System 1200 Newsletter – No. 42
Mixing GPS and TPS Data (2)

Continuing From The Last Newsletter…

The last newsletter gave an overview of the "general problem" of mixing GPS and TPS data and the theory behind **Map Projection Scale Factors**, **Height Scale Factors** and **Geometric Corrections**. It also explained the concept of grid and ground coordinates.

This newsletter applies this theory with examples as to how a total station user can use **Geometric Corrections** in the field. We will also answer the questions about how they are actually computed and when should they be used.

Note that in all the examples below, it is the **CONFIGURE TPS Corrections** panel, **GeomPPM** page on the TPS1200 instrument where the **Geometric Corrections** are configured.

Computing Geometric Corrections

Geometric corrections can be computed **Manually**, **Semi Automatically** or **Automatically** on a TPS1200 instrument. Which way should be used and when? There is no definitive answer – the answer is: It depends!

What is clear is that before conducting any survey with a TPS (or even GPS) instrument, the surveyor must know the existing "control" or "coordinate system" in which he is working to ensure his measurements fit the existing control.

Only when this is known can the appropriate corrections be applied…

Manually Computing Geometric Corrections

It is possible to manually compute the **Geometric Corrections** by settings the **Calc Scale** to **Manually**.

Example 1

Imagine you are using a total station in a quarry where a number of control points are placed around the quarry - the actual coordinates of the control points may be on an "arbitrary" grid (say 100, 500) – and it is simply not known if any **Geometric Corrections** should be used.

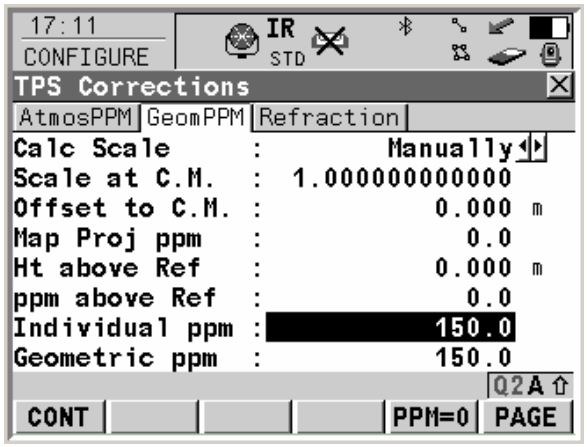
In this case it is most likely not required to use any geometric corrections - simply press the **F5(PPM=0)** button.

Since geometric corrections are not being used the total station is measuring **ground distances** and **ground coordinates** will be computed.

Example 2

Imagine you are working in an area or on a construction site where the **Geometric Corrections** are known - they may be written on existing plans and you must use this scale factor to tie into the existing control.

In this case simply enter the given scale factor in the **Individual PPM** prompt.



What distances will now be measured and what coordinates will be computed? **Grid** or **Ground**?

Since we are using geometric corrections, the distances being measured are not ground distances. They could be grid distances but we do not absolutely know for sure…

The scale factor given on the plan may be the "correct" scale factor for this location, therefore correctly converting the measured distances to grid distances and computing grid coordinates.

What is more likely however, is that this is a scale factor to allow the measured distances to fit the existing control – and this existing control may or may not be based on true grid coordinates.

Imagine what would happen if we were to make a traverse using the same scale factor for all the traverse station setups. The previous newsletter stated that the **Map Projection Scale Factor** changes as you move around an area and the **Height Scale Factor** will also change since it is quite likely that you will be changing elevation during the traverse.

This means that even though the given scale factor is suitable for a specific area; it is not suitable outside of that area.

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For these reasons it could be said that the distances and coordinates being computed when using "fixed" geometric corrections such as in this example, are **pseudo grid distances** which generate **pseudo grid coordinates**.

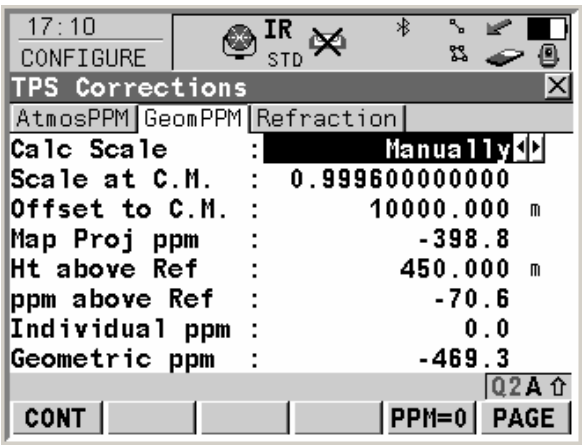
Semi Automatically Computing Geometric Corrections

Imagine you are working in an area and you must measure grid distances and tie into existing grid coordinates.

In this case, set the **Calc Scale** setting to **Manually**.

Enter the scale of the projection at the central meridian in the **Scale at C.M.** field and the offset (perpendicular distance) at which you are working from the central meridian in the **Offset to C.M.** field. This will compute the **Map Projection Scale Factor** – **Map Proj ppm**.

Also enter the elevation where you are working in the **Ht above Ref** field. This will compute the **Height Scale Factor** - **ppm above Ref**.



These 2 scale factors are then added together to compute the **Combined Scale Factor** – **Geometric ppm**. (It is also possible to "add" individual corrections to the **Geometric ppm** – enter the additional ppm values in the **Individual ppm** field).

If all this information is entered correctly, the geometric corrections will be used and the total station will measure **grid distances** and **grid coordinates** will be computed.

Remember that it will be necessary to correctly re-enter the **Offset to C.M.** and **Ht above Ref** information at each new station setup. If not, the correct geometric corrections for that location are not used, the wrong corrections will be applied and true grid distances and coordinates will not be computed. You will instead be measuring "pseudo-grid" distances and computing "pseudo-grid" coordinates.

Automatically Computing Geometric Corrections

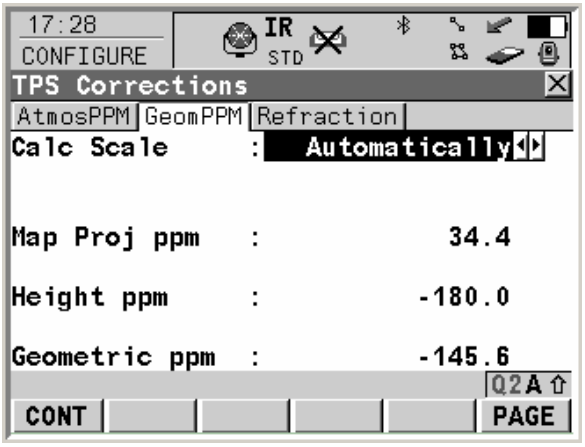
The previous example of semi-automatically computing geometric corrections was not very "user-friendly". Is there an easier way to ensure that at each and every total station instrument setup the correct geometric corrections are automatically computed and applied?

The answer is yes!

This is possible because the TPS1200 instrument knows "where it is" at each instrument setup. And since the instrument knows where it is, the **Map Projection Scale Factor** and the **Height Scale Factor** can be automatically computed. The user isn't required to input additional information!

The only thing to be aware of is that the job being used must contain the correct coordinate system for the area where the survey is being conducted. This would normally be the "national" coordinate system or State Plane Zone – or it could also be a OneStep or TwoStep coordinate system.

Once the appropriate coordinate system is attached to the job being used then you set the **Calc Scale** field to **Automatically** in the **CONFIGURE TPS Corrections** panel.



The corrections for the current setup stored in the instrument are displayed.

As the total station instrument is moved from setup to setup and the **Setup** application is used, new geometric corrections are automatically computed for each new location.

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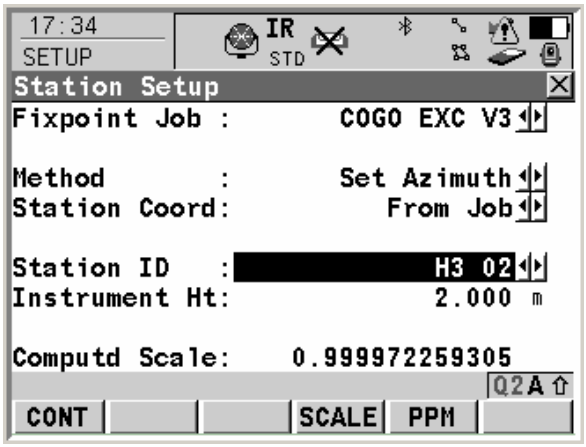
This can be seen during the setup routine – as the instrument station is selected in the **Station ID** field, then the **Computed Scale** is updated.



The automatic computation of the geometric corrections also works for resections. The "final" geometric corrections to be used can of course only be calculated once the resection is complete and the instrument"knows where it is".

The automatic computation of the geometric corrections also works for SmartStation setups.

If it is required to work in true grid coordinates, then the option to automatically compute geometric corrections is an enormous benefit for the user.

Simply turn on, setup the instrument and start working – the geometric corrections have already been computed for that location and are being applied. Grid distances and grid coordinates are being computed.

An Efficient Way To Work

Remember, use configuration sets! If you often alternate between measuring ground distances (using the "manual way" of computing geometric corrections) and measuring grid distances (using the "automatic way" of computing geometric corrections) then use 2 different configuration sets.

Set up the first configuration set to manually compute the geometric corrections and name the configuration set, for example, **Ground** and set up the second configuration set to automatically compute geometric corrections and name the configuration set, for example, **Grid**.

Now when you start any onboard application (Survey, Stakeout or another selection) then simply select the appropriate configuration set in the application begin panel.

Summary

Before conducting any survey with a TPS (or GPS) instrument, the surveyor must know the existing "control" or "coordinate system" where he is working and ensure his measurements fit the existing control.

Another way of looking at this is that it must be known how the control points being used were derived. This will then determine what geometric corrections should be used.

Only if this is known can the correct settings be made on the TPS1200.

If the existing control was established without using a scale factor or using a fixed scale factor, then the same geometric corrections should be entered and used on the instrument. In this case, **ground** or **pseudo grid** distances are measured and **ground** or **pseudo grid** coordinates are being computed.

If the existing control was established based on true grid coordinates then using the correct coordinate system will allow the geometric corrections to be computed automatically. In this case, **grid** distances are measured and **grid** coordinates are computed.

The next newsletter will look at how to fit GPS measurements into existing control and summarize the 3 newsletters.

Please contact your local Leica representative if there are specific topics you would like covered in these newsletters.

We welcome all suggestions for TPS1200, GPS1200, specific applications or LGO. We look forward to receive your ideas.

BA Surveying & GIS
Geosystems Division

- when it has to be **right**

Leica Geosystems