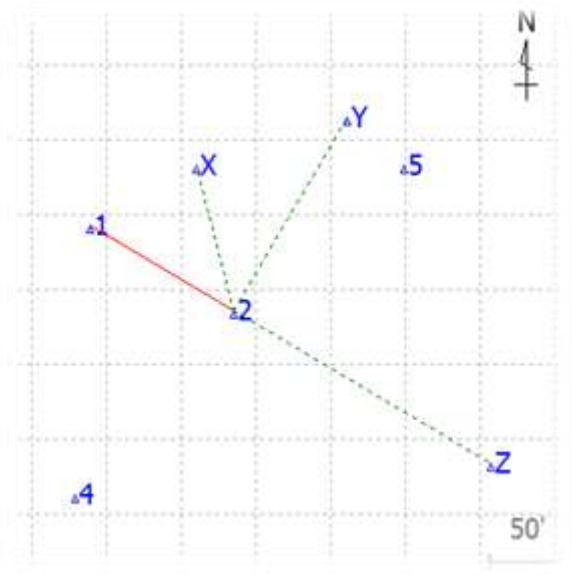
G-COGO™ V1.0



GEOMATICS COORDINATE GEOMETRY UTILITY

Getting Started Guide

G1-LoTUS™ | **Geomatics USA, LLC** | November 2018

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Definition

G1-LoTUS™ GNSS System is a real-time differential positioning and navigation system utilizing the widely available correction services from Continuously Operating Reference Stations (CORS) across the world to yield cm-level positional accuracy.

Purpose

This guide covers how to utilize coordinate geometry (COGO) techniques for the **G1-LoTUS™ GNSS System** to precisely survey and stakeout points using GPS

Audience

This guide is intended for G1-LoTUS™ system users. Basic knowledge of GPS, GIS, and surveying and mapping terminology is presumed.

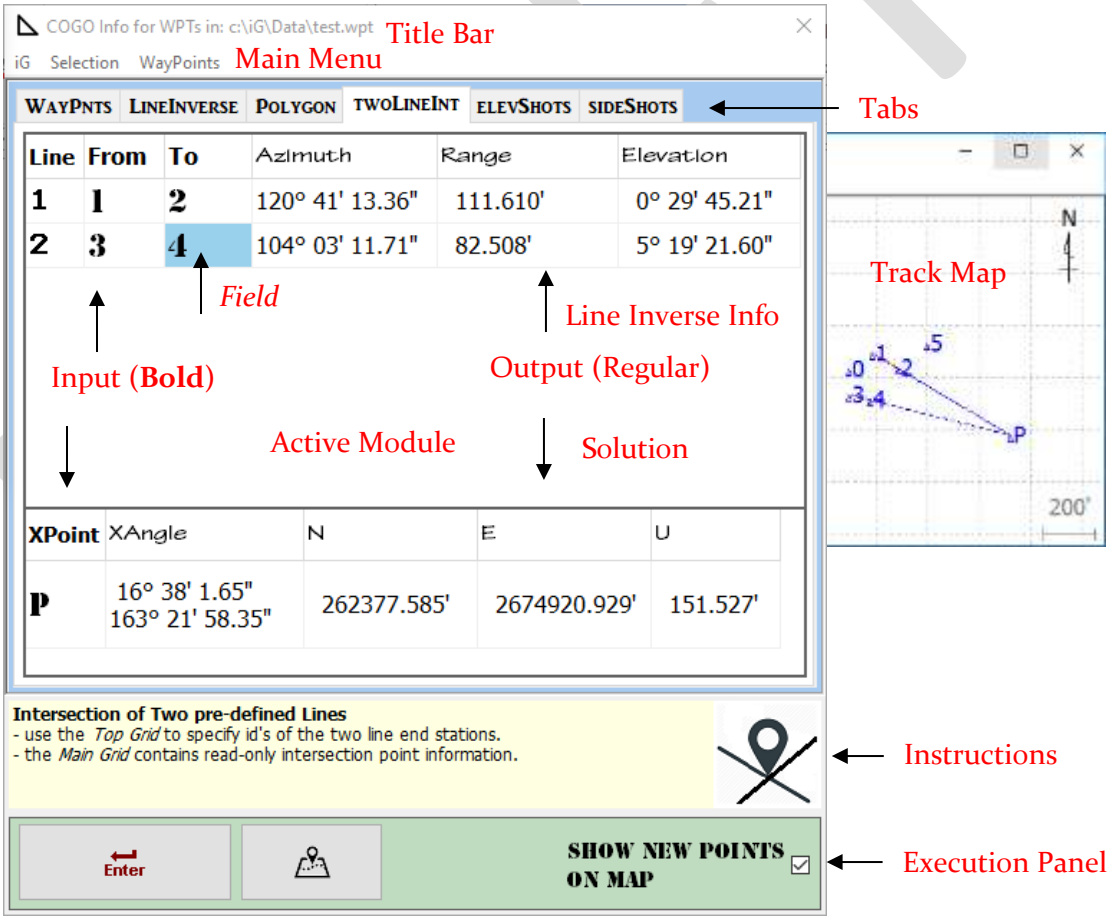
1. G-COGO™ Software

The G-COGO software module can run as stand-alone application or invoked as an embedded module from the G1-LoTUS Field software.

1.1 G-COGO™ Interface Structure

The G-COGO software package is a collection of independent modules each of which tackles a specific COGO problem. Each module has its independent tab of the application main dialog.

ⓘ ***all G-COGO modules are connected to each other through the waypoint database file used and displayed in the main dialog title bar. They, however, do not interact directly among themselves.***



To use the G-COGO utility, you must load a waypoint database from a ".wpt" file. The waypoint file is a comma-separated-values (csv) text file with the "PNEZD" format for each line as follows:

"*PID, Northing, Easting, Up, Description*".

Each line represents a single waypoint. In order to comment out a line and exclude the waypoint, precede it with a "#" sign as follows:

#A, 1000.000, 1000.000, 100.000, post.

The main components of the interface are:

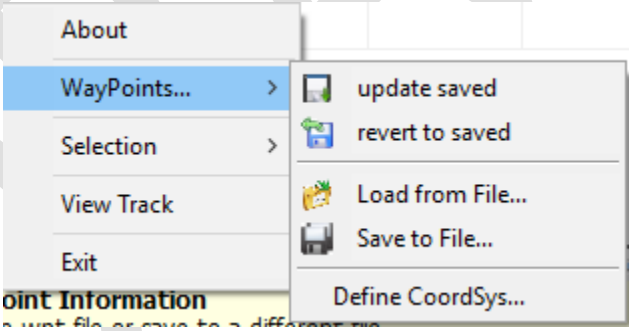
a. Title Bar

This shows the file path of the waypoint database.

b. Main Menu

This has generic commands applicable to all modules such as to update the waypoint file or to revert to its stored values and so on.

ⓘ ***the main menu is replicated as a "speed menu" through right-clicking in the main area of the active sheet.***



c. Tabs

Except for the first tab that has a tabular view of the waypoint database, each tab is an independent module that tackles on problem. Only one tab can be handled at a time. Bold fields with bold column titles in the active module (sheet) represent input by the user. Light italics column titles represent a by-product or a solution value. Based on the problem at hand, some tabs have limited number of fields for input and/or output, while others may have open-ended series of input/output.

ⓘ ***the output is only available after the user has entered the input values and then hit the "Enter" button.***

d. Instructions

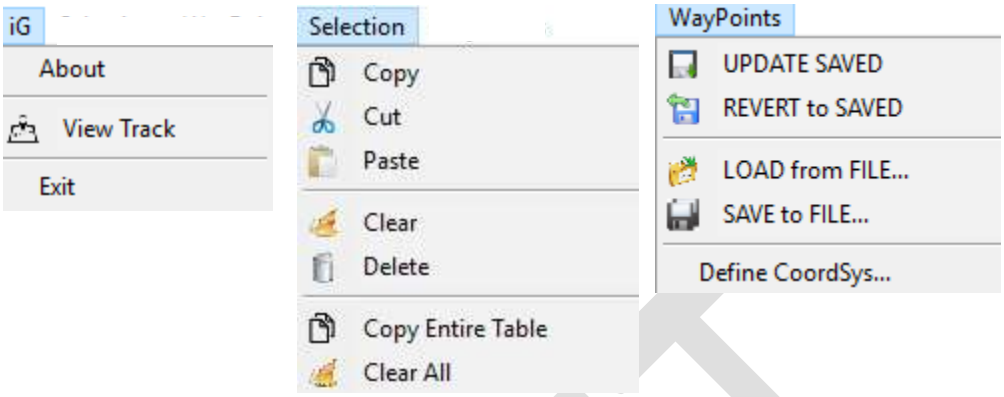
Quick guide on the COGO problem and what it represents.

e. Execution Panel

Main execution button and track map viewer button.

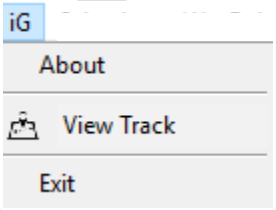
ⓘ ***The main dialog and its grids are sizeable.***

1.2 Main Menu



a. iG Menu

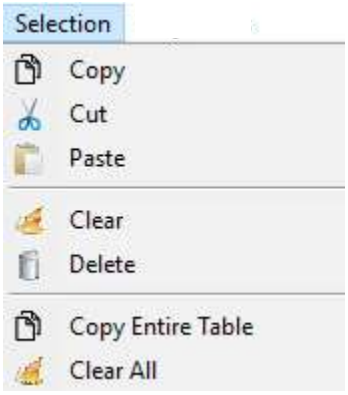
This has the main commands to:



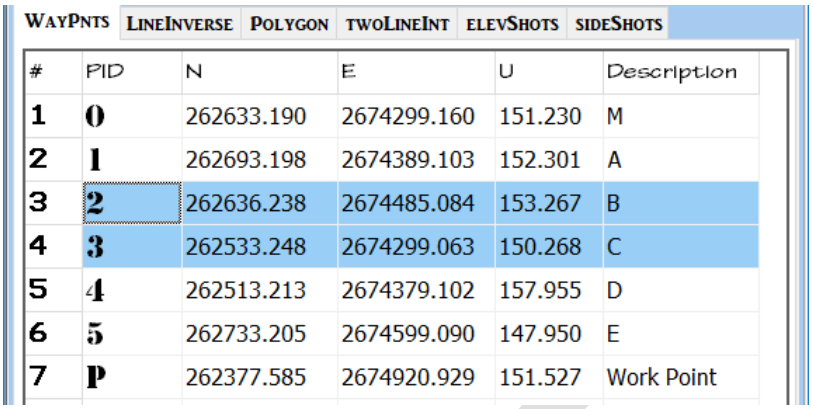
- show the "**About**" dialog
- invoke the "**Track Map**" dialog, a replication of the button in the "execution" panel
- **exit** the application, a replication of clicking the red "x" on the top-right corner of the main dialog

b. Selection Menu

These commands presumes that a selection has been made in the active sheet like the one below. Commends are executed on the selection as follows:

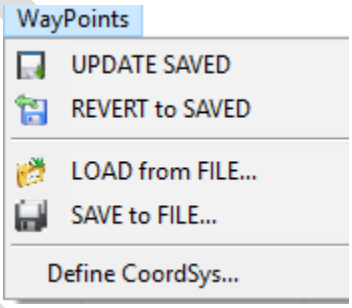


- "**Copy**": makes a copy of the selection to the clipboard to become available to other Windows applications
- "**Cut**": similar to "Copy" but with the removal of the selection
- "**Paste**": replaces the selection with the content of the clipboard
- "**Clear**": removes the selection content without making a copy in the clipboard
- "**Delete**": removes the rows containing the selection off the grid
- "**Copy Entire Table**": similar to "Copy" applied to the whole grid
- "**Clear All**": clears the contents of the whole grid



#	PID	N	E	U	Description
1	0	262633.190	2674299.160	151.230	M
2	1	262693.198	2674389.103	152.301	A
3	2	262636.238	2674485.084	153.267	B
4	3	262533.248	2674299.063	150.268	C
5	4	262513.213	2674379.102	157.955	D
6	5	262733.205	2674599.090	147.950	E
7	P	262377.585	2674920.929	151.527	Work Point

c. WayPoints Menu



- ***Update Saved***: use the current values in the "WayPnts" grid and ***overwrite*** those in the current "wpt" file

ⓘ *commented-out lines in the original "wpt" file are not represented in the grid and will be lost if the file is over-written.*

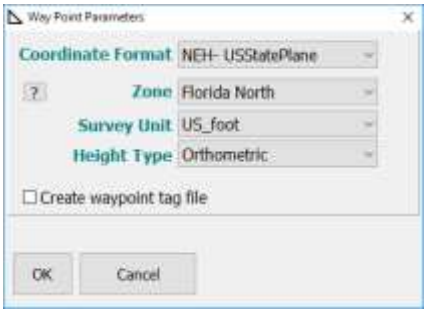
- ***Revert to Saved***: opposite of the above; reload what is in the "wpt" file and use their values to ***update*** the grid

ⓘ *all unsaved grid changes will be lost when you revert to the saved values*

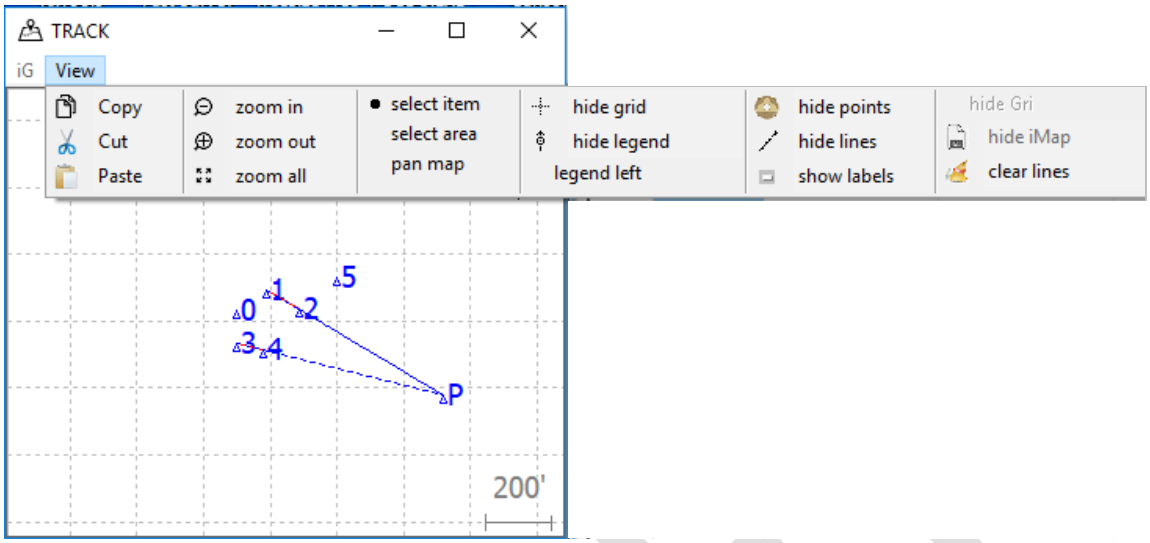
- ***Load from File…:*** navigate to a folder on the computer to load a "wpt" file and use its content as the current wpt database; the "WayPnts" grid will also be updated.

- ***Save to File…:*** navigate to a folder on the computer to save the "WayPnts" grid content to a "wpt" file; the main dialog title bar caption will then report the new name as the current "wpt" database name.

- ***Define CoordSys…:*** "wpt" files have an auxiliary tag files that has the same name with ".tag" extension. The tag file is necessary for modules that deal with map projection like the "Line Inverse" one. Use the pop-up dialog to specify, and create a file containing, the map parameters of the waypoints database.



1.3 Track Map



The track map is a planar graphical representation of the waypoint database points on a non-projected planar ground. It also shows work lines for the module at hand, e.g. the intersection point "P" of lines "1-2" and "3-4" in the example above. The main dialog has the following:

- **Main display** area which contains the waypoint locations and the work lines. The display area can be scaled by zooming in and out. It also can be panned by pressing and holding on the area and move left, right, up, or down. The "***pan map***" must be checked before the area can be panned.

- **Legend** which includes a line scale, a north direction, and a grid. The scale line and the north symbol can move left or right. They can also be shown or hidden. The grid also can be hidden.

- **View Menu** which has the following submenus:
  a. **Copy Menu**
     Use as described.

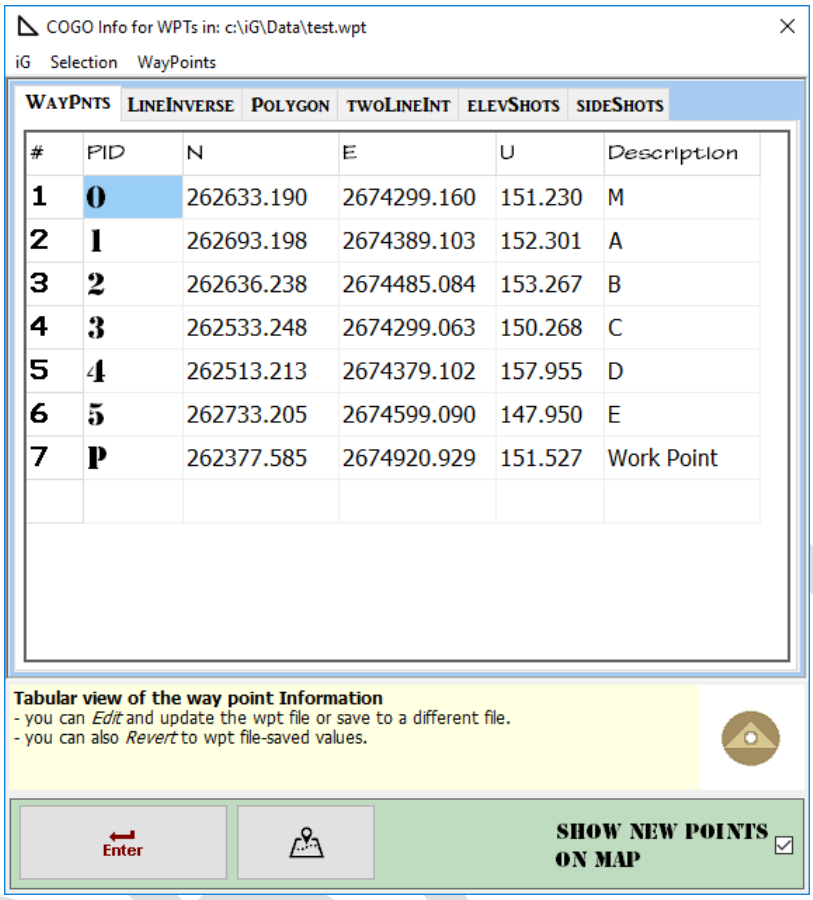
  b. **Zoom Menu**
     Use as described. A double click on the main display area is similar to clicking the "Zoom All" menu item. "Zoom All" brings all waypoints to the main display screen.

  c. **Select Menu**
     This is a radio group menu; one item can be selected at a time. Use "**select item**" to click on a single waypoint to set focus on it in the waypoint grid. Use "**select area**" to draw a box around a subset of the waypoints to zoom to. Use the "**pan map**" to move the display area by pressing and holding then moving it.

d. Show/Hide Menu
Use as described.

e. Clear Lines Menu
This forces a ***reset*** of all work lines to make sure the following operation starts afresh. This is similar to the “revert to saved” from the waypoints menu.

1.4 Waypoints Tab



This tab is a tabular representation of the waypoint database stored in the file. Each row of the grid represents a row in the file.

ⓘ ***commented-out lines in the file are not represented in the grid and will be lost if the file is over-written.***

ⓘ Except for the first row number column, the fields of the grid are editable.

ⓘ to select a row, click its first column.

ⓘ clicking the first row of a column selects and sorts the whole table based on the values in the selected column

ⓘ **a** blank row is added automatically to the end of the grid when needed.

ⓘ ***in order for the grid changes to take effect after fields have been modified, the "update saved" menu item must be clicked.***

ⓘ ***to centre the track map on a waypoint, double click its row in the "WayPnts" grid.***

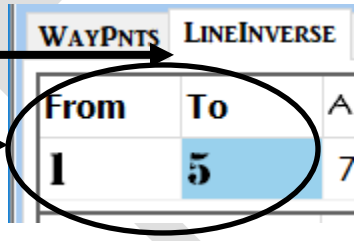
2. G-COGO™ Modules

The following is a description of the modules making up the G-COGO package. To execute any of the module, follow the steps:

1. Load the waypoint database from the file

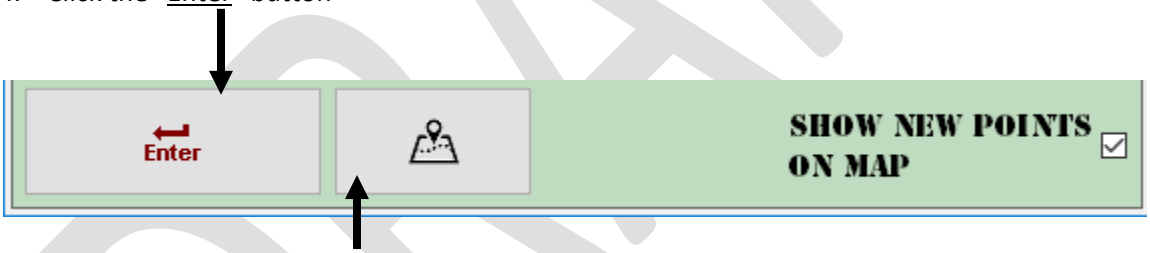
ⓘ ***When G-COGO is invoked from within the LoTUS Field data collection application, the waypoint database is loaded automatically***

2. Go to the intended module by click on its sheet to make it the ***active*** one
3. Fill in ALL **bold-titled** fields



ⓘ ***Waypoint ID Fields are read-only dropdown lists that cannot be edited. Newly generated point fields, however, are editable text fields that require user entering of a new point ID that does not exist in the waypoint database to avoid duplications.***

4. Click the "Enter" button



5. Click the "Track View" button to view the track map, if needed

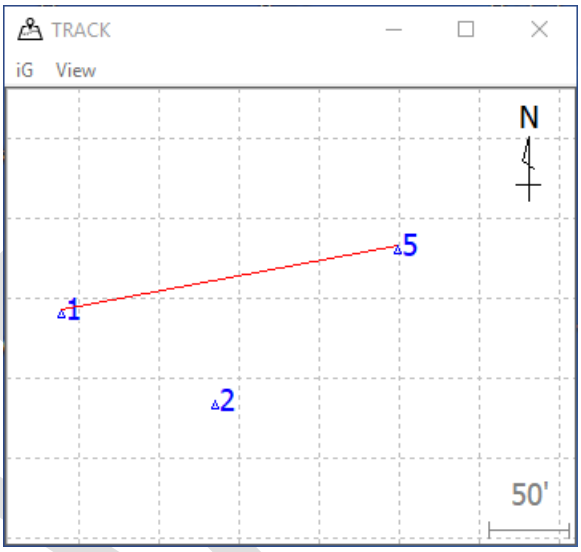
ⓘ ***before clicking the "Enter" button, check the "Show New Points on Map" first to view the ID(s) of the newly created point(s) on the map.***

Line Inverse Information

INPUT

IDs of two waypoint, e.g. “From” point 1 “To” point 5

OUTPUT



- Quick inverse info

Azimuth, Range, and Elevation are ground-based values in the horizontal and vertical planes assuming planimetric trigonometry (no map projection takes effect.)

- Detailed inverse info

Ground-based and grid-based (map-projected) values of the designated line representing changes between the “From” point to the “To” point in:

Northing, Easting, Distance (Horizontal), Azimuth, Bearing, Elevation (Vertical Angle), Grid Convergence of Meridians (Grid North – True Ground North), Point Scale Factor on the map and the combined scale factor after taking height difference into consideration, Height difference, and 3D Spatial (Mark-to-Mark) distance.

ⓘ Ground *means <u>reduced</u> to the reference surface, i.e. ellipsoid for geodetic computations or plane for planimetric computations*

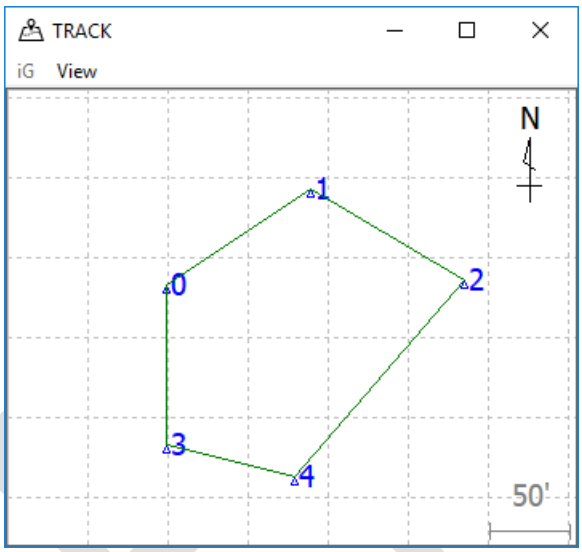
ⓘ Grid *means <u>projected</u> to a mapping surface, e.g. a cylinder for TM, a cone for LC. Most States use TM and/or LC in their US State Plane Coordinate Systems.*

Polyline Inverse Information

INPUT

IDs of waypoints forming the polygon rotating clock- or anti-clockwise, e.g. point 0, point 1, point 2, point 4, and point 3

ⓘ ***make sure the polygon lines do not cross one another other than at the vertices***

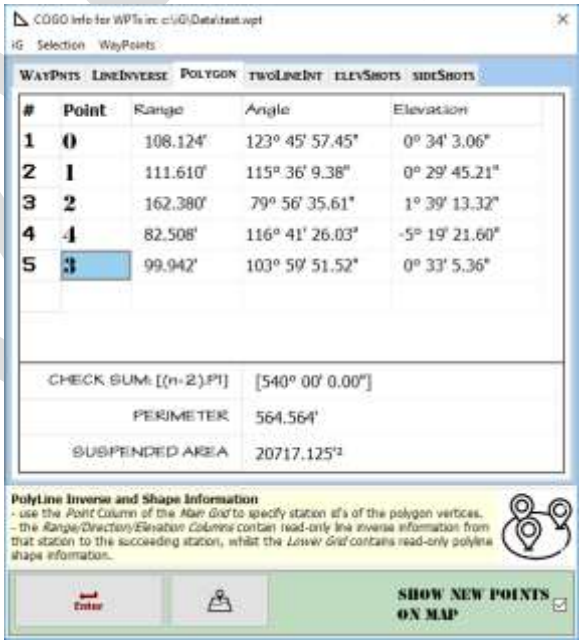


OUTPUT

- Quick inverse info

Azimuth, Range, and Elevation are ground-based values in the horizontal and vertical planes assuming planimetric trigonometry (no map projection takes effect.)

ⓘ ***the "Range" and "Elevation" reported at a point are for the line "From" that point "To" the succeeding point, e.g. the line reported at point 0 is Line 0_1; the succeeding point for the "Last" point is the "First" point***



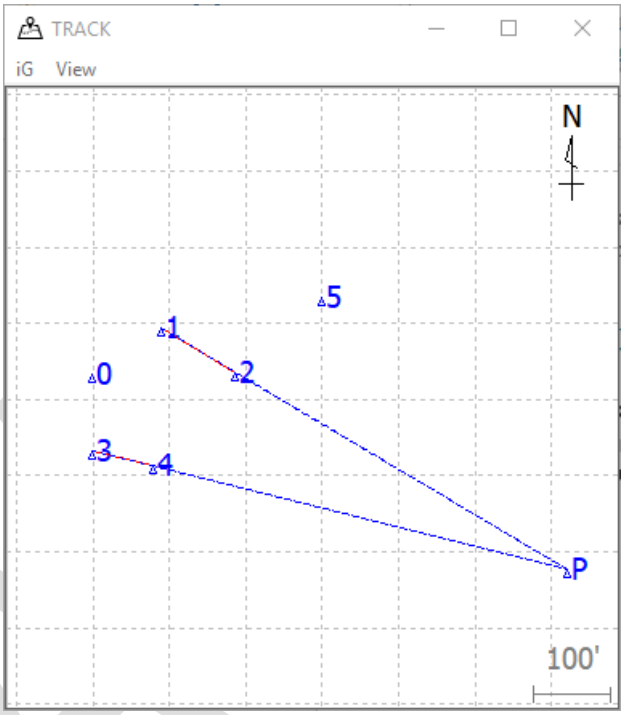
- Shape info
  - a. ***"Check Sum" of all angles must equal to (n-2) x 180 degrees, where n is the number of polygon vertices, 5 in the illustrated example***
  - b. ***"Perimeter" of the polygon is the sum of all ranges of its sides***
  - c. ***"Suspended Area" is the area enclosed by the polygon sides***

Two-Line Intersection

INPUT

- IDs of waypoints forming two lines, e.g. point 1 and point 2 for line 1_2, and point 3 and point 4 for line 3_4
- ID of the intersection point, e.g. XPoint "P"

ⓘ ***Lines may be intersecting or crossing***



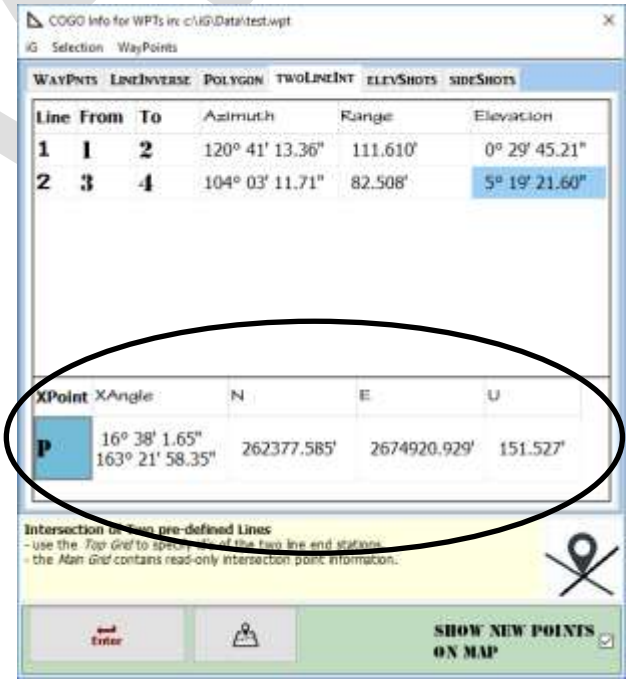
OUTPUT

- Quick inverse info

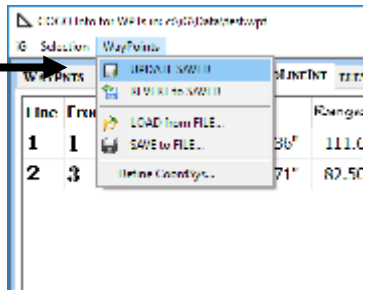
Azimuth, Range, and Elevation of the two intersecting lines

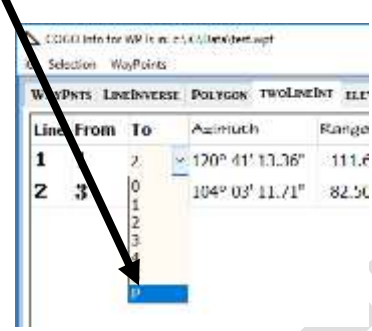
- Intersection point info

- ***"XAngle"*** the angle suspended by the two lines, both acute and obtuse
- "***Northing, Easting, and Up***" coordinates of the intersection point



ⓘ *to add point "P" to the current waypoint database, click the "<u>update saved</u>" menu item. To make sure "P" is added, click any waypoint dropdown list to see it.*





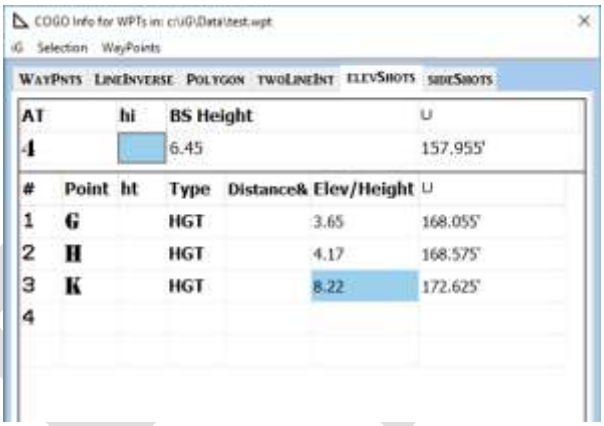
Elevation Shots

From a single occupation

INPUT

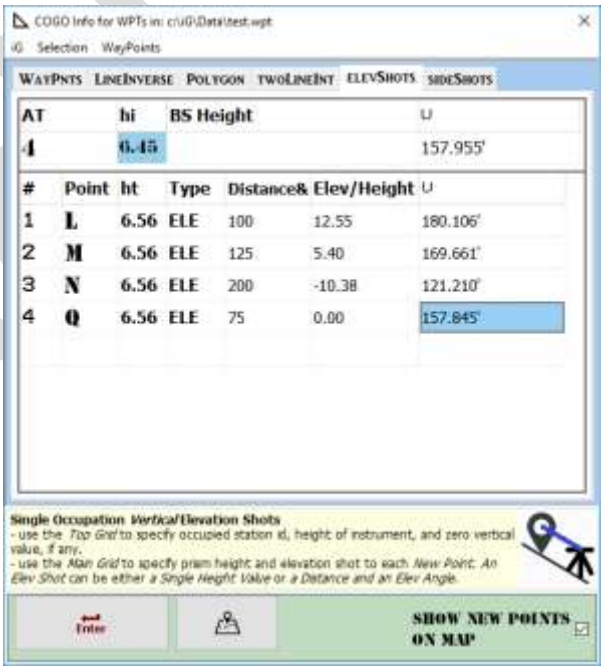
Spirit Levelling (Type=HGT)

- ID of the Bench Mark (point of known elevation), e.g. point 4
- Instrument height = 0 or leave blank
- Back Sight staff reading on the Bench Mark
- ***ID and Height (staff reading)*** on each new point



Trigonometric Levelling (Type=ELE)

- ID of the occupied station (point of known elevation), e.g. point 4
- Instrument height, e.g. total station height
- Back Sight height, e.g. zero for vertical circle readings and 90 for zenith angle readings
- ***ID, height of target (prism), distance, and elevation angle*** in degrees of each new point



ⓘ ***Blank field in a grid is interpreted as zero value***

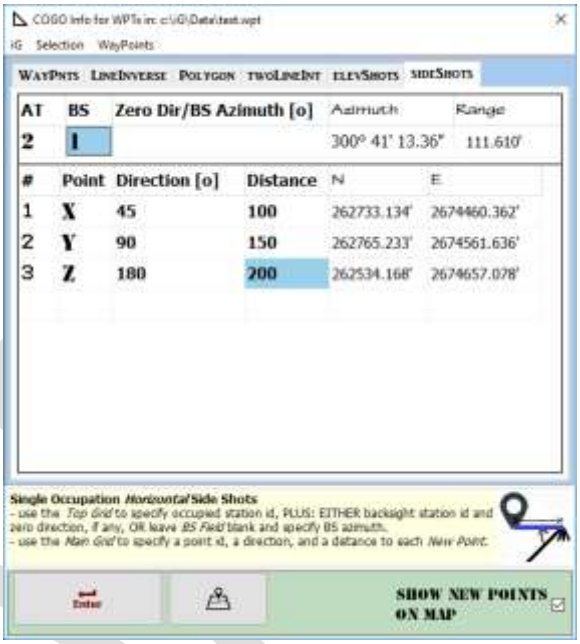
OUTPUT

Heights of newly shot targets

Side (*Directional*) Shots

From a single occupation

INPUT



Known Back Sight Station

- ID of the occupied station, e.g. point 2
- ID of the back-sight station, e.g. point 1
- Zero Direction Reading for reporting Total Station Horizontal Circle Readings; leave blank if reporting angle right
- ***ID, direction, and distance*** for each new point

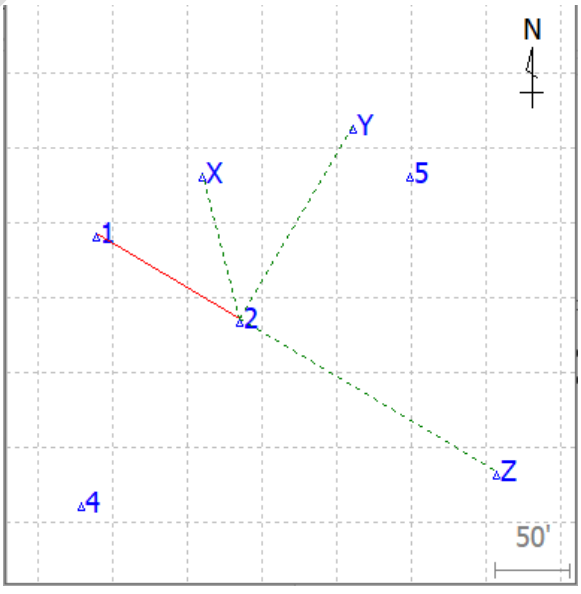
Known Back Sight Azimuth

- ID of the occupied station, e.g. point 2
- Leave blank ID of the back-sight station
- Back sight azimuth value, e.g. -89.05
- ***ID, direction, and distance*** for each new point

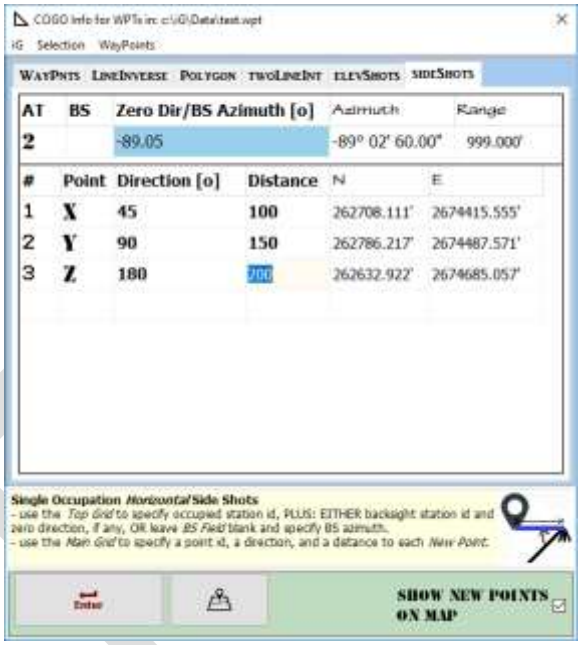
ⓘ use the *LineInverse* module to find azimuths of lines, if needed

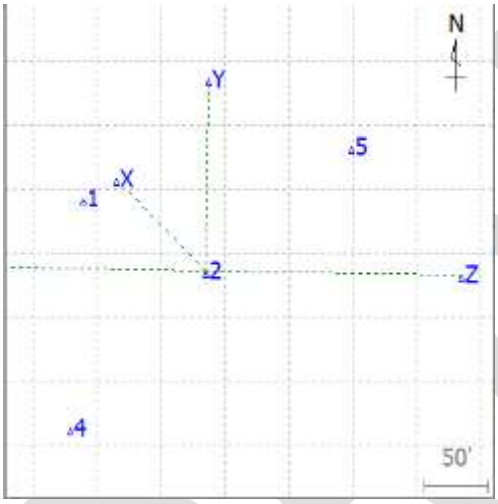
OUTPUT

Northing and Easting of newly shot targets



Known Back Sight Azimuth Case





Station and Offset Shots

For a single baseline

INPUT

Known Back Sight Station

- ID of the occupied station, e.g. point 4
- ID of the back-sight station, e.g. point 0
- ***ID, station, and offset*** for each new point

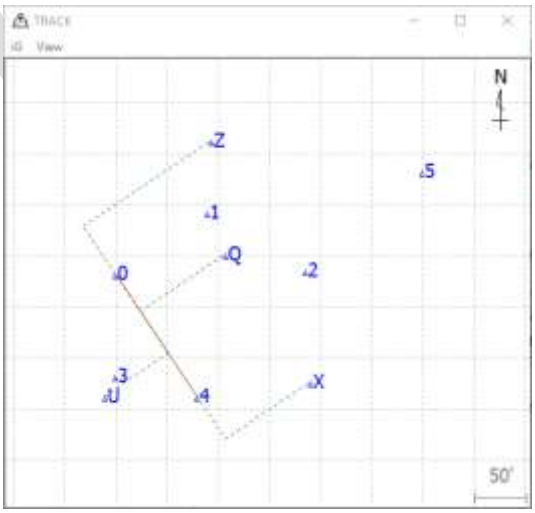
Known Back Sight Azimuth

- ID of the occupied station, e.g. point 4
- Leave blank ID of the back-sight station
- Back sight azimuth value
- ***ID, station, and offset*** for each new point

ⓘ use the *LineInverse* module to find azimuths of lines, if needed

OUTPUT

Northing and Easting of newly shot targets



ⓘ leave offset fields blank to divide a line into stations

ⓘ use the same station value with different offsets to divide a perpendicular line