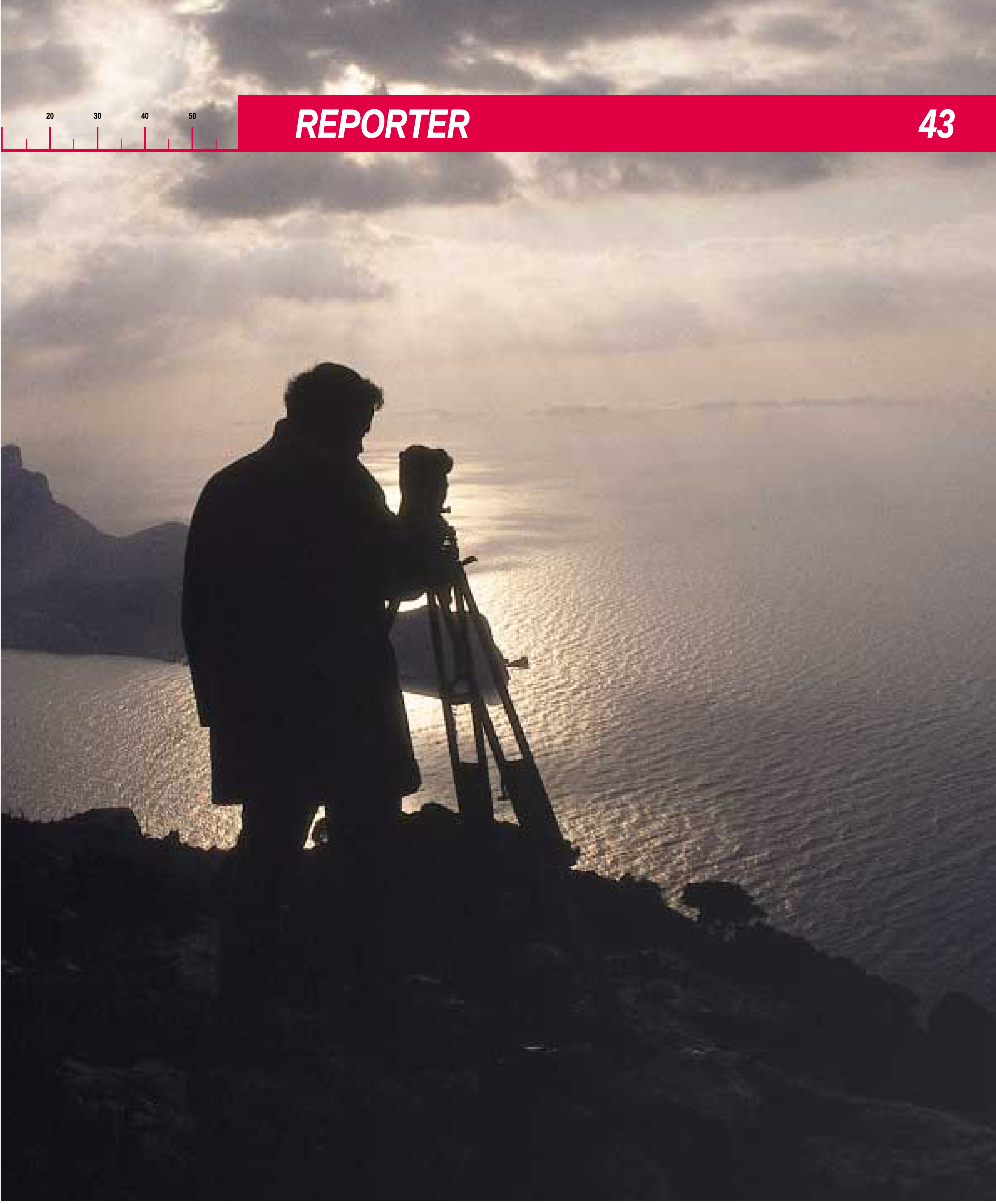
REPORTER 43



The Magazine of Leica Geosystems

Welcome to the New Millennium!

How will future generations look back to that threshold at which the first digit of the year changed from a one to a two, there to remain for a thousand years?

Never before have so many people been alive on this Earth, nor has the gross international product ever been so large. Never before have people from all countries and cultures been able to communicate so cheaply and so easily. Once, Eratosthenes used the Sun to determine the circumference of the Earth. Today, we use GPS satellites to determine the exact shape of the geoid.

Science and technology have given us these new opportunities. Our understanding has been finely honed by fundamental new technologies. These encompass the fields of high-performance optics, electronics, semiconductors and lasers, along with software engineering, space travel, satellite technology and telecommunications. They have triggered a quantum leap in the manufacture of survey instruments and in the integration of survey systems.

Interaction between these technologies has given us the Leica Geosystems laser total stations, so that the dream of tracking targets automatically without using a reflector has now come true. It has also given us GPS systems having millimetre accuracy in real time, and GIS databases with interactive data exchange between field and office. To keep up this momentum in the next millennium, over ten percent of our outlay is invested in research and development projects and in co-operation with our technology partners. With Leica instruments and systems you, our customer, will continue to solve problems faster, better and cheaper, all round the world.

When the dateline in the Pacific heralds the first day of the new millennium, and then later there are celebrations in London's new Millennium Dome near Greenwich; when the old Hatteras lighthouse then flashes on the coast of North Carolina, and the new day finally closes in Polynesia, survey specialists on all continents will have made a decisive contribution to this increasingly co-ordinated world – and they will continue to do so. You can count on our continued partnership. In the 21st century, as in the 20th, we will apply the latest technologies to our goal of making your survey procedures easier and your work yet more productive. Our distribution and support teams across the globe will be increasingly at your side, and even more accessible.

Welcome to the threshold of the third millennium!

Sincerely

Hans Hess
President & CEO
Leica Geosystems

Editorial

Dear Reader,

International activities are becoming increasingly important, not only economically and politically, but also geographically and from a surveying viewpoint. National borders are becoming less and less of an obstruction.

The microwave signals emitted by Navstar and Glonass GPS satellites ignore political boundaries and provide us with a more exact picture of the Earth's three-dimensional shape (the geoid). When this survey data is combined with gravity-field measurements that, for the first time, also take account of density anomalies beyond territorial boundaries, topographic co-ordinates can be determined more precisely. This leads to appreciably more accurate triangulation and levelling points, so the derived data is of higher quality. A territorial geoid of this nature, accurate to two or five centimetres, has been recently created and is described in this magazine by Urs Marti, who was involved with the project. One of the Swiss GPS ground points lies in Zermatt's high basin, surrounded by peaks more than 4000 metres high. When Giorgio Poretti started to survey the Matterhorn from the Cervinio area (Italy) on the southern flank of the Alps and from the summit, we were standing here in the high valley with our GPS and total stations.

Waltraud Strobl

In Zermatt, at 1687.566 m. a.s.l. is a precisely defined point for national levelling systems using the GPS CHGEO98 and LV95 networks. It was used by professor Giorgio Poretti of the University of Trieste in autumn 1999 for a new measurement of the Matterhorn, using GPS and tachymeter triangulation. Leica GPS 500 systems were simultaneously positioned at the peak, while reflectors on Leica T2002/DI3002 tachymeter systems were trained on the Italian and Swiss peak stations from the valleys flanking the border. Look out for a comprehensive report in our next issue.

IMPRINT

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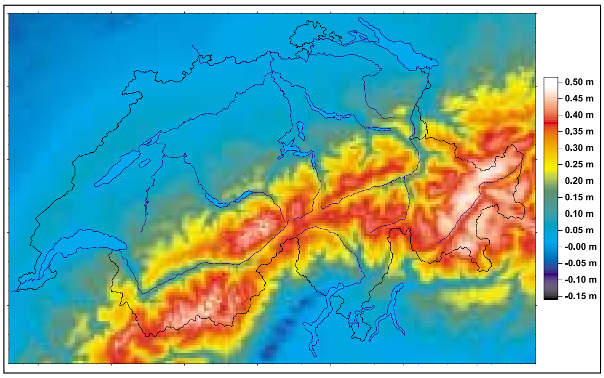

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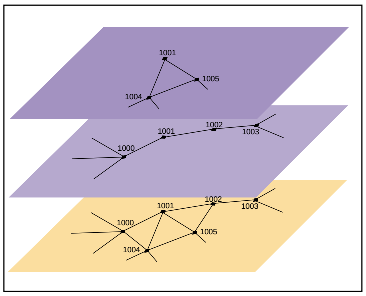

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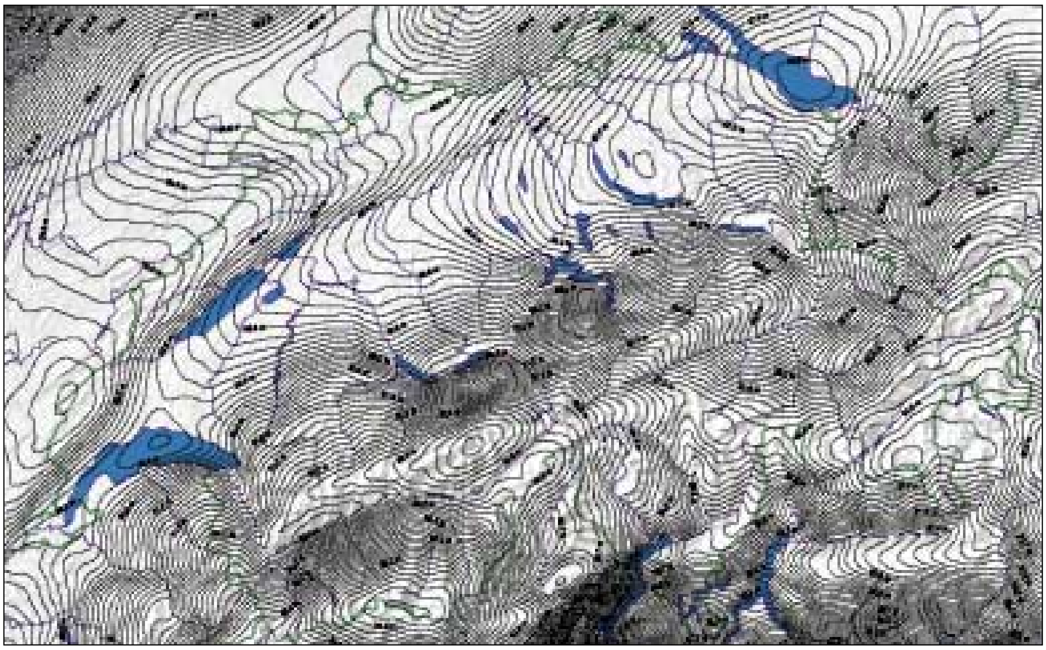
CHGEO98 – The new Geoid for Switzerland



Geoid of Switzerland in ETRF93.

In the last few years the geoid and quasigeoid of Switzerland was developed in a joint project by the Federal Institute of Technology (ETH Zurich), the Federal Office of Topography (L+T, SWISSTOPO) and the University of Bern (AIUB). The aim was to determine a highly accurate reference for height determination with GPS, and provide a base for the new national height system (LHN95).

Around 600 deflections of the vertical, 70 GPS/levelling stations and 20,000 gravity values were used in the calculation. A 25-metre DTM and some geological density information were used to reduce the observations. Residuals were interpolated by least square collocation and the geoid and quasigeoid were obtained by summing the influences of the mass models.
Solution of CHGEO98 was completed in 1998 and includes only the deflections and the GPS/levelling measurements, because many of the gravity measurements are yet to be validated and contain gross errors.
CHGEO98 accuracy is in the order of 3 cm in the flatter areas, and around 5 cm in the Alps over the whole country. This could be verified by comparison with the EGG97 European quasigeoid.

GPS has made it possible to determine co-ordinate differences between widely spaced stations with a relative accuracy in the order of 10^{-7} to 10^{-8}. However, this holds true only for the horizontal components, not for height. This is partly caused by asymmetric measurements (no satellites available below the horizon) and by tropospheric refraction effects. The main problem is due to the fact that GPS-derived heights are referred to the reference ellipsoid, not to the geoid, as is usually the case for terrestrial surveying. Differences can reach up to 100 metres on a global scale, but even on a regional scale like the alpine area the differences exceed 10 metres. The objective of this work is to determine the geoid and quasigeoid of Switzerland at the cm level and to discuss the various components to be considered in the error budget. Furthermore, we aim to analyse data density and accuracy requirements for achieving geoidal undulations at this high level of accuracy, even in mountainous regions such as the Swiss Alps.

The Swiss geoid is influenced by the Lake of Geneva and the Lake of Constance (photo) – central Europe's largest lakes.

Past attempts to determine the geoid of Switzerland included application of the remove-restore technique (Elmiger, 1969), collocation (Gurtner, 1978) and integrating Stokes' Integral (Geiger, 1990). Astrogeodetic observations in the Ivrea area (Bürki, 1989) were used by Marti (1988) to examine the possibility of obtaining a cm-level accurate geoid of southern Switzerland. Wiget et al. (1986) and Marti (1990) were the first to consider space geodetic data in the geoid determination of Switzerland. Wirth (1990) performed initial geoid determinations in Switzerland using combined terrestrial and satellite data sets. This report – first published at the IAG conference in Budapest in March 1998 – marks a continuation of these efforts.

In order to incorporate deflections of the vertical, gravity anomalies, GPS/levelling data, as well as mass models, we first developed a software package that enables calculation of:

- gravitational effects of mass models (gridded DTMs or irregularly formed polyhedrons) in terms of potential and the gravity vector,
- reduction of the observed gravity field information for effects of mass models,
- interpolation of residual fields and calculation of the reduced co-geoid,
- predicted deflections of the vertical, gravity anomalies, and geoidal undulations in surveyed regions between measured points,
- height calculations for various height systems,
- transformation of the geoid and gravity vector into various reference systems.

Data used

About 600 astrogeodetic stations with at least one component of the deflection of the vertical could be used in the calculation (fig. 1). Most have been recompiled and referred to an identical reference system. In general, accuracy is in the order of 0.5". The oldest measurements included date from the last century, whereas some 100 stations have been observed between 1990 and 1992 for the express purpose of a new geoid determination. After cross-validation, around 520 stations could be included in the final calculations.

Data for most of Switzerland's 2,500 gravity stations are publicly available (and are included in the EGG97 European quasigeoid). The data stems from works by the geophysical commission of Switzerland (SGPK) for the gravity map of Switzerland (Klingelé, Olivier 1980). A new SGPK project to compile a gravity atlas of Switzerland is currently in progress. About 20,000 stations in the western part of Switzerland could be included into the geoid determination (fig. 2)
As well as deflections of the vertical and the gravity data, some 80 GPS stations connected to the first-order levelling lines could also be included as 'observed' geoid undulations. These observations are part of the new national GPS base network (LV95) and have been introduced with an accuracy of 2 to 5 cm. (fig. 3)

Mass models of Switzerland

In order to perform a downward continuation and facilitate interpolation of the gravity field, it is necessary to model the distribution of the attracting masses.
A high-resolution digital terrain model is of primary importance, but other models such as density anomalies in the interior of the earth also need to be considered.

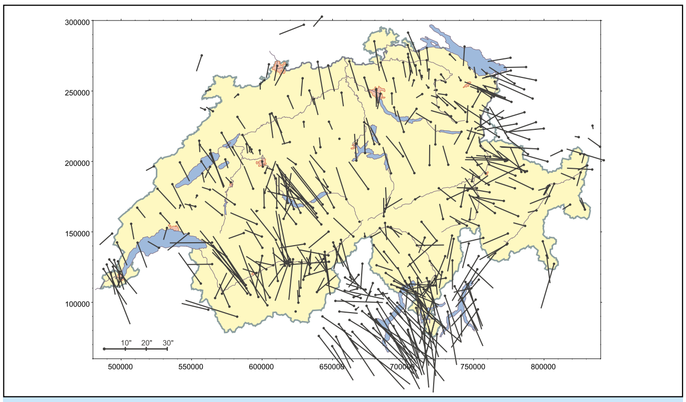


Fig. 1: Observed deflections of the vertical (only stations with both components).

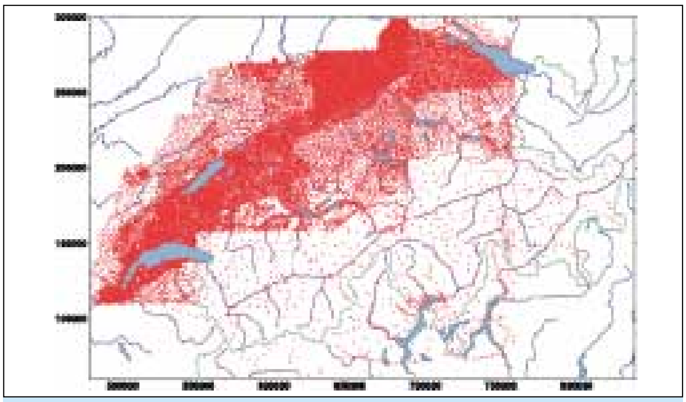


Fig. 2: Gravity data used for the geoid determination.

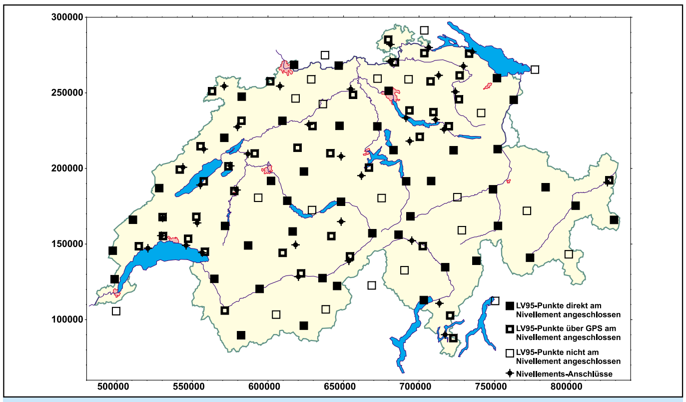


Fig. 3: The national GPS network LV95 and its connection to the 1st-order levelling network.

Digital Terrain Model

The digital terrain model used in the geoid calculations is derived from the Federal Office of Topography's 25-metre grid (DHM25), which was produced by scanning 1:25,000 maps.

To reduce computation time, compatible grids with a resolution of 50, 500 and 10,000 metres have been derived. In neighbouring regions where no (Swiss) 1:25,000 maps are available, these grids have been derived from NIMA's DTED1 data set (original resolution 3" x 3"). A global DTM (TUG87, with a resolution of 5' x 5'), compiled at the Technical University of Graz (Wieser, 1987), has been used outside the 50 km zone surrounding Switzerland.

DTM	Formula	Max. distance	Max. simplification error due to		
			Potential	Gravity	Deflection
25 m	prism	100 m	0	0	0
50 m	prism	300 m	0	0.09 mgal	0.02"
50 m	line	1250 m	0	0.01 mgal	0
500 m	prism	5000 m	0.2 mm	0.18 mgal	0.05"
500 m	line	20000 m	1.0 mm	0.09 mgal	0.02"
500 m	point	50000 m	3.0 mm	0.03 mgal	0.01"
10000 m	point	Entire model	16.0 mm	0.13 mgal	0.07"
5'	point	Entire earth	?	?	?

Table 1: DTMs and formulae used for terrain correction, and errors caused by simplification.

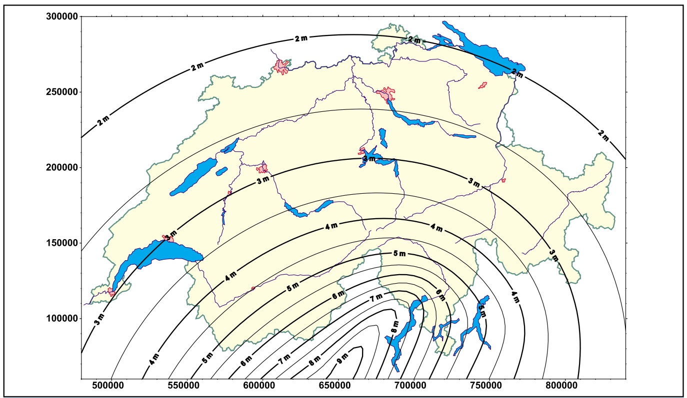


Fig. 4: Influence of the Ivrea body on the geoid.

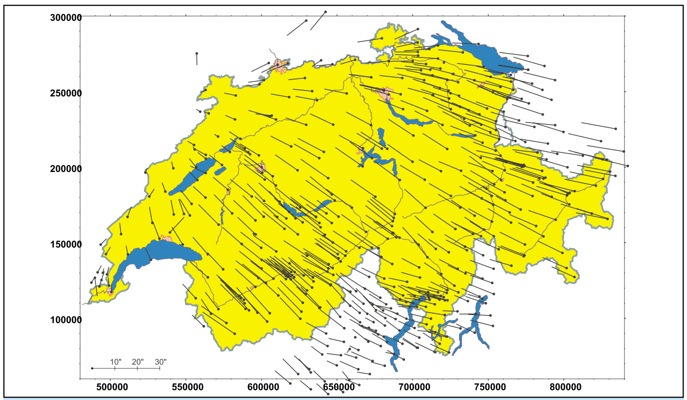


Fig. 5: Deflections of the vertical after subtraction of the effects of mass models.

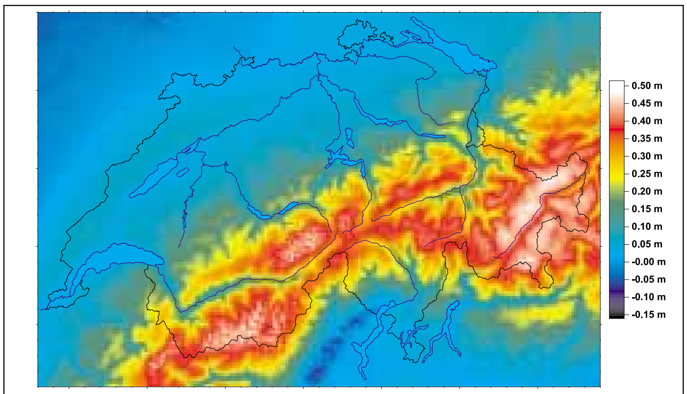


Fig. 6: Differences between the quasigeoid and geoid CHGEO98.

In general, a density of 2.67 g/cm³ was used for the whole DTM, except for regions where reliable density information was available. This is mainly the case for lakes, glaciers and quaternary sediments of large rivers, but also for the area surrounding Ivrea and the upper regions of the Po plain.

For the calculations, grid values were used in prism formulas, or replaced by line or point masses at increasing distance. Table 1 shows the model and formula used for a given distance.

As we can see, the critical simplification appears to be the boundary of 50 km between the 500 m and the 10 km DTM. The problem with this boundary is that it very much affects the time for terrain effects. Moreover, at a value of 70 km the error still exceeds 1 cm, making it necessary to find a compromise between accuracy and computation time.

Mass models for the interior of the earth

The largest effects on the gravity field, other than those attributable to topography, are caused by the density contrast at the crust-mantle boundary (Moho). Usually this effect is considered in an isostatic model, but in this project a 5-km grid of the Moho-depth was used. The density contrast that proved most suitable for our data set was 0.37 g/cm³. Other important density models are the sediments of the Po plain with a maximum depth of 11 km and a maximum density contrast of -0.8 g/cm³, and a model of the Ivrea body in the Southern Alps with a maximum density contrast of 0.4 g/cm³. As an example of the influence of such a model, fig. 4 shows the effect of the Ivrea body on geoid undulation.

Calculation of the co-geoid

After all the observations had been reduced by the influences of the mass models, we obtained a smooth field of residuals. For example, fig. 5 shows the reduced deflections of the vertical, which may be contrasted with the observed field values included in fig. 1.

These residuals show a trend that cannot be explained by our mass models. It is caused mainly by the choice of reference system and by masses that were not included in our models. This trend was subtracted by means of harmonic polynomials, to facilitate the next step of interpolating the residuals. Interpolation of the residuals has been performed by means of least squares collocation. A harmonic 3rd-order Markov model was chosen as the covariance function. Its parameters, which mainly depend on the chosen data set, the mass models used, and the trend function, have been determined empirically. Test calculations revealed that with astrogeodetic data only, the geoid can be determined to an accuracy of about 4 cm over the whole country. Introducing the

The mass of the Swiss alpine range with its 4000 m peaks and glaciers introduces a significant correction factor in geoid calculation.

GPS/levelling stations reduces this value to about 2–3 cm. Considering gravity data as well gives improved local accuracy, but which nevertheless remains at about 2 cm over the whole country.
A combination of astrogeodetic data and GPS/levelling data was chosen for the final solution of the co-geoid. Integration of the gravity measurements caused inconsistencies of more than 10 cm. This needs to be investigated in more detail before we can present a complete combined solution of all available data.

The calculation of the geoid and quasigeoid
The quasigeoid is derived from the co-geoid by restoring the effects of the mass models at terrain elevation. The geoid is obtained by restoring these effects at 'sea-level'. Both reference surfaces have been calculated in the reference frames of Switzerland (CH1903, Bessel ellipsoid) and of Europe (ETRF93, GRS80 ellipsoid).

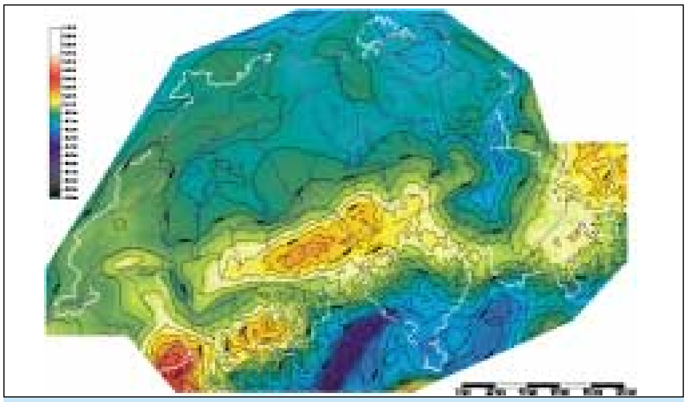


Fig. 7: Differences between European (EGG97) and Swiss quasigeoid.

For example, page 4 shows the geoid in ETRF93.

Fig. 6 shows the differences between the geoid and the quasigeoid, which are of course highly correlated with topography. Whereas differences tend to 0 in the flatter regions, they exceed 0.5 metres on the highest mountains.

Comparison of the solution with the European quasigeoid EGG97
As a completely independent quality control of our solution, we compared it with the EGG97 European quasigeoid, which was calculated at the IfE in Hanover (Denker et al., 1998). We did not apply any offset or trend function in this comparison; we simply interpolated the EGG97 values (1' x 1.5' resolution) to our grid points. The comparison can be seen in fig. 7.
Differences in the plains are generally less than 5 cm, but there are differences of 10 cm or more in the southwest, near Lausanne and Geneva. In the Alps too, differences are normally under 10 cm. Only in some parts of central and eastern Switzerland are there differences in excess of 15 cm.
Comparison of these two totally independent solutions shows that both solutions are accurate to within a few centimetres in the flatter areas. In mountainous regions, we assume that these differences are largely caused by the European quasigeoid (simpler DTM, less data). We therefore give our solution an accuracy of about 5 cm in the Alpine regions as well.

Conclusions and outlook
In summary, we achieved the project goal of determining a geoid to an accuracy of a few centimetres. This is mainly proven by comparison with the EGG97 solution.
The CHGEO98 geoid was declared the official geoid for Switzerland in October 1998 and is now widely distributed to users in form of a 1 km or 0.5' grid. It is now integrated in most GPS receivers and GPS software sold in Switzerland. First results showed significantly greater accuracy of the transformation between GPS heights and levelled heights in many regions. Tilts and offsets disappeared almost completely. However, the full benefits of CHGEO98 can only be achieved by introducing a strictly orthometric height system (LHN95) as the official system for Switzerland.

Urs Marti

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The bibliography for this article is available at: http://www.leica-geosystems.com/reporter

KEYSTONE EPA / GERRY PENNY / STF

The women's world record takes a hammering!

At an athletics meeting at Rüdlingen/Switzerland, a massive hammer-throw by the Rumanian Mihaela Milente was measured at 76.07 metres by a Leica TCA 1103 total station. This distance established a new world record for this year's world champion hammer-thrower, who had been in action just a week earlier at Seville (photo).
After rough sighting of the hammer's landing point, the Leica TCA 1103 automatically took care of the fine aiming and measurement. Leica measuring instruments are features not just of major construction sites and Olympic events, they are increasingly present at specialised and regional meetings like the "Weltklasse am Rhein" in the canton of Schaffhausen. ***Martin Vögele***

***Below**: Construction work on the new airport at Baatsfjord. A Leica TCA 1103 total station automatically tracks the prism attached to the grader blade and transmits height information to the control system in real-time. The equipment performed reliably and with great precision despite poor light conditions, a harsh climate, and very stringent construction site requirements.*

A world fi

"The Leica system is the only way to fly", said Roar Johansen, perched on his grader north of the Arctic Circle. The innovative Kolo-Veidekke construction company used a Caterpillar grader fitted with Moba automation and controlled by a Leica measurement system for fine-planing the takeoff and landing runways and taxi-ways at continental Europe's most northerly airport. This marked the system's world premiere north of the Arctic Circle.

For the airport at Baatsfjord in Norway to open before the onset of the long, dark winter, the Kolo-Veidekke SA company had to use the most efficient construction techniques possible. Hence the commission given to Eddie Engebredsen, manager of Abas, Moba's Norwegian representative, to augment the Moba GS496 system installed in the Caterpillar grader's cab. The additional equipment included a PC running Leica Geosystems' software, a radio data link, and a Leica omnidirectional prism on a tall mast fitted to the grader blade, which would clear the vehicle for permanent visibility to a total station.

3-D millimetre precision at all times

The prism is the target for continuous tracking by an automated Leica total station, which transmits a stream of angle and distance measurements to the Leica and Moba automation on board the construction machine. Leica software analyses the data with an unmatched dynamic height accuracy of ±5 mm. The benefits of such precision include considerably less avoidable removal of material, and a flatter runway profile.

rst north of the Arctic Circle

Automatic longitudinal slope compensation

The system, in operation here for the first time, delivers correction data considerably more conveniently, faster, and with greater reliability than earlier methods. Unlike most other systems, Leica Geosystems' 3-D machine control also provides continuous compensation for the longitudinal slope of the prism mast.

The driver's cab: a universal control centre

As well as all-round greater precision, the Leica equipment and Moba automation generates considerable time savings and correspondingly greater productivity for a wide range of manufacturers' construction machinery. Guide wires and after-the-fact measurements, with associated work stoppages, are unnecessary and no longer impede progress. The bi-directional communication link between the construction machine and the total station positioned a safe distance away can nevertheless be overridden by the driver at any time, to cope with special circumstances or obstructions. For example, should a parked construction vehicle interrupt the line-of-sight between the total station and the target prism for a prolonged period, the total station can be reactivated and oriented directly from the driver's seat. The PC in the cab also allows the driver to continually view deviations between stored project data and the construction machine's cross slope, height and lateral distance.

Problem-free deployment on all types of construction machinery

The Leica measurement and control system is compatible with all Moba automation systems, which in turn interface with various manufacturers' construction machinery. This new and dependable technique offers rapid cost-savings on any construction site. Roar Johansen, a veteran of other systems, is adamant: "I'll only be using the Leica system in future", he says. It does indeed have a considerably edge on other systems available in the world market. Moba's internationally experienced automation specialists chose Leica Geosystems as their measurement technology partner only after exhaustive system comparisons and unambiguously positive test results. If it works in the inhospitable climate north-east of Hammerfest in the sparsely-populated Finmark area, it is certain to bring cost savings and greater reliability to construction sites the world over. ***Stf***

Baatsfjord, on the coast of the Arctic Sea, is the site of continental Europe's most northerly airport.

Below: A Leica TCA 1103 total station automatically tracks its target to obtain the position of the grader blade in real-time.

The height of the grader blade is controlled automatically. The driver reads control information from the GS496 display (below), and project comparisons on the PC (above). He can also communicate with the total station without leaving his seat.

The mast carrying the omnidirectional target prism is clearly visible, and is attached directly to the grader blade.

NEW: Leica GS50 – GPS and GIS converge

The GS50 is a new GPS/GIS data recording system that features unmatched receiver precision, GIS-oriented operation and system flexibility. The GS50 system marks the launch of a further Leica Geosystems product based entirely on the ESRI platform.

Simple GIS-oriented data recording in the field, with flexible data-entry options.

GS50 – the most precise code receiver

GS50 operates with a single-frequency code receiver offering a unique performance standard: 30 cm DGPS point precision in post-processing, and 40 cm for real-time measurements. Leica Geosystems' ClearTrak™ technology is one of the factors responsible for this precision.

Fully upgradeable

The GS50 is a fully-fledged member of the GPS 500 system family. It adapts to expanding requirements, being readily upgradeable to any other model in the family – all the way to real-time, dual-frequency technology offering precision in the 1 cm range. Accessories and user software are fully compatible with the 500 system.

Simple field measurements

The GS50 system is particularly effective at simplifying fieldwork. Menu-controlled software offers procedural guidance to users. Most GIS applications require comprehensive attribute-entry options, in addition to basic point or object information. The GS50 system is exemplary in this respect. A regular palmtop computer, or the TR500 terminal from the GPS 500 family, are equally suitable for operating the GPS sensor. For ultimate user convenience, the GS50 can also be controlled by Leica FieldLink, which typically runs on a penpad.

Bi-directional data flow means you can take existing GIS data into the field for editing positions or attributes. Points that are inaccessible, or cannot be measured with GPS, may be acquired as indirect points using a Leica DISTO™.

Wide-ranging DGPS options

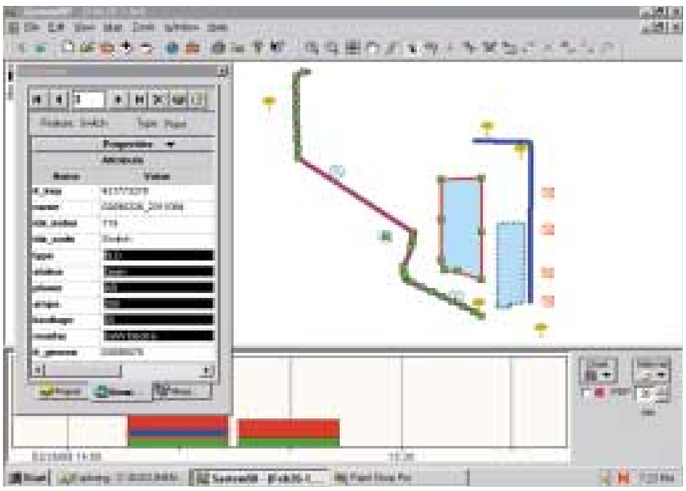
The GS50 can also be used as a reference station for real-time or post-processing applications. As a rover, difference data can be received by radio (VHF or long-wave), via GSM modems, or beacon RTM modules. This facilitates tapping-in to the high-level GPS reference network (SAPOS).

Powerful software

GIS Data PRO Office is a new office software package for GPS analysis, processing and preparing geographical data. It supports a wide range of export formats (ESRI shape files, AutoCAD, MapInfo, Microstation, etc.) for problem-free data interchange.

Sepp Englberger

Analysis software with graphical preparation and hassle-free data interchange.



110 customers of LH Systems attend User Club Meeting

LH Systems

For the first time ever, LH Systems combined its annual User Club meeting with its popular Aerial Camera Workshop. For this event, LH Systems, LLC invited customers to San Diego, California at the end of August. Historically, the Aerial Camera Workshop had always been held in Denver, Colorado, headquarters of this renowned photogrammetry and aerial camera systems company. Customers interested in aerial cameras, scanners, and analytical and digital workstations were able to meet up, share experiences and gather information on the latest product developments.

The event attracted more than 110 customers, who attended a rich mixture of customer presentations, focus groups, clinics, demonstrations and workshops. The User Group meeting was warmly welcomed by attendees. As a result, LH Systems President and CEO, Bruce Wald, announced the company's intention to repeat the formula for next year's event. If you are interested in the newest developments in photogrammetry, mark your calendar for August, 20-25, 2000. Additional regional versions of the event are planned for next year, held in local languages. For dates and locations, visit the LH Systems web site: www.lh-systems.com.

Leica highlights

With 12,000 visitors and participants from 16 nations, the INTERGEO trade show and associated convention is the largest European event of its kind, and one of the global industry's key meeting-places. Exhibiting their products and services at INTERGEO 99 in Hanover, Germany were Leica Geosystems, and 250 other companies and associations. Show highlights included the new, reflectorless, automated Leica TCRA – the flagship of the TPS1100 total station, the Leica GS50 GPS/GIS data acquisition system, and Leica FieldLink, the tailor-made GIS system for acquiring data in the field. In addition to the TPS300 and TPS1100 series total stations, products on show included machine guidance systems, the DISTO™, Leica levellers, and the 500 GPS system.

On an equal footing with the products were Leica services such as customer consulting, hotline contacts, service and maintenance contracts, repair centres, training courses, and technology partnerships with other companies such as ESRI. These intangibles, allied with the performance of our instruments and systems, result in dramatic productivity increases and overall customer benefits.

Christiane Claar

Below: There was much customer interest in the numerous innovations at the Leica Geosystems exhibition stand at INTERGEO 99 in Hanover.

Leica provides precise GPS Station to monitor world's longest suspension bridge in Japan

A network of precise GPS reference stations, supplied by Leica Geosystems, has been installed on the world's longest suspension bridge in Japan to monitor movements of the bridge's structure in real-time, with millimetre-level accuracy.

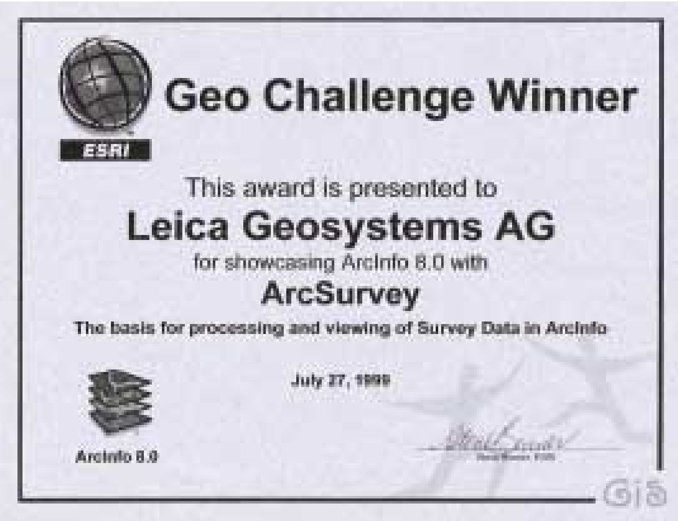
The monitoring system consists of three Leica MC1000 DGPS receivers, connected through a network of fibre optic cables. Two of the units are mounted atop the tall towers at either end, and the third is at the midpoint of the bridge. This enables engineers to determine the precise extent of the bridge's movements, including critical excursions outside the structure's design specifications. The Akashi Strait is 110 m deep and has rapid currents that reach a speed of up to 4-5 m/sec. Navigation is extremely difficult and there have been many shipping accidents in the straits in the past. The region is also at risk from high winds and earthquakes.

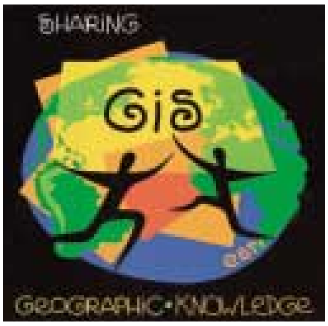
Real time 3-D millimetre-level accuracy

The Leica MC1000 is a 12-channel L1/L2 GPS receiver that uses real-time kinematic (RTK) processing with on-the-fly (OTF) ambiguity resolution to achieve millimetre-level accuracy in three dimensions. The MC1000 provides full-wavelength phase and P-code tracking, even under anti-spoofing (AS) conditions. Installation of the GPS receivers on the Akashi bridge was performed by Akasaka Tec, Leica's licensed representative in Japan.

An award-winning entry to the world of GIS and LIS

Leica's ArcSurvey software package was this year's "ESRI Geo Challenge" award winner at the 19th ESRI User Conference. ArcSurvey is the first of a new series of state-of-the-art software products that augment ESRI's powerful ArcInfo 8® software with surveying know-how and automated routines for solving GIS and LIS tasks.
It offers surveying customers easy entry to the market leader's future-proof GIS and LIS solutions.





With 9,500 delegates, the 1999 ESRI User Conference in San Diego ranks as the world's largest Geographical Information Systems (GIS) event to date. A lecture programme, workshops, and an expo under the motto "Sharing Geographic Knowledge" raised delegates' awareness of just how much society already benefits from GIS solutions.

Leica builds bridges to the global GIS community at the ESRI conference.

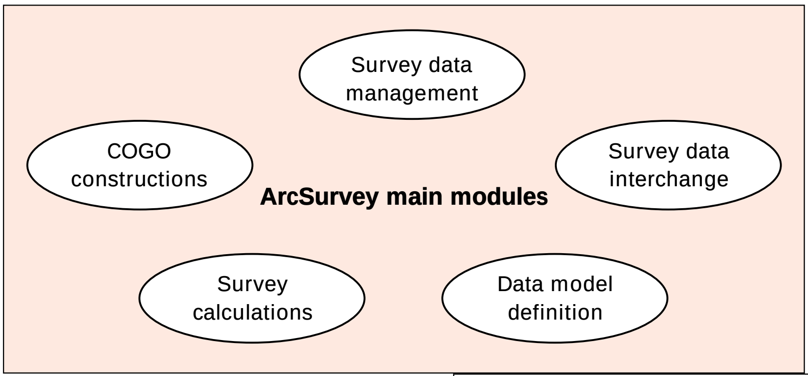
Realisation of how geographically based solutions are simplifying life and improving its quality has meanwhile spread beyond the GIS community and around the globe. ESRI, the Environmental Systems Research Institute, has made a heavy contribution to this success, with comprehensive software solutions and numerous technology partnership agreements.

Field surveying and terrain data

Why not give Leica's surveying customers access to the groundbreaking world of GIS? Top management at both companies understood the synergies early on.
As Martin Tremp, Leica's Software Business Director said two years ago:
"When the market leader in surveying technology and the top GIS software company co-ordinate their development efforts, both communities can grow together in a harmonious and complementary way."
Fine words – which were backed up by positive action. All the Leica products presented in this issue, like FieldLink (p. 16) and GS50 (p. 10) already include ESRI technology, or are ESRI-compatible. When developing ArcSurvey, Leica specialists addressed not only surveying customers, but over seventy thousand ESRI GIS users from various disciplines as well. The result is a powerful and highly sophisticated tool for integrating and utilising survey data acquired from diverse sources, from Leica total stations to GPS equipment. ArcInfo 8's universality and GIS power was also apparent in developments by other award-winners at San Diego: applications included maintenance and fault-management software for a utility supply company, a management program for fibre-optic and copper telecommunications cables, and an Oracle relational database for monitoring ground and drinking water. In future, these types of specialised solutions will also be accessible by ArcSurvey users in conjunction with ArcInfo.

ArcSurvey with integrated surveying know-how

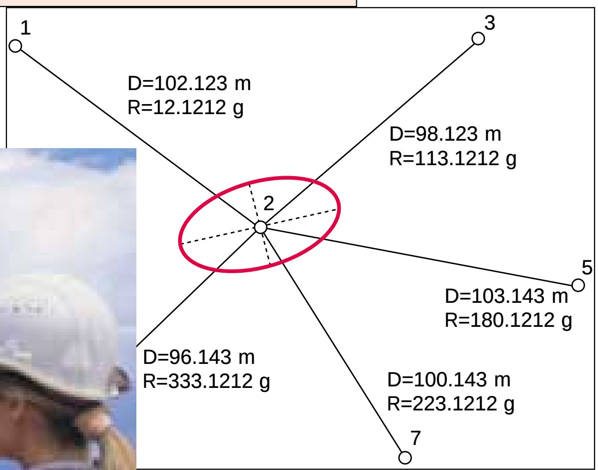
ArcSurvey provides surveying professionals, land registry officials and planners with processing facilities and a visual display of survey data held in an ArcInfo GIS. It augments ESRI's ArcInfo 8 with functions for recording, saving, editing and maintaining spatial survey, terrain, and engineering data. ArcSurvey supersedes ArcInfo's earlier ArcCOGO package for acquiring survey data and integrating it in the GIS. Compared with the predecessor software, ArcSurvey features extended surveying task solutions for ESRI's GeoDatabase, field survey data management and editing, creating and reconciling survey traverses and triangulation networks, establishing custom attributes, field/office data interchange, and a wide range of calculations (e.g. property lines, profiles, etc.). ArcSurvey allows users to create their own arbitrary data models, and adapt attributes and display characteristics to exact project needs and commissioning requirements.



ArcSurvey: the full range of surveying functions in GIS-friendly form for ArcInfo.

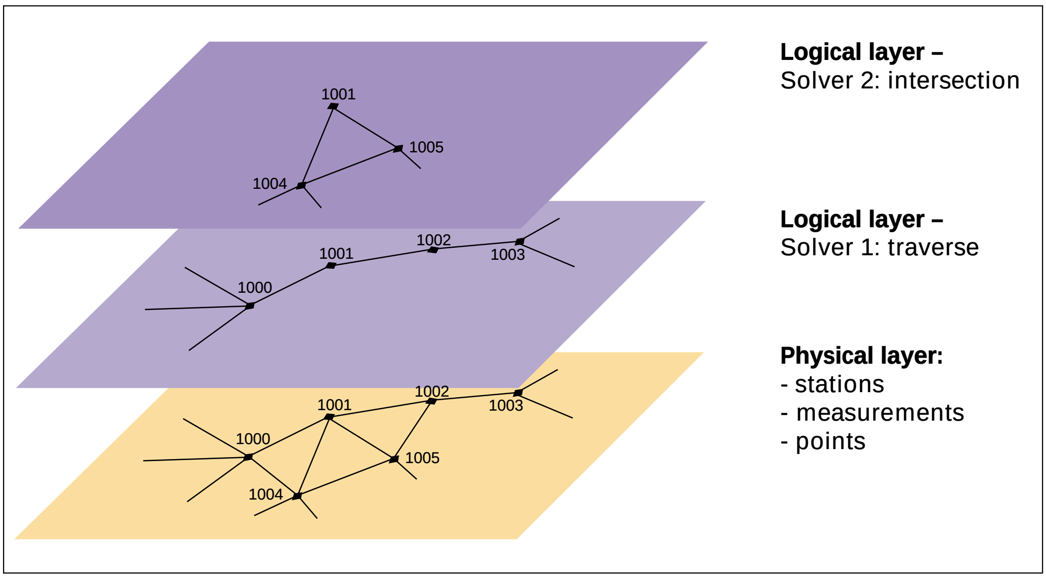
Highly useful solver and solution functions

ArcSurvey's "solver" and "solution" functions offer some highly specific advantages. The solver permits specialists to assign individual quality attributes and weightings to every single instrument, station point, and/or observer. Once data has been acquired, the system suggests the most appropriate reconciliation method. ArcSurvey's solution functions facilitate various analyses of measurement datasets stored in GeoDatabase, in accordance with individually optimised criteria – e.g. network reconciliation with display of the remaining residual error ellipses, longitudinal profile, or an area calculation. All these specialised analyses are performed without modifying the actual database contents.



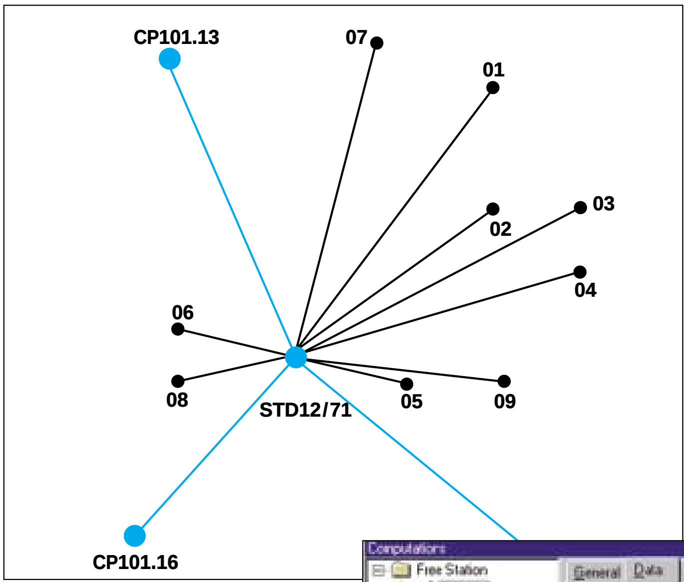
Solver functions offer optimisation solutions for the field.

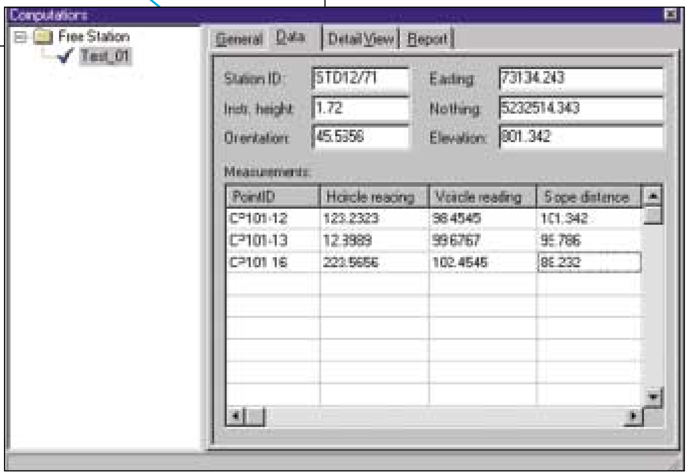
Below: Various results can be retrieved from the uniform GeoDatabase (physical layer) and optimised without modifying the database contents.



COM-based Measurement Engine – the driving force

Leica's MeasurementEngine and COM technology lie at the heart of the new solutions. The Measurement Engine co-ordinates relationships between measurement values from different sources, be they





With simple clicks in the Garcia Editor, the Solver can insert or remove data and calculations for free stationing, for example, with clear user guidance and graphic display at every step. The "calculate" command recalculates the network and immediately displays results on the report page.

Leica total stations or GPS systems, as well as their points or nodes within the GIS geometry and topology. In conjunction with ArcInfo, it guarantees a continuous, logical, water-tight flow of physical data between field and office, all the way to publication of finished plans and special reports. The ESRI database and ArcInfo software use object-oriented methodology for storing and managing data and attributes from various sources. COM technology (Microsoft's Component Object Model) offers maximum reliability, coupled with unique flexibility. ESRI application software and Leica system software work extremely closely together.

Leica CadastralOffice – easy entry to GIS and LIS

"Leica Geosystems is planning the CadastralOffice software package as a logical continuation of ArcInfo for land-registry projects", says GIS specialist Eduard Jericke. "CadastralOffice will simplify recording, storing

ESRI and Leica Geosystems: successful GIS/LIS Power Partners

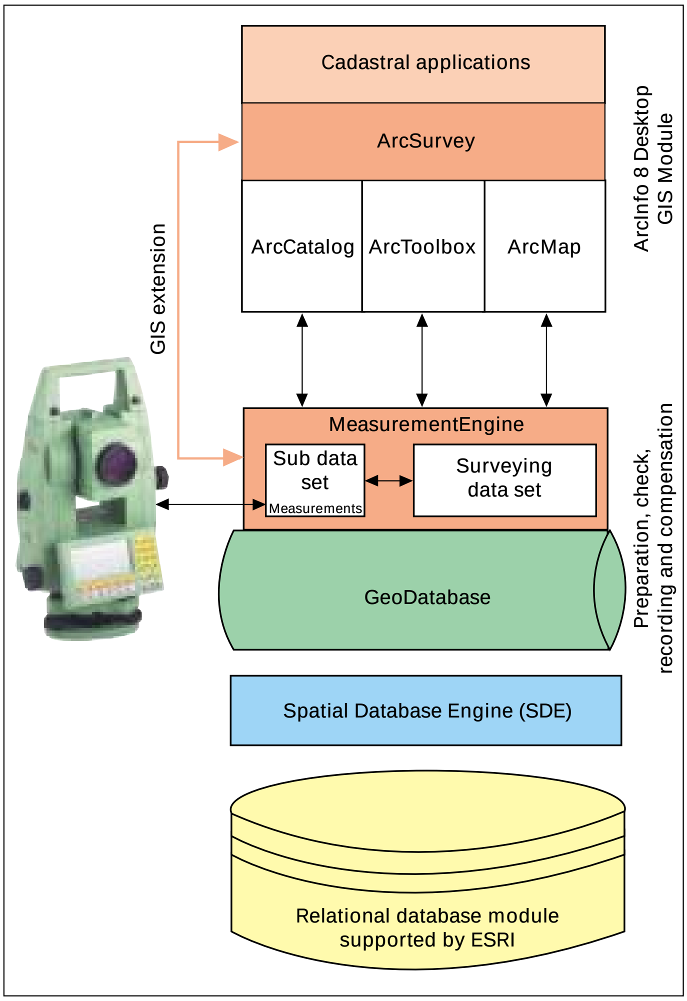
In 1997, ESRI and Leica jointly announced a co-operation agreement for software development activities, which will culminate in fully integrated LIS and GIS solutions. This agreement brings together the respective know-how of Leica Geosystems, with its wealth of cadastral and surveying experience, and ESRI, a company with solid roots in GIS technology and over 70,000 users of its popular Geographic Information Systems software.

A press release issued at the time explained: "This next-generation LIS/GIS solution will be engineered using object-oriented (COM) technology, and will incorporate existing and emerging ESRI technologies such as SDE, component engines from ARC/INFO and ArcView. COM technology is anticipated as the foundation for the next generation of Leica's INFOCAM land records application. This will lead to extremely efficient workflow and optimum data movement for any surveying and land registry organisation. Leica's software engineering team will be working with ESRI to design and develop new LIS/GIS solutions to be marketed and supported jointly world-wide.

Hans Hess, President of Leica Geosystems, announced that he is very happy to have ESRI as a software development partner: "ESRI's software technology will significantly enhance the overall functionality of current Leica products. We have always felt committed to providing LIS/GIS solutions for our customers. Users can now look forward to new solutions that will integrate Leica's TPS and GPS measurement tools with the GIS world."

Jack Dangermond, president of ESRI, said: "I am very excited about this relationship because it will enable various surveying and traditional mapping communities to work more closely with the database-oriented GIS communities. Furthermore, it will allow the whole world of measurement technology, which Leica does so well, to be integrated into a software application. This is in keeping with our vision of surveying as a transaction on a spatial database, for updating and maintaining integrated sets of geographical measurement information." It was not long before these promises were transformed into real products, as the new Leica FieldLink and GS50 show!

Martin Tremp: "Leica Geosystems and ESRI are now focusing on further products that address surveying and cadastral tasks. These will allow Leica Geosystems to offer comprehensive solutions on a joint platform that closes the gap between data acquisition (surveying) and data management (GIS). This will fulfil the vision at the root of this co-operative venture."



CadastralOffice build on present ESRI and Leica concepts enabling their integral use for cadastral applications.

and managing survey and cadastral data, with due attention to legal requirements and long-term updating and documentation obligations.“ Integrating classical surveying tasks in the world's most powerful and universal GIS will benefit Leica Geosystems customers in their everyday work. Whatever the size of the company or organisation, this represents an exceptional opportunity to acquire new markets. With one workstation or hundreds, ESRI/Leica products finally permit economical performance and solving of multidisciplinary GIS and LIS tasks.

Stf

1000th GPS500 delivered within just a few months

The technology and convenience edge of Leica's 500 GPS system comes from ClearTrak™, flexible and modular design, light weight and ease of use. And that's translating into brisk sales: just a few months after the first systems shipped, Hans Hess (left), president of Leica Geosystems, was able to “deliver“ the 1000th system on the occasion of the ESRI User Conference in July 1999. He took evident pleasure in the personal hand-over to Chad Shields (right), survey product manager at Baker GeoResearch, Inc. (USA).

Benefit from the new Leica Geosystems internet web site!

Leica Geosystems' internet presence has a new look. The site now offers faster-than-ever global navigation and positioning in the world of Leica Geosystems. Here you'll find not only an overview of the entire product range, along with performance figures and applications for every instrument and system, but interesting application examples as well. Page content is dynamically generated and even includes animated and interactive sequences to illustrate the various products and techniques. Here, you'll also find details and contact information for your national Leica Geosystems representative. It's a good idea to bookmark www.leica-geosystems.com and visit the site regularly for the latest product development news, applications and offers!

Miren Kauer