

The use of Leica Geo Office in mine surveying

Uporaba programskega paketa Leica Geo Office v jamomerstvu

GREGOR BILBAN¹, MILIVOJ VULIĆ², ALEKSANDAR GANIĆ³

¹Geoservis d.o.o., Litijska cesta 45, SI-1000 Ljubljana, Slovenia;
E-mail: gregor.bilban@geoservis.si

²University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geotechnology and Mining Engineering, Chair for Mine Surveying and Applied Geophysics, Aškerčeva cesta 12, SI-1000 Ljubljana, Slovenia; E-mail: milivoj.vulic@ntf.uni-lj.si

³University of Belgrade, Faculty of Mining and Geology, Chair for Mine Surveying, Đušina 7, 11000 Belgrade, Serbia; E-mail: aganic@rgf.bg.ac.yu

Received: November 5, 2007

Accepted: December 19, 2007

Abstract: Software forms an important part of a surveyor's product basket. Leica Geosystems offers a broad range of software solutions that seamlessly connect measurement sensors to provide maximum productivity from field data collection to final data processing presentation. Leica Geo Office is a powerful software package that offers complete office environment for a mine surveyor. Regardless of the surveying instrument and field technique used, a mine surveyor can easily transfer data to and from the instrument, create various reports, export data into most popular formats, process, adjust and present data. Due to its modular design, one can fully suit the package to one's needs. Different options support everything from regular daily measuring to specific and highly specialised surveying tasks, from network design to combined adjustment. The core of Leica Geo Office's options is of course GNSS processing and adjustment kernel. Leica Geo Office is a programme to be used by the mine surveyor in carrying out his most vital office operations.

Izvleček: Programska oprema je pomembno orodje vsakega geodeta. Leica Geosystems nudi širok nabor programskih rešitev, ki predstavljajo komplement merilnim inštrumentom in zagotavlja najvišjo produktivnost od zajema meritev na terenu do končne predstavitve podatkov. Leica Geo Office predstavlja zmogljivo in celovito pisarniško okolje tudi za potrebe v jamomerstvu. Ne glede na izbran inštrumentarij ali mersko tehniko jamomerec z njim prenaša podatke med inštrumentom in osebnim računalnikom, pripravlja terenske zapisnike in zapisnike obdelav, izvaža podatke v številne besedilne, GIS in CAD zapise, naknadno obdeluje in izravnava meritve ter nenazadnje predstavi rezultate. Zaradi modularne zasnove si lahko vsak uporabnik popolnoma prilagodi Leica Geo Office svojim potrebam. Posamezni standardni in opcijski moduli nudijo podporo tako vsakdanjim rutinskim kot tudi

specifičnim merskim nalogam, od tahimetrije do načrtovanja in izravnave geodetske mreže. Poglavitni del Leica Geo Office sta nedvomno jedri za naknadno obdelavo opazovanj in izravnavo. S programom Leica Geo Office jamomerec lahko opravi ključna pisarniška opravila.

Keywords: Leica Geo Office, GPS, post-processing, adjustment, mine surveying

Ključne besede: Leica Geo Office, GPS, naknadna obdelava opazovanj, izravnava, jamomerstvo

INTRODUCTION

Leica Geo Office is a single software package that supports all sensors and surveying techniques. Based on its predecessors – Leica Survey Office, Leica Ski-Pro and Leica LevelPack Pro, Geo Office allows handling GPS (or wider Global Navigation Satellite Systems), TPS (Terrestrial Positioning System) and levelling data in a similar way with standardized tools and data flow, either individually or in an integrated way.

It is based on an intuitive, graphical interface within a Windows™ multitasking environment, rendering it easy to learn and operate.

A consistent operating concept, a common Windows™ look and feel, common tools and data flows for all different survey instruments and the possibility of customising and configuring the customer's needs all ensure a shorter learning curve, and thus less effort is needed regardless whether one uses it for a highly specific, or regular and day-to-day tasks.

This common concept also avoids the duplication of effort connected with maintenance, training and support.

LEICA GEO OFFICE MODULES

Leica Geo Office is modularly designed. It includes the following standard functionality:

- Data Management,
- View and Edit,
- TPS processing,
- Flexible Reporting,
- Flexible Import and Export,
- Tools for GNSS, TPS and levels.

The *Data Management* module is responsible for data transfer between Leica Geo Office and all kinds of sensors – GPS families 500, 900 and 1200, TPS families Builder, 300, 400, 700, 800, 1100, 1200 and electronic levels Sprinter and DNA. One can transfer not only measurements, but also format files, codelists, coordinate systems, stakeout points etc.

View and Edit allows the user to visualise and edit observations – the reflector or prism height and type, plot error ellipses, verify setups, create, edit and visualise lines and areas, check coordinates etc.

The *Import and Export* functionality allows creating customisable ASCII files, ESRI Shapefiles, DXF/DWG files and even preparing DXF files to be used as an active map in the field.

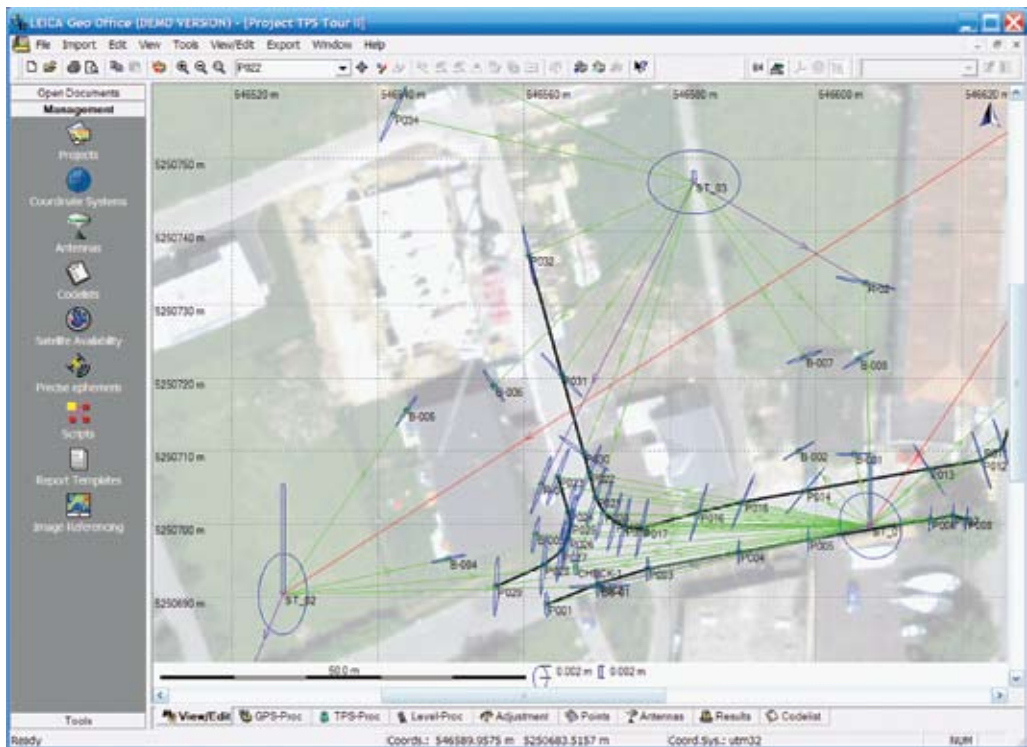


Figure 1. Leica Geo Office main view. In the View/Edit tab one can visualise, check and edit objects collected as well as observations, error ellipses and background.

Slika 1. Glavno okno programa Leica Geo Office. V zavihku View/Edit uporabnik grafično pregleduje opazovanja, elipse pogreškov, zajete objekte, v pomoč pa mu je tudi rastrska podlaga.

Reports (fieldbook, GNSS processing, traverse processing, adjustment, loop misclosure, mean coordinates and differences, satellite availability, datum and map transformation) are based on XML/HTML and fully customizable using XSL.

TPS Processing is another module in a Standard Leica Geo Office package. It allows one to edit and update existing TPS setups, recalculate TPS and/or SmartStation stations and orientations and even create new TPS setups and TPS traverse.

Since the introduction of Leica SmartStation – the first total station with an integrated GPS receiver, it is also important that Leica Geo Office allows an exchanging coordinate system for the whole or part of the project and recalculating TPS station with only one mouse click.

The standard functionality can be extended with additional powerful options:

- Coordinate Transformations,
- GNSS post processing,
- Level data processing,

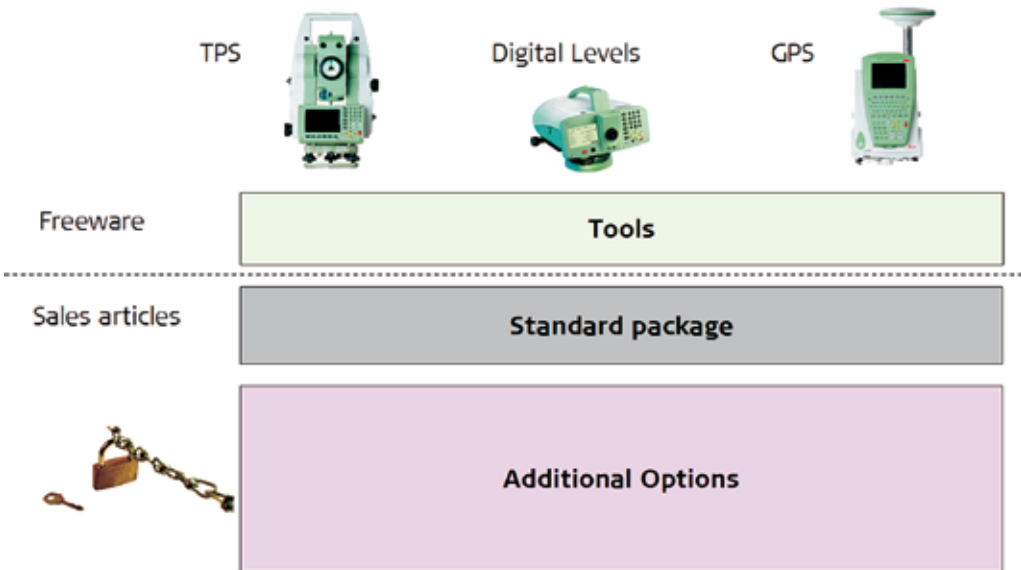


Figure 2. Different Leica Geo Office Packages from free of charge Geo Office Tools, to the standard package suitable for RTK GPS and TPS users, up to the most complete and flexible options for specific tasks

Slika 2. Leica Geo Office je na voljo v različnih paketih kot brezplačni Leica Geo Office Tools, kot standardni paket, ki je najbolj primeren za RTK GPS in TPS uporabnike, do najbolj celovitih in fleksibilnih možnosti, ki jih nudijo dodatni moduli

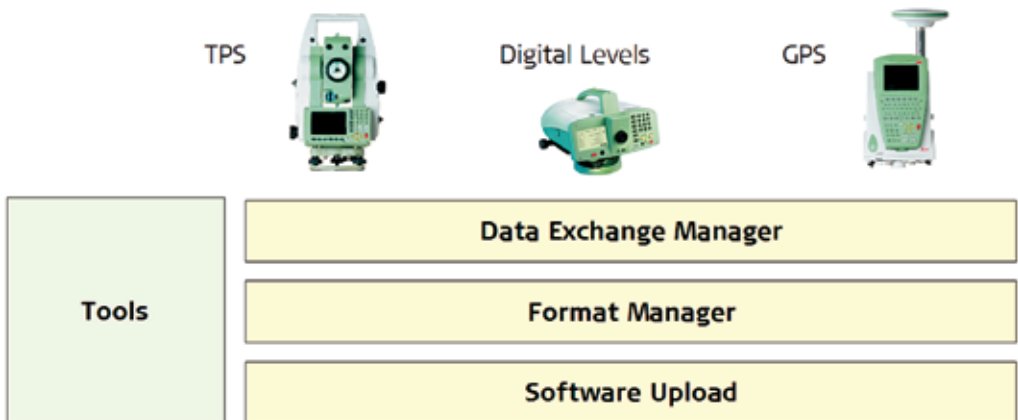


Figure 3. Leica Geo Office Tools components mainly consist of tools for data transfer between the instrument and personal computer

Slika 3. Leica Geo Office Tools v prvi vrsti sestavljajo orodja za prenos podatkov med inštrumentom in osebnim računalnikom

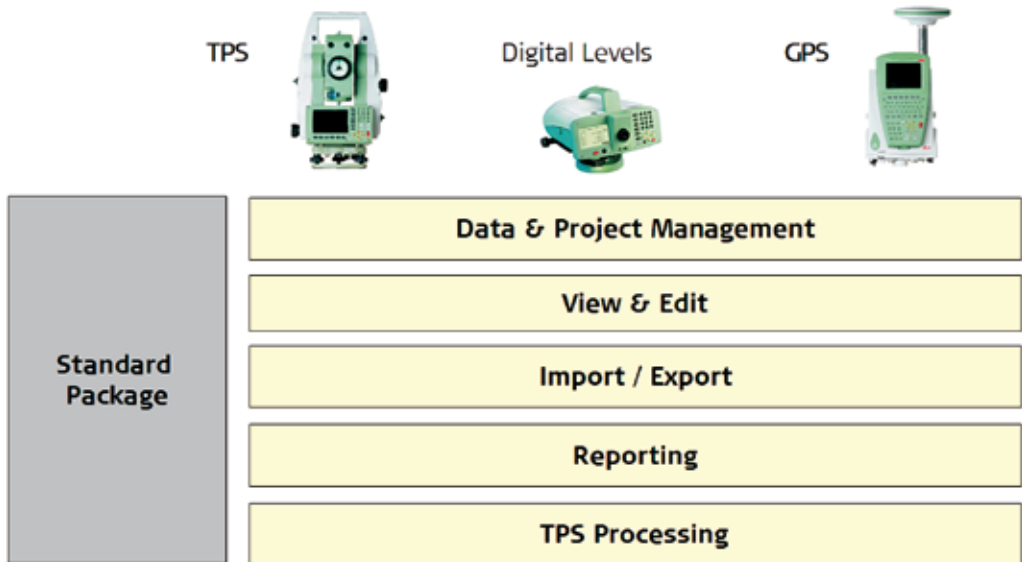


Figure 4. The standard package is expanded to viewing and editing, powerful export and import possibilities including a Design to Field module for creating backgrounds from AutoCAD DXF, flexible reporting and TPS processing e.g. the recalculation of station and orientation, traverse etc.

Slika 4. Standardni paket je razširjen z možnostmi pregledovanja in urejanja, zmogljivimi možnostmi za uvoz in izvoz podatkov, vključno s pripravo vektorskih podlag, fleksibilnimi možnostmi za pripravo zapisnikov in obdelavo tahimetričnih opazovanj

- Network Adjustment,
- GIS/CAD Export,
- Surfaces & Volumes.

kinematic, kinematic on-the-fly etc. PSI-Pro is used in the office software as well as on the field.

POST-PROCESSING MODULE

GNSS processing and the adjustment kernel are the most important and powerful components of Leica Geo Office. The GNSS processing kernel - since PSI-Pro offers GPS+GLONASS post-processing since version 2.0 with the same processing algorithms found in RTK, namely SmartCheck. It is the only processing kernel which is able to handle all different processing scenarios; static, rapid static, stop-and-go,

The continuous ambiguity check algorithm SmartCheck increases the reliability, in the way that the ambiguity is permanently and independently determined, approximately every ten seconds, and checked for consistency during the whole kinematic chain. In addition to that, the processing kernel also includes backwards processing, which ensures an unprecedented reliability of the results provided.

Of paramount importance for both the first-time user and a professional one, is

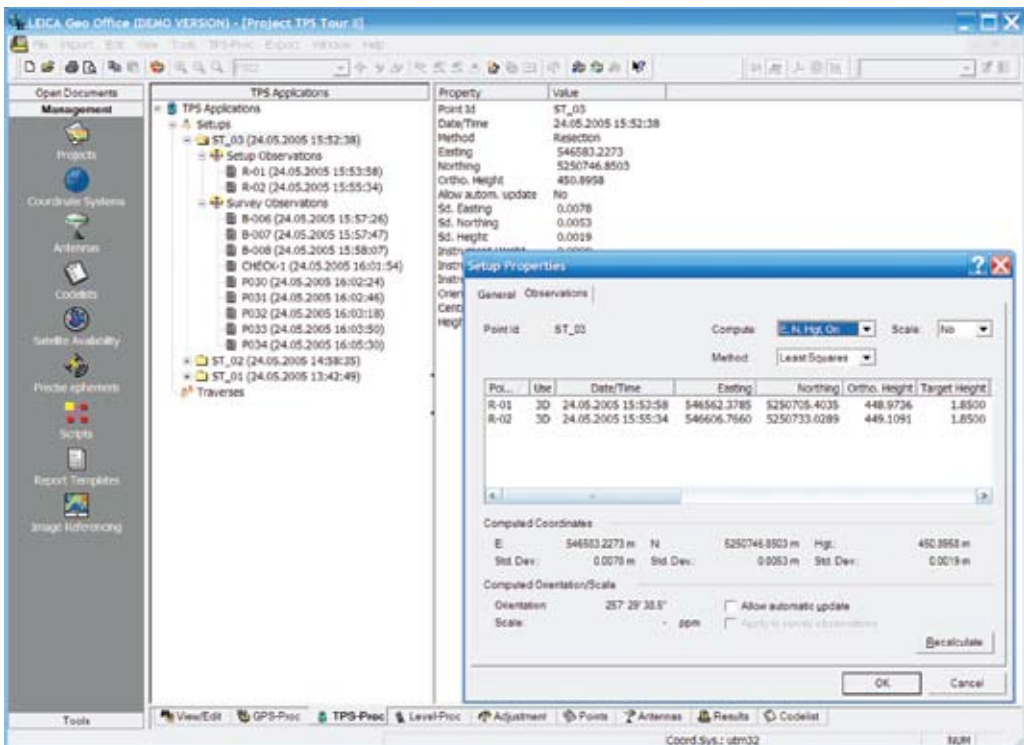


Figure 5. In the TPS Processing tab, one can check and edit station and orientation coordinates, instrument and reflector height, prism type, and use these to recalculate station and orientation

Slika 5. V zavijhku TPS Processing lahko uporabnik preverja in ureja koordinate stojišč in orientacij, višine inštrumenta, višine in tipe reflektorjev in preračunava tahimetrična opazovanja

the selection of processing parameters. With the built-in intelligence Leica Geo Office selects the best possible parameters by default. This is due to the analysis just before post-processing. On the other hand, skilled users have the full option to select appropriate settings. To illustrate the power of Leica's GNSS processing kernel, one would notice the baseline length for ambiguity fixing, which is by default set to 80 km.

Of course, RINEX and precise ephemeris files including GLONASS can be imported for post-processing.

Post-processing results are presented in XML/HTML reports with an extensive amount of information: project information, point information (receiver, antenna, initial coordinates, time frame), processing parameters (selected and used), satellite selection, computed iono model, antenna information (type, horizontal and vertical offset, phase centre offsets and phase centre variations based on either elevation/azimuth or spherical harmonics), observation statistics (common epochs, used observations, rejected observations, tracking sta-

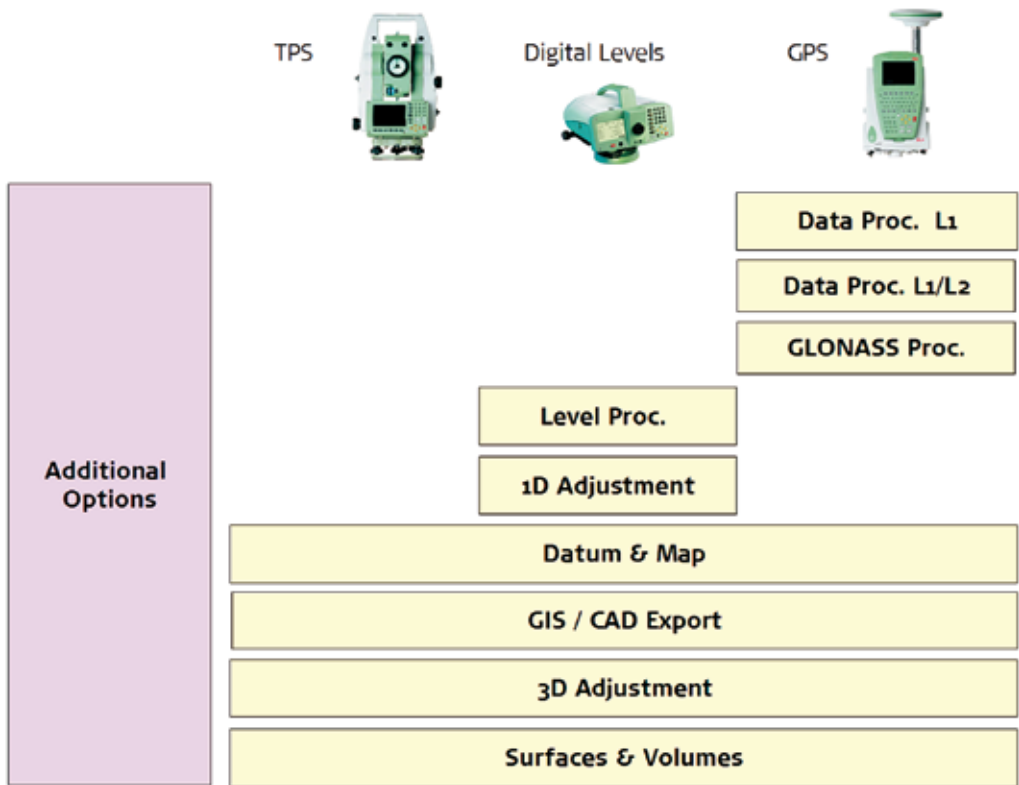


Figure 6. Leica Geo Office options give additional power to more specific tasks in surveying

Slika 6. Opcijski moduli Leica Geo Offica nudijo podporo tudi najzahtevnejšim specifičnim merskim nalogam

tus), ambiguity statistics (the total number of ambiguities, the number of fixed ambiguities, the number of independent fixes, the average time between independent fixes, as well as the percentage of fixed epochs and overall statistical data), cycle slips statistics and final coordinates. The graphical part of results displays residuals which allow the user to quickly detect poor satellites or to give general statements about ionospheric influence. The user will per default get the DOP values, azimuth information and the elevation of the used satellites. An advanced user has the option to plot all different kind of residuals for

single, double and triple differences, code and phase residuals.

THE DESIGN AND ADJUSTMENT MODULE

The adjustment kernel in Leica Geo Office is based on Grontmij’s MOVE3. MOVE3 is a software package for design, adjustment and quality control of 3D, 2D and 1D geodetic networks in compliance with the procedures of the “Delft School” of geodesy. MOVE3 allows fully integrated processing of GPS and terrestrial (TPS and level) observations.

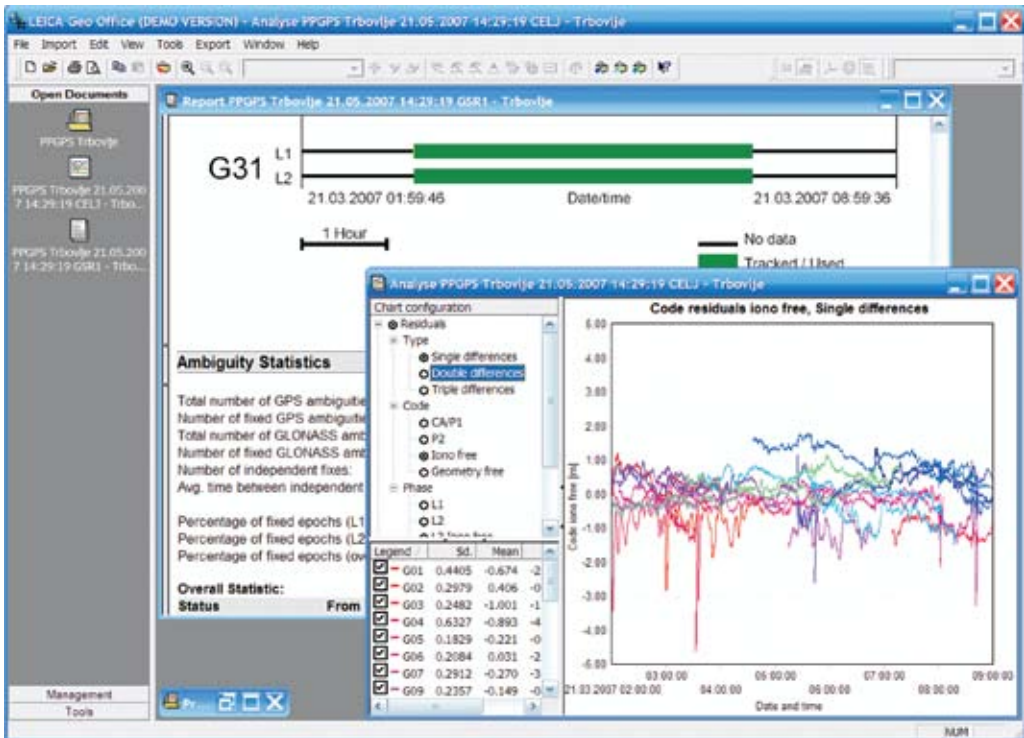


Figure 7. An important part of Geo Office's processing kernel is a complete and powerful reporting including tools for in-depth analyses of the processed data
Slika 7. Pomemben del jedra za naknadno obdelavo opazovanj je zmogljivo orodje za pripravo celovitih zapisnikov ter analizo obdelanih opazovanj

More than that – the Design & Adjustment option was even customised to our needs. In cooperation between Leica Geosystems Technical Support Team, Geoservis d.o.o. a Leica Geosystems representative for Slovenia and University of Ljubljana, Faculty of Natural Sciences and Engineering, Chair of Mine Surveying and Applied Geophysics this option was extended to create a full co-variance matrix of the adjusted system as a separate ASCII file, which is needed for additional quality control and analysis.

THE SURFACES AND VOLUMES MODULE

The Surfaces & Volumes option allows one to calculate digital terrain models from points being stored in his project. Surfaces can either be imported from System 1200 jobs using the application onboard a TPS or GPS1200 instrument, or can be created manually from any set of points that is stored in the project. Single points can be de-activated or activated, or complete triangles can be excluded or included from the calculation. In addition to that, the cre-

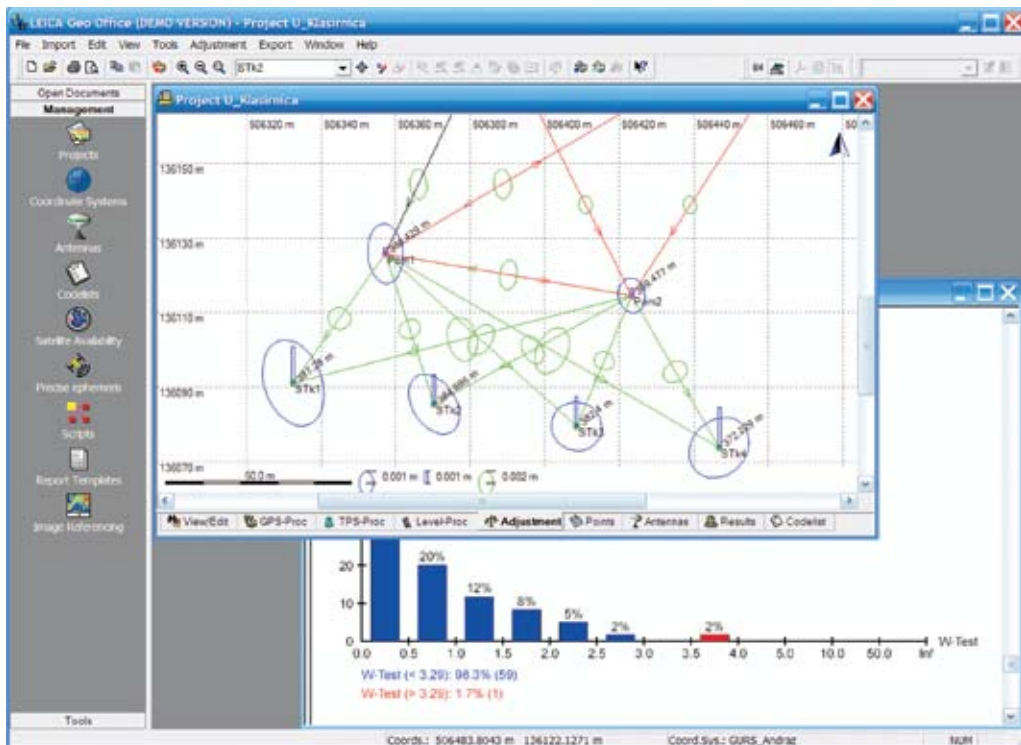


Figure 8. The Design and Adjustment kernel offers one total control of all crucial parameters, as well as extensive reporting with the result of the adjustment including various statistical testing

Slika 8. Jedro za načrtovanje geodetske mreže in izravnavo nudi uporabniku popoln nadzor nad pomembnimi parametri ter podroben zapisnik z rezultati izravnave vključno s statističnim testiranjem

ated digital terrain model can be modified by introducing break-lines or boundary lines. Computed results such as volumes, areas and additional statistical information are presented in a property view underneath the Surface View. It is possible to choose between a calculation Above Level and Against Surface (e.g. to control excavations). Surfaces stored in the project can be exported to either a System 1200 DTM job or to a DXF file.

UTILITIES

Last but not least, two standard options are Format Manager and Codelist Manager.

Format Manager is used to create format files. A format file is quite simply a “mask” or “filter” which allows surveyed data collected in the field to be exported in any format as an ASCII text file (e.g. DXF, report, coordinate list).

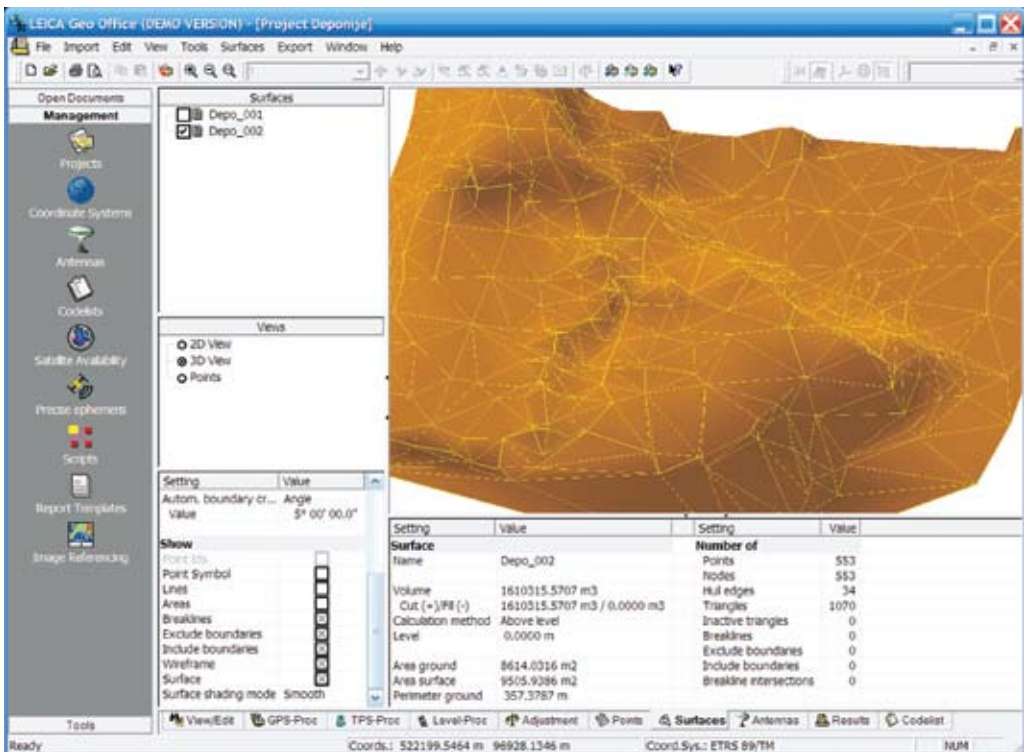


Figure 9. The surfaces in Leica Geo Office can be easily created from GPS, TPS, imported or entered points. One can create break-lines and boundaries. Volume can be calculated against reference height or another surface.

Slika 9. Površine v Leica Geo Office uporabnik pripravi neposredno iz GPS ali tahimetričnih opazovanj, iz uvoženih ali ročno vnešenih točk, vnese lome in meje. Prostornina se lahko izračuna glede na referenčno višino ali med dvema površinama.

A Codelist contains a list of predefined descriptions and information (codes) that can be used to describe the surveyed features in the field. Thematical codes are point-related, and contain non-spatial information (e.g. Code: tree, Attributes: species, diameter etc.). Codes can later be interpreted by the office software to create symbols, lines and areas and speed up the whole process from field to finish.

CONCLUSIONS

Leica Geo Office is a programme with the aid of which the mine surveyor is able to carry out the most vital office operations (for surface and underground surveying) such as:

- Optimal design of standard daily survey procedures in underground and open pit (quarry) mining including ex-

tended networks for underground and surface control, subsidence observations, engineering constructions survey and control, etc.

- Assessing the quality and cost of any survey activities.
- Processing the observations made by staff mine surveyors.
- Assessing the quality of the processed observations.
- Obtaining a "terrain model" that for the time being can be created exclusively for surfaces (topographic survey of surface installations, quarry operations: drilling, blasting, production control, disposal and waste management).

POVZETEK

Uporaba programskega paketa Leica Geo Office v jamomerstvu

Programska oprema je pomembno orodje vsakega geodeta. Leica Geosystems nudi širok nabor programskih rešitev, ki predstavljajo komplement merilnim inštrumentom in zagotavlja najvišjo produktivnost od zajema meritev na terenu do končne predstavitve podatkov.

Ne glede na izbran inštrumentarij ali mersko tehniko jamomerec z njim prenaša podatke med inštrumentom in osebnim računalnikom, pripravlja terenske zapisnike in zapisnike obdelav, izvaža podatke v številne besedilne, GIS in CAD zapise, naknadno obdeluje in izravnava meritve ter nenazadnje predstavi rezultate. Zaradi modularne zasnove si lahko vsak

uporabnik popolnoma prilagodi Leica Geo Office svojim potrebam. Posamezni standardni in opcijski moduli nudijo podporo tako vsakdanjim rutinskim kot tudi specifičnim merskim nalogam.

Leica Geo Office predstavlja zmogljivo in celovito pisarniško okolje tudi za potrebe v jamomerstvu. Podprte so standardne vsakodnevnne merske naloge tako rudnikih kot pri odprtih kopih (topografska merjenja, kontrolna merjenja, izračuni volumnov, obdelava tahimetričnih opazovanj...), vse do najzahtevnejših nalog, vključno s projektiranjem, merjenjem in obdelavo geodetskih mrež. Prav jedri za naknadno obdelavo opazovanj in 3D izravnavo sta najpomembnejša in zelo zmogljiva modula v programskem paketu. Modul PSI-Pro omogoča naknadno obdelavo GPS in GLO-NASS opazovanj s SmartCheck algoritmi, ki omogočajo najvišjo zanesljivost zaradi stalne neodvisne kontrole integritete inicializacije. Algoritmi omogočajo samodejno izbiro parametrov naknadne obdelave, izkušenemu uporabniku pa so na voljo številne napredne možnosti, popoln nadzor nad obdelavo ter zmogljiva orodja za predstavitev in analizo rezultatov. MOVE3 jedro za izravnavo omogoča kombinirano GPS in terestrično izravnavo opazovanj. V sodelovanju z Leico Geosystems, podjetjem Geoservis, ki je njihov avtoriziran distributer in serviser, ter Naravoslovno tehniško fakulteto, Katedro za rudarsko merjenje in geofizikalno raziskovanje je bil modul celo nadgrajen z možnostjo izpisa celotne variančno-kovariančne matrike, ki je potrebna za dodatne analize in kontrolo kvalitete.

REFERENCES

- [1] *Guidelines to Data Processing in Ski-Pro v3*. Leica Geosystems, 2003.
- [2] *Leica Geo Office v3 Release Notes*. 2005.
- [3] *Leica Geo Office v4 Release Notes*. 2006.
- [4] Leica Geo Office v5 online help.
- [5] *Leica Geo Office v5 Release Notes*. 2006.
- [6] Leica Geosystems homepage, www.leica-geosystems.com, 2007.
- [7] *Ski-Pro v3 – GPS Data Processing, What's New*. Leica Geosystems, 2003.