



THEOLT RELEASE 7 PRO USER GUIDE





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This manual has been designed to lead the reader through the process of installing, configuring and measuring using the TheoLT R7 Pro base module.

A command reference is available separately.



INSTALLATION

The entire TheoLt range is installed from a single setup during which the various modules may be selected.

TheoLt is distributed in 2 formats:

- CD
- Web Download

When using the CD, selecting “Install TheoLt” from the list of options starts the same installation process as the web download.

The name of the web installation file is: `TheoLtR7xx.exe`. To start this installation, double-click the `TheoLtR7xx.exe` file.

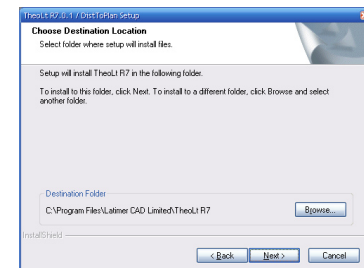
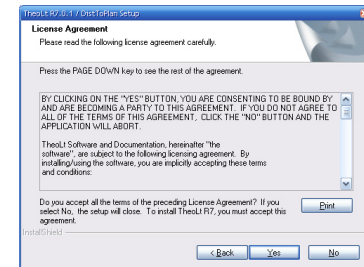
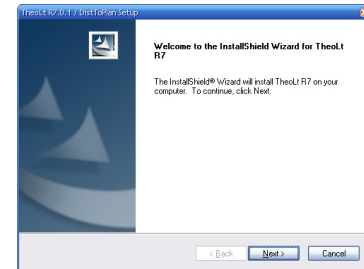
The **[Next]** button steps through the installation.

The first stage is to agree to the license. To confirm this, click **[Yes]**

Confirm the installation Folder. The default is

`C:\Program Files\Latimer CAD Limited\TheoLt R7`

Click **[Next]**.





Select the installation type:

- TheoLt Base includes all the required components.
- TheoLt Building Survey: 1 option per AutoCAD type.
- DistToPlan: 1 option per AutoCAD type

TheoLt / TheoLt Pro users should select TheoLt Base.

TheoLt Building Survey / TheoLt Building Survey Pro users should select the TheoLt building survey option with the correct AutoCAD type. Only one option can be selected.

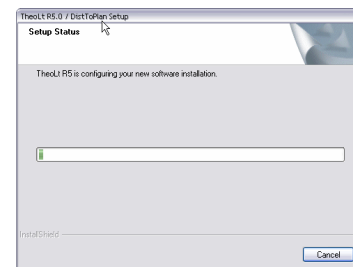
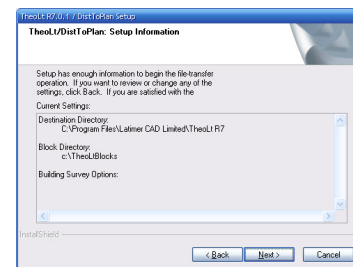
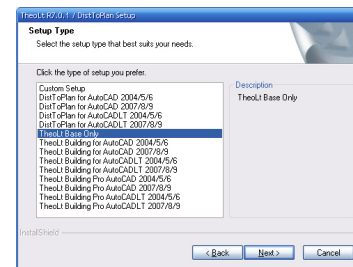
DistToPlan / DistToPlan Pro users should select the DistToPlan option with the correct AutoCAD type. Only one option can be selected.

Confirm the installation options by clicking **[Next]**.

The files are installed.

Click **[Finish]**.

Once installed the software will need authorisation.





AUTHORISATION

The standard installation of TheoLt creates a Program Group called TheoLt in the Windows Start Menu. From this, select **License Manager**.

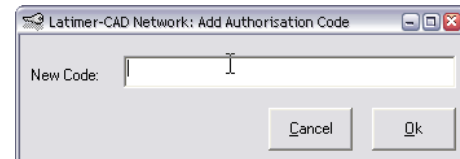
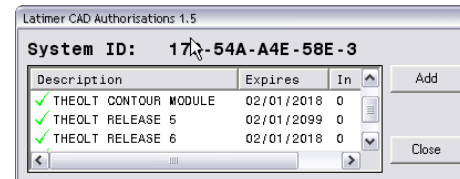
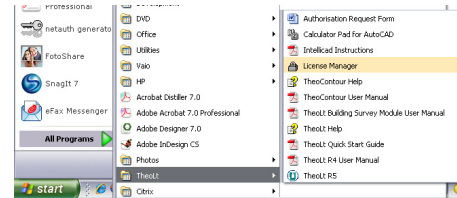
The Authorisations dialog box will be displayed. Make a note of the System-ID.

Complete the Authorisation Request document (enclosed) and either:

- Fax to +44 207 900 6381
- Email to: auths@latimer-cad.com

Once the Authorisation code is supplied, click **[Add]**. This will display a dialog box in which the Authorisation should be entered. Press **[OK]** to complete.

[Close] the dialog box.





MAKE A NOTE OF YOUR AUTHORISATION DETAILS HERE:

SYSTEM ID:

THEOLT BASE MODULE AUTHORISATION:

THEOLT BASE MODULE PRO AUTHORISATION:



STARTING THEOLT

Start Up:

The start-up process of TheoLt allows aspects of the current configuration to be viewed:

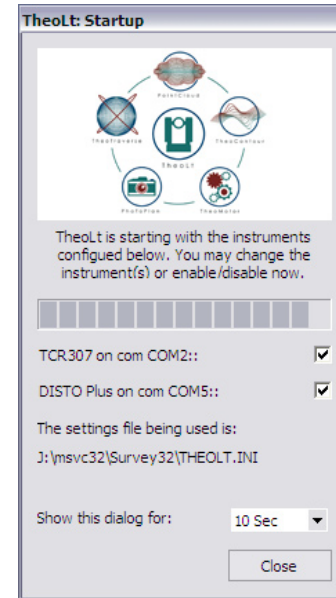
- Configured Instruments
- Configured Settings File.

The start-up dialog is displayed for a user defined time (the default is 10 seconds).

The **[Close]** button may be clicked at any point to continue the start-up with the displayed settings.

The time for which the dialog is displayed may be altered by selecting a different value from the **Show this dialog for:** list.

Note: Setting the length of time for which the dialog is displayed to a short time may not allow the user to re-lengthen the time again as the dialog will disappear before the time out is reset. Therefore is advisable to keep the time out to approximately 10 seconds and use the [Close] button to reduce the start-up time.





Instruments:

TheoLt may be configured to use two instruments (a Total Station Theodolite and a Distance Meter). The configured Instruments are listed. Either Instrument may be disabled by unticking the relevant tick-box. The instruments will be re-enabled when TheoLt is next started.

Note: Disabling both instruments allows quick access to the settings section of TheoLt for reconfiguring the instruments.



BASIC CONCEPTS

General:

In its basic form, TheoLt provides an interface between a Total Station Theodolite and a CAD system for the collection of 3 Dimensional Information. In addition, a distance meter such as the Leica Disto may be used to collect 2D Dimensional Information.

The main principle of TheoLt is to allow the use of 3D Total Station data to provide coordinate data to AutoCAD commands. For example, to allow the Line command to be invoked within AutoCAD and then to take observations with the instrument to provide the endpoints of the lines.

Additionally, TheoLt provides a set of drawing tools which control the CAD system. These tools, located on the **Draw** tab, enable not only drawing, but layer management.

The User Interface is divided into 2 dialog boxes (which may be docked together to form one):

- Main Toolbar
- Instrument Interface



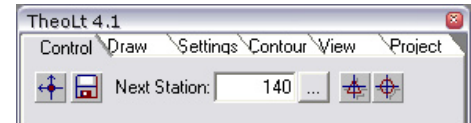
Typical setup: tablet PC and Leica TCR



The Main Toolbar is divided into 6 “tabs” providing access to groups of functionality:

Control tab:

- Automatic Insertion of Control symbols (Station and Reference) from Instrument.
- Direct Text File Control Import.
- Orientation Control:
- Default Orientation
- Orientation to reference
- Resection / Locate
- Position Verification Report.
- Network Adjustment.
- Direct access to next station identifier
- Station and Reference Symbol insert by pick.



Draw tab:

- Direct Text File Control Import
- 2D and 3D drawing:
- 2D Line
- 3D Line (with optional 2D copy)
- 2D Polyline
- 3D Polyline (with optional 2D copy)
- 3pt Arc (3D)
- 3pt Circle (3D)
- Block Insert





- Feature Library
- All items drawn on managed layers

Settings tab:

- Direct Access to datafile.
- Access to all settings.

Contour tab:

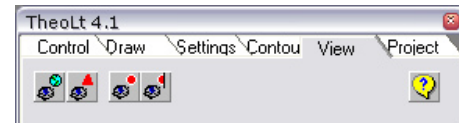
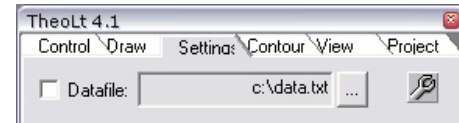
- If authorised: Part of Pro version

View tab:

- Plan World.
- Centre Instrument in Window.
- View from Instrument to Last Point
- Section through Last Point
- Display the Help file.

Project tab:

- Project Manager.
- Current Active Project.





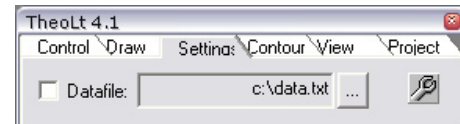
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CONFIGURING FOR FIRST USE

Before TheoLt can be used, there is a minimum configuration that must be completed:

- Select the AutoCAD Version
- Select the Instrument in Use



Start TheoLt.

Selecting the AutoCAD Version:

- Start TheoLt, uncheck both instruments in the start-up dialog.
- Select the **[Settings]** tab.

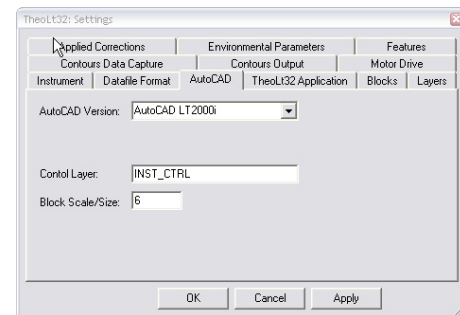


- Select **[Display Options / Settings]** Icon.
- Select the **[AutoCAD]** tab:

The Drop-Down menu contains a list of the AutoCAD versions currently supported by TheoLt.

Select the correct version.

The Control Layer indicates the Layer within the AutoCAD drawing on



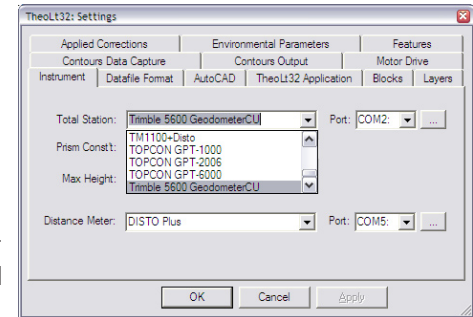


which blocks representing station positions will be placed.

Selecting the Instrument:

Select the **[Instrument]** tab:

TheoLt allows 2 instruments to be connected simultaneously. The 2 drop-down menus contain a list of the instrument interfaces currently supported by TheoLt.



Select the correct Total Station interface for your instrument.

Note: Due to rapid changes of instrument names, the exact instrument name may not be listed. Most instruments are supported via an interface for a similar instrument from the same manufacturer. Contact TheoLt support for advice if your instrument is not listed.

The communication parameters are defaulted. Confirm the COM (RS232) port being used to connect the instrument to the PC. This connection may be a physical cable to a physical COM port on the PC or a virtual Port created by a Bluetooth or USB connection.

Note: TheoLt is only able to address COM ports 1 to 8. Any port will need to



reside within this range.

The Port field allows the selection of the COM port to be used. The application will need to be restarted to effect a change of COM port.

Select [...] to open a panel which can be used to match the com port settings on the computer with those on the instrument.

Note: The instrument will have to be set up to send data via RS232, and have communication settings in agreement with TheoLt. TheoLt will need to be closed and restarted for instrument settings to effect changes to the comms settings.

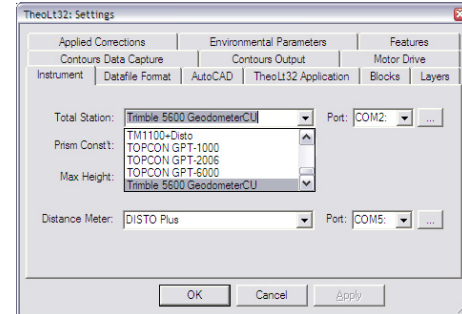
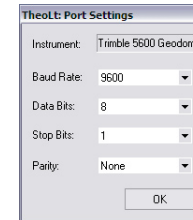
Repeat for the Distance Meter selection and COM port.

[Apply] the Settings.

[OK] to close the dialog box.

[Close] TheoLt.

After re-starting, TheoLt will be ready to use.





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TESTING CONFIGURATION

Once the minimum configuration has been completed, TheoLt may be used:

- Connect the instrument to the PC.
- Start AutoCAD
- Once AutoCAD is loaded, start TheoLt.
- As TheoLt starts, confirm the correct Instruments are listed.

Test the Interface to AutoCAD:



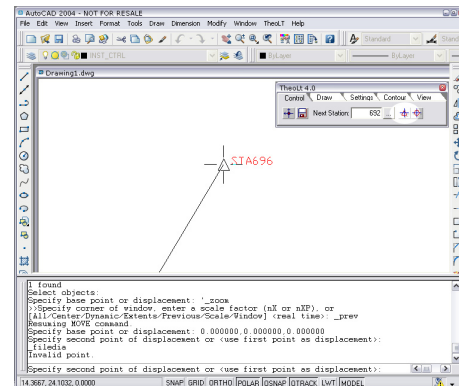
Select the **[Control]** tab.

Select the **[Insert Station Position Icon]**.

The AutoCAD command line should now contain a number of commands:

```
[All/Center/Dynamic/Extents/Previous/Scale/Window] <real time>: _prev  
Resuming MOVE command.
```

Position the block within the drawing. This action confirms the correct configuration of the AutoCAD version.



Test the Interface to the Instrument:

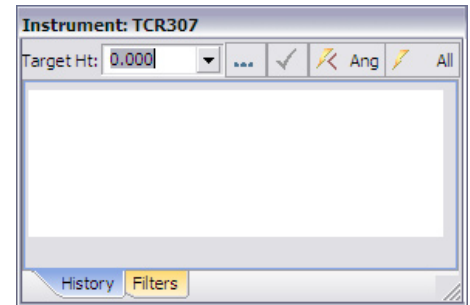


On the Instrument Interface window, click the **[All]** button.

This instrument should attempt a measurement. If no measurement is achieved, check the instrument settings to ensure that one is possible.

Consider the following:

- That the instrument is level.
- That the instrument is in reflectorless mode.
- That the target is valid (good surface and range).
- That if the instrument does not have a reflectorless mode that it is pointing at a valid prism.



After the observation is made, the details will appear in the **History Panel**. The **Orientation Panel** will also be displayed as TheoLt requires the instrument to be orientated. This action confirms the correct configuration of the Instrument

If using a Leica Disto© Distance meter: The **[2nd]** button should be pressed following the Bluetooth link being established. To confirm the correct configuration:

Disto Plus: Take a measurement and then press the **[Enter]** button.

A6: Take a measurement and then press the **[Bluetooth]** button

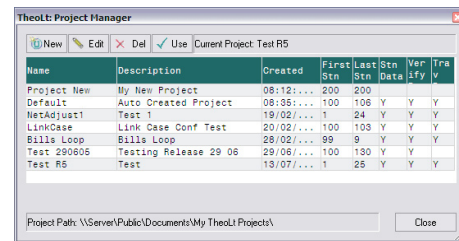



BASIC USE

Create a project:

In addition to the AutoCAD drawing files, TheoLt builds a project database. This database includes:

- Station and Reference Positions.
- Station Occupations (Orientations).
- Height of columnation for each station.
- Position Verification (QA) data.
- Observation data files.
- Network Adjustment data files.



 The first stage of any work should be to create a new project. Select the **[Project]** tab. Click the TheoLt logo button to open the Project Manager.

 Click the **[New Project]** button to create a new project.

Enter the relevant data. Once set, the **[Project Name]** may not be altered as this is also the name of the folder which will contain the data. The **[First Station]** field allows the Station Numbers to be controlled according to the project.

TheoLt: New Project

Project Name:

Description:

Created By:

Stations:

Next Point No:

Project Datum:



Likewise the point numbers. The **[Description]** and **[Created by]** fields offer documentary information only.

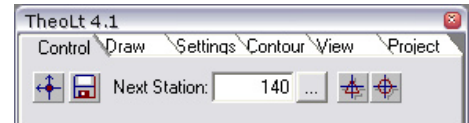
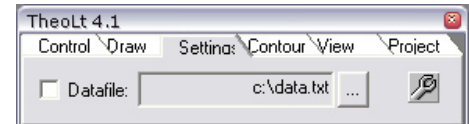
Click [OK] when complete. The new project will be listed.

Double Click the project to activate it.

[Close] the Project Manager.

Create datafiles:

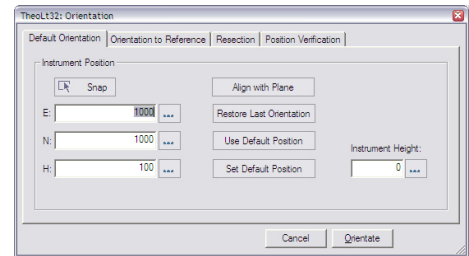
Select the **[Settings]** tab. Use the [...] button to name the datafile to save. Tick the Datafile button to ensure the file is created.



Note: The format of the datafile (fields, field order, data separator) is controlled within the settings. See the reference manual: Datafile Settings for further details.

Default Orientation

During the surveying process, TheoLt must “understand” the location of the instrument in relation to the AutoCAD drawing. This process is called





“Orientation”. During orientation, TheoLt records the location of the instrument and its rotation.

To start a survey, an arbitrary position and instrument rotation may be assumed. In TheoLt, this method is known as a **Default Orientation**.



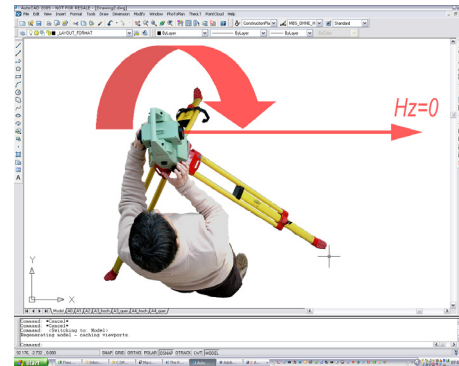
Select the [Control] tab. Click the **[Orientation]** icon.

From the **Orientation Panel**, select the **[Default Orientation]** tab.

Location: The **E N H** fields correspond to the **X Y Z** co-ordinates in AutoCAD. Enter the values you wish to use. TheoLt defaults to 1000,1000,100 to ensure that the coordinates of data always remains positive.

Rotation: Because the default angular direction of AutoCAD is ‘East =0’ the alignment of drawing files for ‘North up’ orientation is achieved by the simple procedure of setting the zero on the horizontal circle to face east. Once the zero is set a default orientation will result in a survey aligned to ‘North’ in WCS.

- Point the end of the telescope to face where the right hand of the drawing is to be.

**New Station Orientation: STA6**

Position: 145.486, 106.397, 0.000

Height of Collimation: 1.565

Raw Orientation: 28.669



- Use the Zero Horizontal angle function.

Enter the instrument height in the correct field in the Orientation panel.

Click **[Orientate]** to set. The orientation panel will close and a pop-up message will be displayed. A Station position symbol (block) will be inserted in the drawing at the correct location. Additionally, the station details will be recorded to the project database

TheoLt: Control Type

Station Name: Sta8

This is the first time this station has been referenced in this traverse. Please confirm whether the station is a control station or not.

☐ Control Station (Fixed)

☒ Unfixed Station

After this, a request for the status of the station will be prompted. The station should be declared as fixed or unfixed. If this dialog doesn't appear it can be activated in "Set Station Status on Insert" in Settings, TheoLt32 Application tab. Select the relevant status. Fixed stations will not be adjusted, unfixed ones will. 2 fixed stations are required in a project.

Collecting Data

After orientation, the **[Draw]** tab is automatically selected. This tab needs to be active to record data in AutoCAD.

The simplest method is to use the **Transparent** option. With this option set, all instrument observations are converted to the AutoCAD 3D space (World UCS) and forwarded to the AutoCAD command line. This allows any AutoCAD

Instrument: Bluetooth TCR

Target Ht: 0.000

Target Ht: 0.000

Angle: 0° 00' 00"

Distance: 0.953

0° 00' 00"		0.953
0° 00' 00"		0.953
358° 00' 00"		
178° 37' 25"	84° 50' 40"	
178° 37' 25"	84° 50' 40"	
178° 37' 25"	84° 50' 40"	
178° 37' 25"	84° 50' 40"	1.543
178° 37' 25"	84° 50' 40"	1.543
164° 01' 20"	84° 50' 35"	0.991
164° 01' 20"	84° 50' 35"	

History Filters



command that allows 3D points to be used to record data. The most common command to use is the AutoCAD `Line` command

Ensure that the data is separated by making good use of the AutoCAD layers function. It is recommended to separate the data by detail type or description.



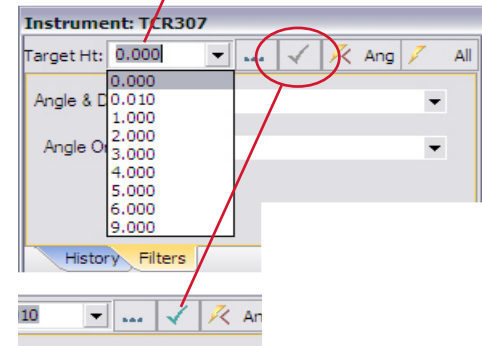
Observations are made either by pressing the **[All]** button on the **Instrument Control Panel** or using the relevant controls on the instrument itself to record an Angle and Distance measurement.

Note: Ensure that the dynamic input in AutoCAD is disabled. (Use the [DYN] button on the status bar)

Each observation is shown the **History** tab of the **Instrument Control Panel**.

Note: Observations may be re-used by a single click within the History list (for example, should the line command not be active).

During collection, points may be observed directly using a reflectorless mode or by observing to a prism mounted on a detail pole. The height of the detail pole is referred to as the **Target Height** and is controlled





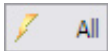
in the **Instrument Control Panel**. For reflectorless measurement the **Target Height** should be set to zero.

The last 10 used heights are stored for quick re-use. Any change in the Target Height List is not activated until the tick icon is pressed.

Observe all the data possible from this station position. Once complete a new station position (orientation) must be established.

Set Out the next Station (foresight)

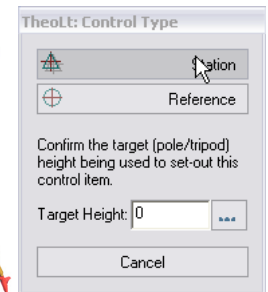
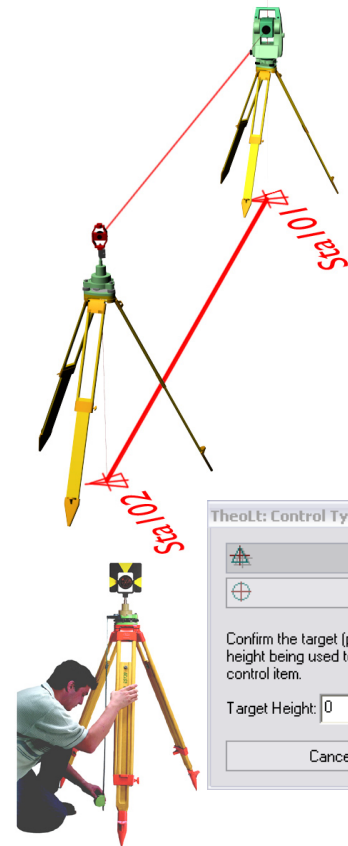
The first step of moving the instrument is to set out the next position (foresight).



Select the **[Control]** tab. Set out a tripod and prism over the next point.

Make an observation: Use the **[All]** button on the Instrument or the TheoLt instrument panel.

The **TheoLt: Control Type** window is displayed.





Enter the Height of columnation of the target prism as the **[Target Height]**.
Choose the type of control symbol to be used.

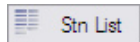
The selected block type is inserted into the current AutoCAD drawing file
and the station details are recorded in the project database.

*Note: The Reference and Station blocks are operationally identical the option
is available for those who wish to make a distinction between occupied points
and a marker for uncoupled ones*



Occupy the Foresight Station

Move the instrument to the Foresight station (and the prism to the old station). In the **Control** tab, select the **[Orientation]** Icon. Select the **Orientation to Reference** tab.



ENTERING THE DETAILS FOR THE STATION POSITION:

Use the **[Stn List]** button to select the new instrument position

Upon selection the Station / Target height confirmation window is displayed.
Two heights are shown; the last used height for the station (or the set-out
height) and the current Target Height from the Instrument Control Panel.

The screenshot shows the TheoLt software interface. The 'Orientation' dialog box is open, displaying the 'Orientation to Reference' tab. It includes fields for 'Instrument Position', 'Reference Position', and 'Observation'. Below these are 'Instrument Height' (0) and 'Target Height' (4.0000) fields, with a 'Swap' button between them. The 'Angle Only (no checks)' checkbox is unchecked. The 'Stn List' button is visible in the bottom left of the dialog.

Below the 'Orientation' dialog is the 'TheoLt: Select Station' window, which displays a table of station data:

Name	East	North	Height
STA124	3.500	8.900	1.100
STA111	123.456	19.990	14.870
STA107	1000.000	1000.000	100.000
STA101	1525.000	2525.000	20.000
STA100	1525.000	2525.000	20.000

At the bottom of the 'Select Station' window are buttons for 'New', 'Insert Stn', and 'Insert Ref'.

Below the 'Select Station' window is the 'TheoLt: Station Target Height' confirmation window. It shows 'Station Name: STA104' and a message: 'This station has a previously used height of 1.568. Please confirm if you wish to use this previous height or the current target height.' It has two input fields: 'Previous Hgt [1.568]' and 'Current Target Height: 0.000'. An 'Ok' button is at the bottom.



Selecting the **[Previous Height]** will close the window and enter this height in the Station Height field.

To use the current Target Height, click **[OK]**.

To use a new height, edit the **Current Target Height** field and **[OK]** when done.



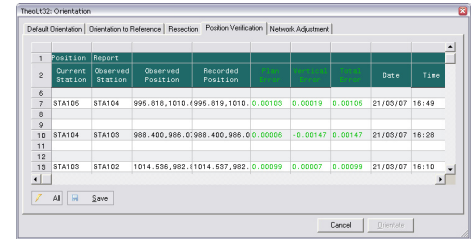
Repeat for the **Reference Position**.

Make an Observation to the prism. The observation details are shown along with the Delta Slope Distance (dD) and delta Heights (dH). These two measurements allow the accuracy of the data to be checked. Both delta (difference) measurements should be within acceptable limits.


Click **[Orientate]** to complete the operation.

Maintaining a record of Orientation Quality

Depending on the settings, the **Position Verification** window may or may not be displayed. If not, select this tab from the **Orientation Panel**.



Position	Plan Error	Vertical Error	Total Error
52,102.418	0.07278	0.00487	0.07294
52,102.418	0.00016	0.00007	0.00017
52,102.418	0.00015	0.00008	0.00017
26,102.414	0.00004	-0.00002	0.00005
26,102.414	0.00005	-0.00006	0.00008

A screenshot of a Mozilla Firefox browser window. The address bar shows the file path: file:///A:\time%20c%20ad%20theone%20beta%20a%20i%20.htm. The page content displays a terminal window with a shell prompt: file:///A:\time%20c%20ad%20theone%20beta%20a%20i%20.htm. The terminal window shows a prompt 'file:///A:\time%20c%20ad%20theone%20beta%20a%20i%20.htm' followed by a shell prompt 'file:///A:\time%20c%20ad%20theone%20beta%20a%20i%20.htm' and a shell prompt 'file:///A:\time%20c%20ad%20theone%20beta%20a%20i%20.htm'.

- | 1 | Position Report | | | | | |
|----|-----------------|------------------|---|-------------------|---------------------|----------------------|
| 2 | Current Station | Observed Station | Observed Position | Recorded Position | Latitude Difference | Longitude Difference |
| 3 | | | | | | |
| 4 | Ita24 | Ita23 | 1001 435, 988 032, 102 4731001 439, 990 019, 102 4760 | 00413 | -0.00191 | 0.00465 |
| 5 | Ita24 | Ita22 | 1001 421, 999 351, 102 4741001 424, 999 352, 102 4780 | 00000 | 0.00295 | 0.00405 |
| 6 | | | | | | |
| 7 | | | | | | |
| 8 | Ita21 | Ita23 | 1001 438, 998 019, 102 4761001 439, 999 019, 102 4760 | 00006 | -0.00005 | 0.00008 |
| 9 | Ita21 | Ita23 | 1001 438, 998 019, 102 4761001 439, 999 019, 102 4760 | 00004 | 0.00001 | 0.00004 |
| 10 | Ita21 | Ita23 | 1001 438, 998 019, 102 4761001 439, 999 019, 102 4760 | 00013 | 0.00002 | 0.00013 |

General conditions for network adjustment:



- Multiple occupations accepted.
- New instrument and target height data acceptable on re-occupation.
- Resection points can be included.
- A current AutoCAD drawing is open for the view of the network diagram.
- Stations cannot be removed from the network.



In the **Control** tab, select the **[Orientation]** icon. Select the **Network Adjustment** tab

Alt: Orientation

default Orientation | Orientation to Reference | Resection | Position Verification | Network Adjustment

Parent Project: Coldham Common 2 Last Occ Stn: STA102 Last Occ Ht: 1.474

1	Network	Adjustment								
2	Name	Observation Data / Station Position	To:	dXY, dZ	C	O	I/E	S		
12	STA100	1000.000 1000.000 100.000								1000.0
13		101°55'24 90°08'28 146.326	STA101	0.0049, 0.0010	5	✓	2			
14		101°53'27 90°06'28 146.326	STA101	0.0055, 0.0006	4	✓	2			
15		273°57'09 89°40'09 37.857	STA102	0.0004, 0.0010	5	✓	2			
16		90°57'07 270°19'54 37.857	STA102	0.0004, 0.0016	4	✓	2			
17		90°57'08 270°19'54 37.857	STA102	0.0005, 0.0016	3	✓	2			
18		1°53'25 269°53'54 146.326	STA101	0.0046, 0.0006	3	✓	2			
19		1°53'25 269°53'54 146.326	STA101	0.0044, 0.0006	2	✓	2			
20		101°53'22 90°06'29 146.326	STA101	0.0057, 0.0046	1	✓	2			
21		101°53'25 90°06'29 146.326	STA101	0.0044, 0.0016	0	✓	2			
22		273°56'54 89°40'11 37.857	STA102	0.0021, 0.0007	2	✓	2			

Alt Save As Run Data Plot View

This window operates very similarly to the **Position Verify** window. The table is built automatically during Orientation and Station Set-out commands.

As the table is opened, the status of all stations will be checked. If any with unknown status (**fixed** or **unfixed**) are encountered, dialogs will be displayed to select the correct status.



Additional observations taken will be added to the table by matching current station and observations to the stations listed in the current project.

If a shot is taken to an existing station a dialog will prompt for the target height. Should the instrument data not match a known station position, a warning dialog will be displayed asking if a new station should be set-out.

TheoLt: Control Type

Station Name: Sta8

This is the first time this station has been referenced in this traverse. Please confirm whether the station is a control station or not.

☐ Control Station (Fixed)

☒ Unfixed Station

TheoLt: Station Target Height

Station Name: STA104

This station has a previously used height of 1.568. Please confirm if you wish to use this previous height or the current target height.

Previous Hgt [1.568]

Current Target Height: 0.000

Ok



Rounds of observations can be taken to stations in the network, face left and face right measurements are recorded; the condition of the each observation is reported as delta dist and delta height in the **Error to Setout** column. Confirmation of the instrument and target heights is shown as a 'tool tip' when the cursor is paused over the observation fields. The Network Adjustment table will build up the observation data and give an indication of the quality of the sighting to the stations by highlighting in red the observations that are out of tolerance.

If the new station option is declined an observation error message will advise of the nearest station and the error.

Observations may be excluded from the net adjustment calculation using a double click on the tick symbol In the I/E (include /exclude) column, rejected observations are then marked with an x symbol.

[Save As] will the current view of the table as Excel, txt or HTML format in the project folder.

[View] will plot the observation lines of the network in the current drawing in a discrete layer.

The screenshot displays the TheoLt software interface. At the top, the 'Orientation' window shows a table with columns: Position, Report, Current Station, Observed Station, Observed Position, Recorded Position, Error, Delta Dist, Delta Height, Date, and Time. The table contains data for stations STA104, STA105, and STA106. Below the table, there is a grid with columns labeled C, O, I/E, S, and a 'Result' column. A tooltip is visible over the 'I/E' column, displaying 'Instrument Height: 1.501' and 'Target Height: 0.000'. Two error dialog boxes are shown at the bottom. The first dialog box, titled 'theoLts', contains the text: 'No existing station was found at this location. The nearest station is: Stazi which is 0.073 error. Do you wish to set out a new station?' with 'Yes' and 'No' buttons. The second dialog box, also titled 'theoLts', contains the text: 'The observation is in error by 0.073. The maximum allowed error is 0.010. Do you wish to increase the tolerance and allow the observation? Selecting No will discard the observation.' with 'Yes' and 'No' buttons.

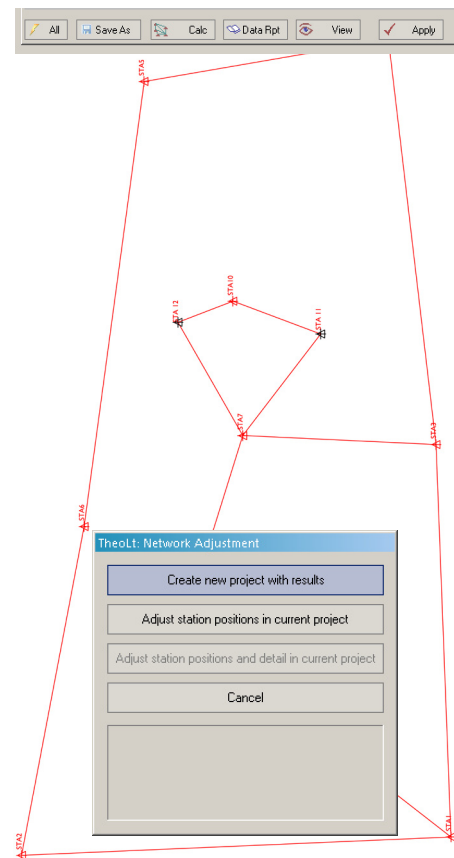


[Calc] will perform a 3D least squares fit on the network. Reports on network precision and performance will be shown in the relevant columns. An incremental backup of the pre-calculated data is saved to the project folder on each use of the calc function.

[Report] generates a text file of the current network data with results for cross checking.

[Apply] applies the corrections to the project and optionally adjusts the AutoCAD drawings. Pre-adjustment and Post-adjustment drawings are created to. See Handling Network Adjusted data in CAD for details of the apply function.

The data in the Net Adjustment table is retained automatically and will be in the current project on restarting TheoLt.





Resection: An alternative method of Orientation

In many situations within building survey, it is not possible to set out a foresight by conventional means. I.e. The next instrument location may not be visible. In these situations **Resection** may be used.

Note: In fact, for internal building survey, this is usually the quickest method as only a single tripod is required.

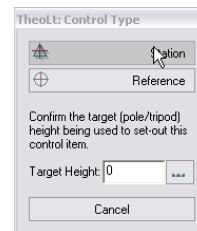
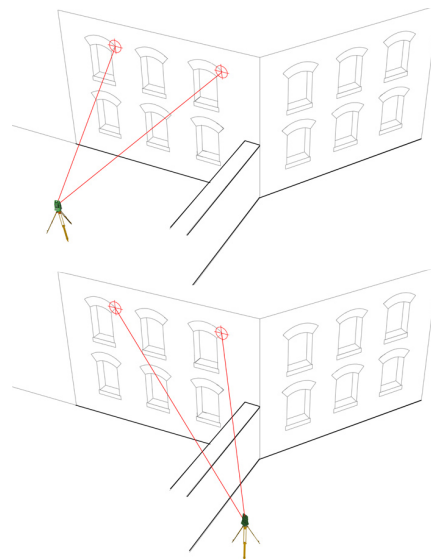
Before moving the instrument, set out 2 (or more) new control points (usually the reference type is used as the instrument will not be located on either of these points). The location of these points must be visible from the intended station location. The diagrams to the right show using **Resection** to negotiate a wall.

Note: The precision required in setting out the Reference Points needs to be optimal as it is a control measurement. When setting out Reference positions with Reflectorless Measurement care should be taken to avoid range and obliqueness errors.

The instrument may now be moved to the new location.

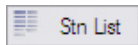


From the **Control** tab, select **Orientation**. Select the **Resection** tab.





Resection requires that Instrument Observations are matched to Reference positions in the drawing. The method is to pick a Reference position from the drawing and then make the corresponding observation with the instrument. Once a matching set has been collected, the next set can be started. The command requires 2 or more complete sets to calculate the instrument position.



Use the **[Stn List]** button to select the first of the reference stations. As with Orientation to Reference, the Station / Target Height confirmation window will be shown. Choose the correct height.

Make an observation to the Reference Point. As the location of the instrument is unknown at this stage, no error checks are possible.

Click the **[Next]** button and repeat for the second and subsequent Reference Points.

Once all of the Reference Points have been observed, click **[Calculate]**. The station location is calculated. TheoLt re-checks the calculation and if the results are within specified limits, no messages are displayed.

The screenshot shows the 'TheoLt32: Orientation' dialog box with the 'Orientation to Reference' tab selected. It contains fields for 'Reference Position' (with 'Snap' and 'Stn List' buttons), 'Observation' (with an 'All' button), and 'Information' (showing 'Points Collected: 0' and 'This Point: 1'). There are also 'Target Height' and 'Instrument Height' fields. Below the main dialog, the 'TheoLt: Select Station' window is open, displaying a table of stations. At the bottom right, the 'TheoLt: Station Target Height' window is open, showing a confirmation message for station STA104.

Name	East	North	Height
STA124	3.500	8.900	1.100
STA111	123.456	19.990	14.870
STA107	1000.000	1000.000	100.000
STA101	1625.000	2525.000	20.000
STA100	1625.000	2525.000	20.000

TheoLt: Station Target Height

Station Name: STA104

This station has a previously used height of 1.568. Please confirm if you wish to use this previous height or the current target height.


Previous Hgt [1.568]

Current Target Height: 0.000

Ok



All Resection observations are added to the Network Adjustment table.



The screenshot shows a toolbar with five buttons: 'All', 'Save As', 'Run', 'Report', and 'View'. The 'Run' button is highlighted with a red rectangle. It features a colorful icon with red, green, and blue elements.

[illegible]

Page: 34





Check the results carefully. Use the available reports (**[report]**) and **[Save As]**

Select **[Apply]** There are 3 options for applying the correction;

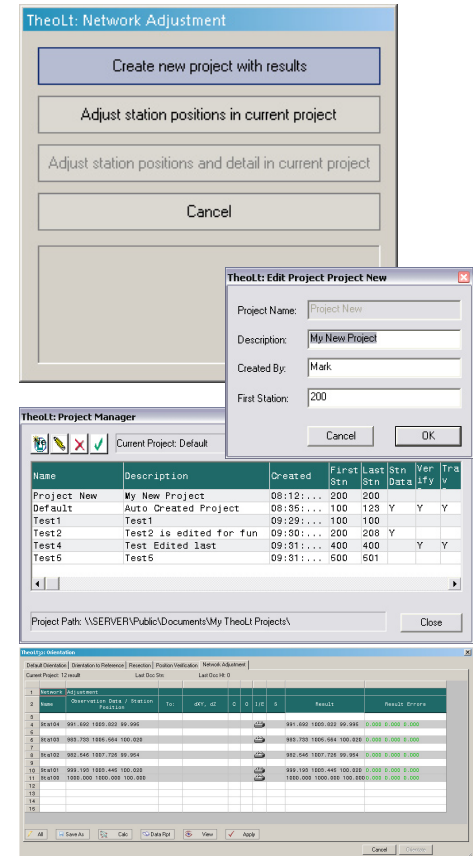
- Create new project with results
- Adjust station positions in current project
- Adjust station positions and detail in current project

TheoLt Pro automates backup of both the computation and the drawing data. When the adjustment is applied pre and post adjustment drawing files are generated.

1.Create new project with results

This option opens the **New Project** dialog to create a new project using the adjusted results: All of the stations are inserted into the new project with the status FIXED and therefore cannot be adjusted in the new project. This option is ideal for creating an adjusted network and then forwarding that network to be used by others for data collection.

Once created, the new project needs to be set as the current project for use.





- **[Close]** the orientation panel.
- Select the **[Project]** tab.
- Open the **[Project Manager]**.
- Double-Click the new project in the list to activate.

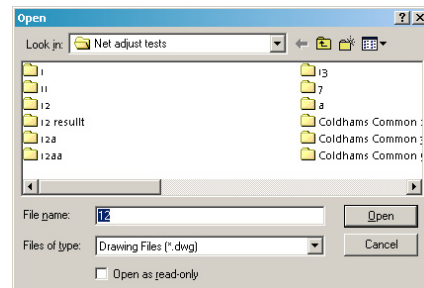
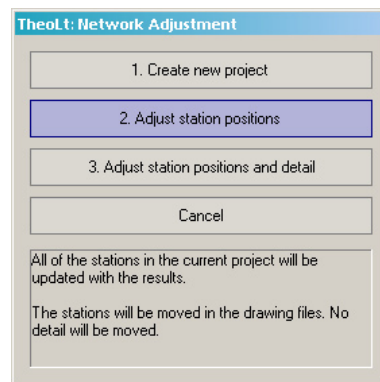
2. Adjust station positions in current project.

Use this option to adjust the station positions in the current project and selected drawings: this option only moves the stations, other data collected from the stations is NOT adjusted. This option is based on the assumption that the work is for the production of a control drawing with stations only that is adjusted for subsequent re-occupation of the stations post- adjustment for the recording of detail.

The adjusted station positions can be applied to the current project and selected drawing files. 2 copies of each drawing are automatically made: pre-adjustment (for backup) and post-adjustment (with the adjusted stations).

Before adjustment, the drawings to be adjusted should be saved.

Upon selecting this option, the **Open** window is shown. It is possible to select multiple drawing files for adjustment, use the **[ctrl]** key.



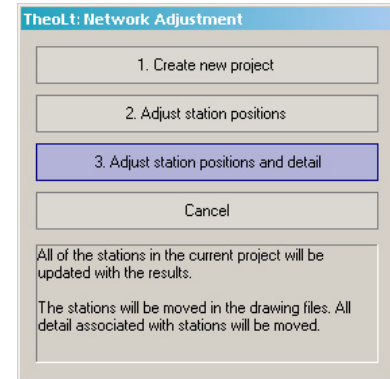


Click **[OK]** when selected.

The correction is applied to the stations but not the observation rays from the view function: the displacement from the insertion point of the station from the endpoints of the observation rays reveals the applied correction.

3.Adjust station positions and detail in current project

The adjusted station positions can be applied to the current project and selected drawing files. This option functions as for option 2 but with the additional benefit that data captured from each station is also adjusted.





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A GUIDE TO TRAVERSING

The follow outlines a basic procedure for starting a new project and building a Traverse in TheoLt

1. Set up a Project

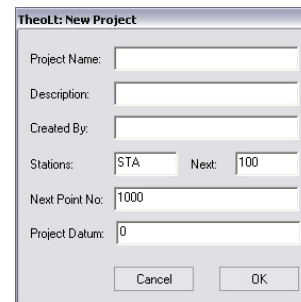
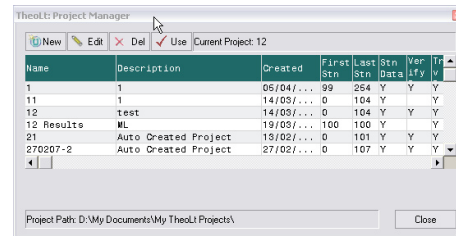
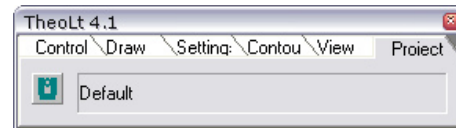
Create a new project, check that the project parameters are to your liking and make the project current.

The project is selected from the table and confirmed with the **[Use]** tick.

If you need to know more about a given project select it and use the **[edit]** function to reveal its properties.

Note that projects can only be deleted by removing the appropriate folder from the system. The del function will only hide the project from the list in the current TheoLt session. The root folder for projects is set in the TheoLt settings tab, spanner button, under TheoLt 32 Application settings, 'project base path'.

Open an AutoCAD drawing and save it to the project path: this drawing will be the plot of the network. If you wish, you may collect radial





observation data from each station on occupation and include them in the adjustment on completion of the network.

2. Choose orientation tool at 1st station

Switch to the Control tab. You now have choices dependant on several factors, viz:

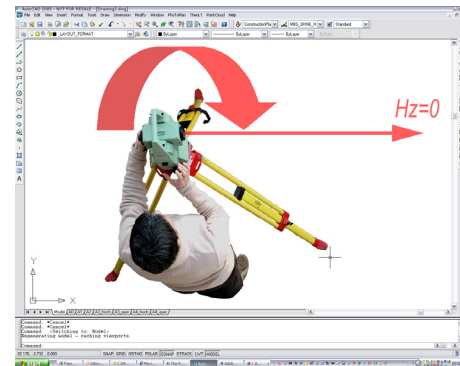
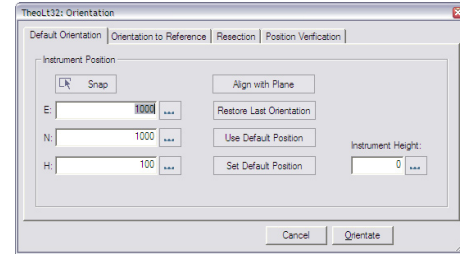
2.1 Arbitrary orientation:

If you are setting up for the first time on a new site you may wish to use arbitrary station values: perform a **default orientation** (first setting the $Az=0$ on the TST at a convenient angle for fitting your survey on screen in CAD). Remember to insert the instrument height correctly.

Since you have used the Azimuth angle on the instrument to orient (i.e. an arbitrary RO),

2.1.2 Set out reference station: close the orientation dialogue and set out the backsight and foresight stations, using the control tab in TheoLt and recording their target heights correctly.

2.2.3 Add the orientation and reference data to the network: Open the Network Adjustment panel, you will be asked whether the status of the station that you are set up on is [Fixed] or [Unfixed]. Choose



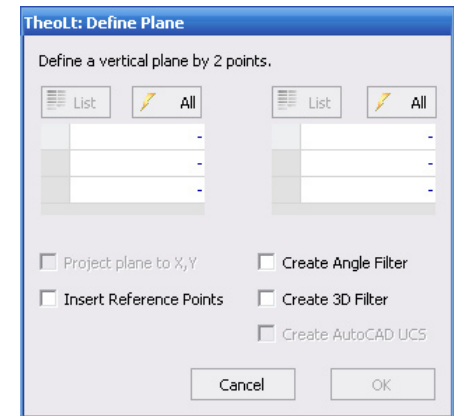


[**Fixed**] and take a shot to the backsight (at the first setup, this will also usually be the last station on your traverse). TheoLt will ask whether you want a new station added at this position – say [**yes**], insert the correct target height and choose [**Station**] rather than [**Reference**]. You will now be asked whether the Station should be [**Fixed**] or [**Unfixed**]. Since this backsight is also going to be the closing station on your traverse, it is best to declare it unfixed. Now, with the Network Adjustment panel still open, take your sets (see 'Taking the Sets') to this station. You will see the measurements being added to the list.

2.1.4 You are now ready to set out the Forward station. With the Network Adjustment panel still open, take a shot to it. Check [Yes] for a new station to be added, insert target height and choose [**Station**] as the control type. This time it is preferable to flag the station as [**Fixed**] (since TheoNetAdjust requires two fixed stations in a traverse). Now, take your sets (see 3 below) to this station. You can then proceed to step 4.

2.2 Align to a plane.

An alternative method for assigning the orientation of the co-ordinate system is available: TheoLt will align the co-ordinate system to a chosen plane (e.g. the principal façade of a building). Select the [Align with





plane] option, shot in the 2 points to define the plane (it is vertical by default) and proceed as for arbitrary orientation at 2.1.2 above.

2.3 Import station values:

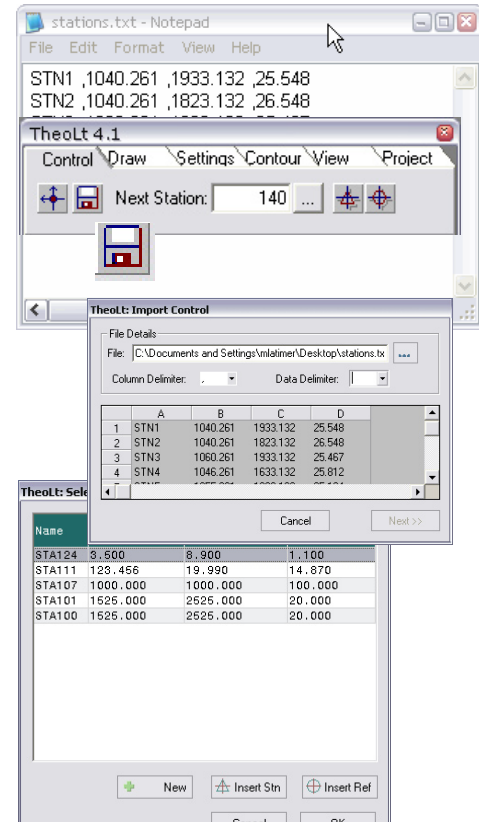
If you have existing control from previous survey these stations can be added by importing the station list into the current project using the **[Import Control]** option at the **[Control Tab]**, the stations should be flagged appropriately as **[Fixed]** or **[Unfixed]** when the Network Adjustment panel is opened.

2.4 Orientation to Reference:

You can perform an **[Orientation to Reference]** to get a starting orientation using two of the stations from an imported list. Once the orientation is complete you are now ready to set out the Forward station (i.e. the first station on your new traverse). With the Network Adjustment panel open, take a shot to it. Check **[Yes]** for a new station to be added, insert target height and choose **[Station]** as the control type. Flag the station as **[Unfixed]**. Now, take your sets (see 3 below) to this station. You can then proceed to step 4.

2.5 Occupying stations added to a station list:

The Station List will show the stations available as loaded in the project station list .dat file.(see 2.3)





2.5.1 Adding stations to the list:

If you wish to add station co-ordinates to the list (e.g: GPS derived co-ordinate values) for two or more stations, the stations may be added in the **[Station List]** panel (accessed from Orientation to Reference). Click **[New]** and enter the number in the New (Manual) Station panel along with the co-ordinates and close the panel with 'ok'. The new station will be added to the station list.

2.5.2 Add the station data to the network:

Open the Network Adjustment panel TheoLt will prompt for the new stations to be added and assigned a fixed or unfixed status. It is advisable to choose one of the GPS positions as Fixed (usually the one you will use as your starting position) and the other(s) as Unfixed since GPS derived positional data is rarely as precise as that derived by Total Station and will require adjustment.

2.5.3 Use Orientation to Reference

To get your starting position and bearing and switch to the Network Adjustment panel. You are now ready to set out the Forward station. With the Network Adjustment panel still open, take a shot to it. Check [Yes] for a new station to be added, insert target height and choose **[Station]** as the control type. This time it is preferable to flag the station

TheoLt: Select Station

Name	East	North	Height
STA124	8.500	8.900	1.100
STA111	123.456	19.990	14.870
STA107	1000.000	1000.000	100.000
STA101	1525.000	2525.000	20.000
STA100	1525.000	2525.000	20.000

Buttons: New, Insert Stn, Insert Ref, Cancel, OK

TheoLt: New (Manual) Station

Name: STA

Easting (X):

Northing (Y):

Height (Z):

Buttons: Cancel, OK

TheoLt: Station

Station Name:

This station has used height of 1 confirm if you want previous height target height.

Previous Hgt [1.568]

Current Target Height:

Buttons: Ok



as **[Fixed]** (since TheoNetAdjust requires two fixed stations in a traverse). Now, take your sets (see 3 below) to this station. You can then proceed to step 4.

3. Taking the sets.

TheoLt will auto detect the target station and prompt for confirmation of the target height for each station found in your round. On completion of the first round (on face 1) transit to face 2 on the last target and repeat the round on face 2.

Note that you will get running feedback on the quality of the rounds shot by shot. The observation count will increment in the o (observation) column of the network table. The quality of the shots is indicated in the colour coded dxy/dz column.

Poor shots should be flagged by a double click in the **[I/E]** column (include/exclude in computation). Excluded observations will be marked with a red cross in the table.

Note a 'round' of observations is a completed sequence of shots to the required stations on one face, a 'set' is at least 1 round on each face of the instrument). Because TheoLt uses a network adjustment method

TheoLt: Station Target Height

Station Name: STA104

This station has a previously used height of 1.568. Please confirm if you wish to use this previous height or the current target height.

Previous Hgt [1.568]

Current Target Height:
0.000

Ok

16	STA100	1000.000	1000.000	100.000						
17		950°16'45	269°54'58	146.324	STA101	0.0068	0.0114	2	✓	2
18		950°16'46	269°54'58	146.324	STA101	0.0067	0.0115	1	✓	2
19		170°16'56	90°04'47	146.324	STA101	0.0005	0.0003	0	✓	2
20		170°16'56	90°41'03	146.334	STA101			0	✓	1

C	O	I/E	S	Result
0	✓	✗	2	
0	✓	2		
0	✓	1		

Instrument Height: 1.501
Target Height: 0.000



you are not restricted to back sight foresight observations: you may include as many different stations as you wish in the observation set.

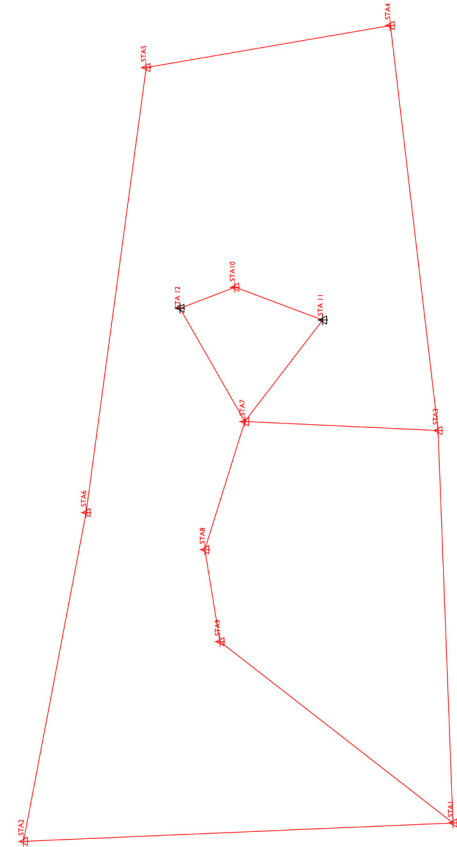
4.Advance to foresight:

Move the instrument to the former Forward station position, set up the new Forward station position. Open the Orientation to Reference panel; perform the orientation using the last station you occupied as the backsight. When oriented, open the Network Adjustment panel, and take your sets to the backsight. You are now ready to set out the next Forward station. With the Network Adjustment panel open, take a shot to it. Check [Yes] for a new station to be added, insert **[Target Height]** and choose **[Station]** as the control type. Flag the station as **[Unfixed]**. Now, take your sets to this station.

5.Progress the loop:

Repeat step 4, stepping forward one station at a time until you have closed the loop, Use the **[view]** option to update the CAD plot of the network in the current drawing file.

Note that the lines on the diagram represent observations; the arrow head indicates the direction of measurement.





6. Closing the loop:

On measurement back to a previously occupied station you will be prompted for the height of target: if you have reset the target over the point enter the new target height and take the closing rounds.

7. Save, Report, Calculate and Apply :

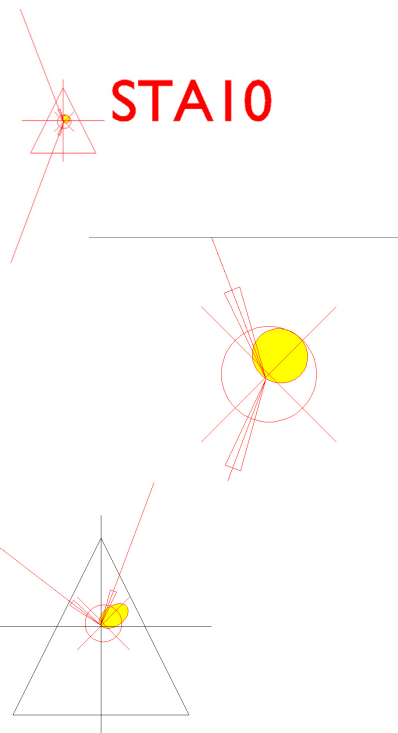
On completion of the observations (remember this is a network so there will be no prompt for the status of a loop closed or other wise) Back up and review the collected data BEFORE proceeding with the adjustment:

- Write out a report which will save the precision data of the observation sets.
- Save the data as a pre-adjust file
- View the network diagram in AutoCAD to check for missing legs,

If there are any these should be address BEFORE applying the adjustment.

Once you are satisfied you have secured the unadjusted observation data select [Calc] and the table will be reformatted to include the adjusted positions of the stations. The distributed station displacements are displayed in the dxy/dz column.

Note: [Calc] may be re-run as many times as required. No data is





adjusted until the [Apply] is selected.

If you are happy with the distribution Select **[Apply]** and choose an option:
See page 35 for options.

Note: If the distributed error is excessive do not apply the calculation but remove the observations indicated as of excessive error by a double click in the [I/E] (include/exclude in computation) column marked as a red cross in the table, re run the calculation and check the result. If there is insufficient data available to compute the network no calculation will be achieved.



UNDERSTANDING THE LIMITS OF GRAPHICAL SURVEY TECHNIQUES

The checks in TheoLt Basic are based on comparison between CAD and measurement sent from the instrument there is no statistical check on multiple observation. TheoLt uses single face angle and distance observations only. Should you require statistical checking and adjustment, the TheoLt Pro version allows this.

Checking the work as you go:

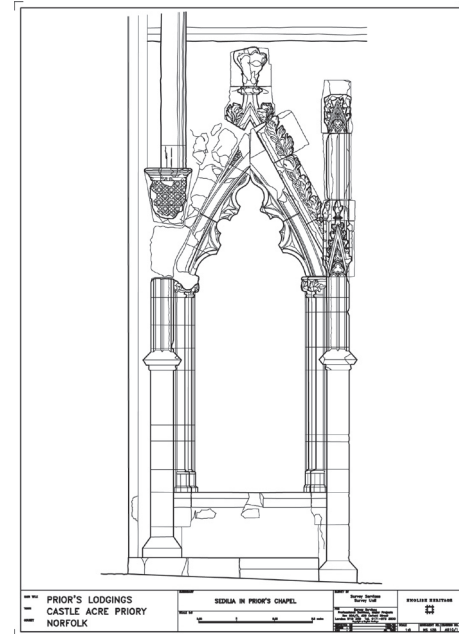
Distances can be checked using AutoCAD dist and ID commands. Coordinates can be checked by reverting to WCS and using list.

REDM measurement tolerances:

At close range (0.3 to 10m) the TCR performs better than the quoted $\pm 3\text{mm}$. The main source of error is obliqueness of targeting. This is particularly important with reflectorless resection observations.

3D data fits are much more demanding than 2D:

The taped height of instrument is a weakness that can be overcome by using zero heights for resected stations: the stations for detail can be used without local heights provided the overall control has precise heighting.





PROCEDURE IN THE FIELD: SOME BASIC PRINCIPLES

- Each new site is a new project
- Each new Instrument set up is a new orientation
- Record instrument and target heights and check they are entered correctly
- Save the drawing file in the project folder
- Always work with a levelled instrument- if it is dis-levelled re centre the Instrument, correct the level and retake the orientation.
- Keep equipment clean and dry
- Always close the instrument case when it is not in use: keeping the case clean will protect the instrument.
- Work from the whole to the part: trace the longest lines first especially when working with the prism



TheoLt will help you get the most out of reflectorless measurement for building surveys; 3D geometry like this vault can be tackled with confidence as the surveyor can check the work as it progresses.



AUTOCAD TIPS FOR SURVEYING WITH THEOLT

- Use viewports to see the whole and the part.
- Use `Plan World` to check the orientation has worked OK
- Use layers to separate work by day, station, and surveyor.
- `Freeze` off layers you don't need : it is always worth the time taken to get a clear view of where you are working
- 3D views will let you keep a check on heights
- Watch out for `filedia` it will need to be reset to 1 from time to time: use a customised button to re-set it when the `saveas` dialog fails.



FREQUENTLY ASKED QUESTIONS

Why are no lines appearing in my drawing, how do I get measured lines into AutoCAD?

There are 2 routes here: Once you have the 3 requirements of 1 instrument comms, 2 a link to AutoCAD and 3 an orientation established, select the draw tab and either select a drawing tool or select transparent to use standard AutoCAD commands (like line) to draw.

AutoCAD 2007 won't accept data from TheoLt, why?

The most common reason for this is that AutoCAD has been set to use the Dynamic input function rather than the command line. Switch off the Dynamic input and make sure AutoCAD is running with a command line!

Why doesn't polyline work when I use TheoLt?

AutoCAD's polyline is a 2D command, TheoLt sends 3d data to AutoCAD so the 2nd point is rejected because it has 3rd dimension to it. Use 3Dpoly or one of the draw tools to proceed.

Why doesn't circle or arc work when I use TheoLt?

Because, like polyline, these are 2D commands. If you need to place a circle or arc in the drawing use one of the draw tools in TheoLt, these will place a 3point arc or circle in true 3D space in AutoCAD

When I save my drawing or open a new one I don't get a browser for the file name?

TheoLt can reset the AutoCAD variable filedia to zero, Reset it to 1 to recover the windows file dialogue, it's a good idea to customise a button to reset it to 1.



Where is the instrument data stored and how to I read it ?

The data is written to a number of files depending on the options you have selected in settings. The folder location is set by default to on install as : c:\Documents and settings, My TheoLt Projects . The data files can be opened and read in Windows notepad.