COGO+ Tutorial

By *Simple Geospatial Solutions*

Purpose: Transforming point coordinates from one coordinate system to another by matching common points in both coordinate systems.

Method: The Helmerts program available in COGO+ Std and COGO+ Pro.

The **Helmerts** program in COGO+ Pro applies a two-dimensional conformal coordinate transformation, also known as a four-parameter similarity transformation. The parameters are computed by matching control pairs in two separate coordinate systems. Although a two-dimensional coordinate transformation is performed, the control pairs can be matched 3D to compute an average elevation shift.

Example 1

In this example we have an existing project in NAD27 UTM coordinates with the following points:

```
1,5366358.241,470146.326,22.112
2,5366207.625,470340.584,17.416
3,5366043.182,470551.834,14.643
4,5366215.676,470348.232,0.000
5,5366290.117,470401.822,0.000
6,5366123.497,470616.424,0.000
7,5366048.800,470552.152,0.000
```
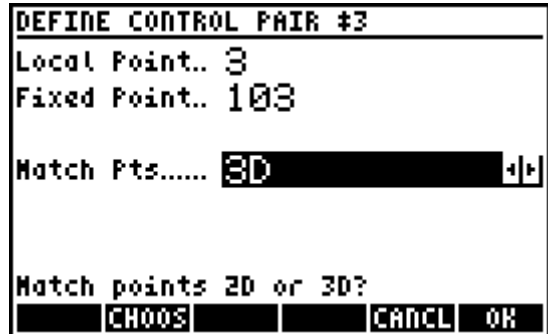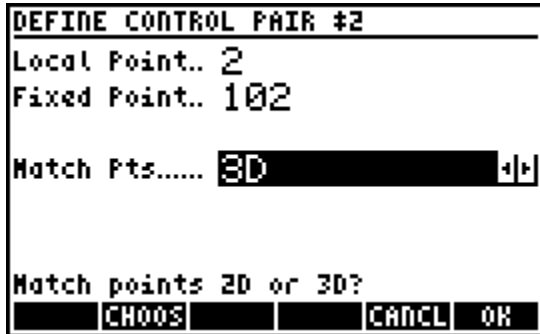
Points 1, 2 and 3 are control points with published NAD27 coordinate values from historical records. These control points now have updated NAD83 published coordinate values. These NAD83 coordinates have been stored as points 101, 102 and 103:

```
101,5366557.381,470050.977,22.107
102,5366406.762,470245.234,17.411
103,5366242.317,470456.485,14.639
```

The goal of the transformation is to calculate NAD83 coordinates for points 4-7. With all the points stored in the current job, open the **Helm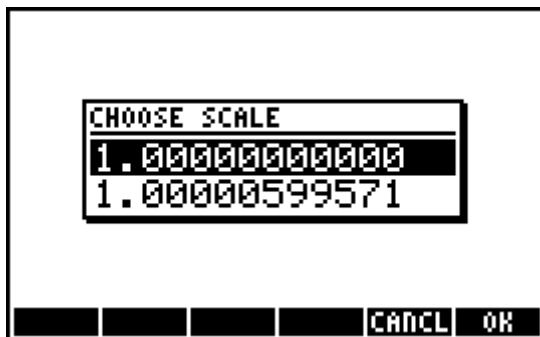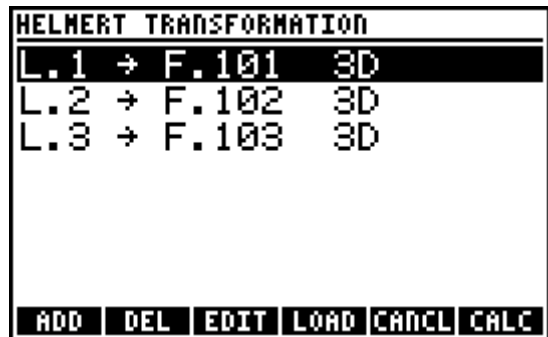erts** program from the ADJUstments menu (shortcut key ⬚5⬚). Next press ⬚Fl⬚ **ADD** to define the control pairs, see screen captures.

```
HELMERT TRANSFORMATION
...

 ADD | DEL | EDIT | LOAD | CANCL | CALC
```

```
DEFINE CONTROL PAIR #1
Local Point.. 1
Fixed Point.. 101

Match Pts...... 3D          ◄|►

Match points 2D or 3D?
   | CHOOS |      | CANCL | OK
```

```
DEFINE CONTROL PAIR #2
Local Point.. 2
Fixed Point.. 102

Match Pts...... 3D          ◄|►

Match points 2D or 3D?
   | CHOOS |      | CANCL | OK
```

```
DEFINE CONTROL PAIR #3
Local Point.. 3
Fixed Point.. 103

Match Pts...... 3D          ◄|►

Match points 2D or 3D?
   | CHOOS |      | CANCL | OK
```
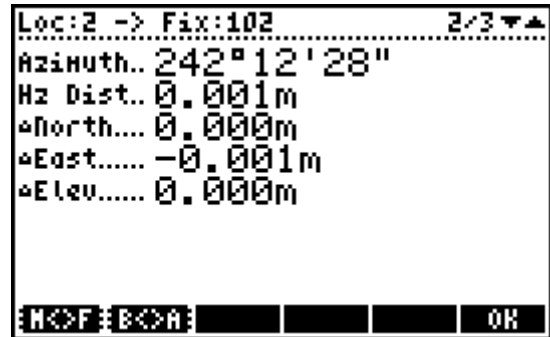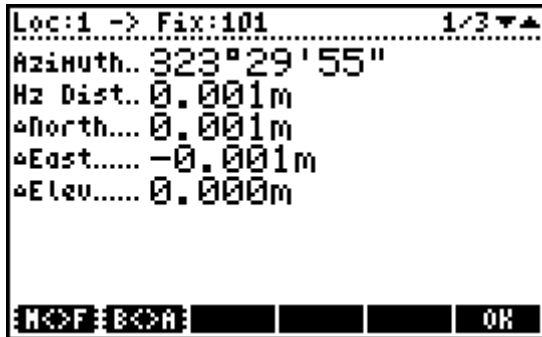
Press [F5] **CANCL** when the last control pair is defined to return to the main **Helmerts** screen where all the entered control pairs are now listed.

Press [F6] **CALC** to calculate the transformation. A choose box allows the selection of a scale factor. Generally the scale factor should be forced to be exactly
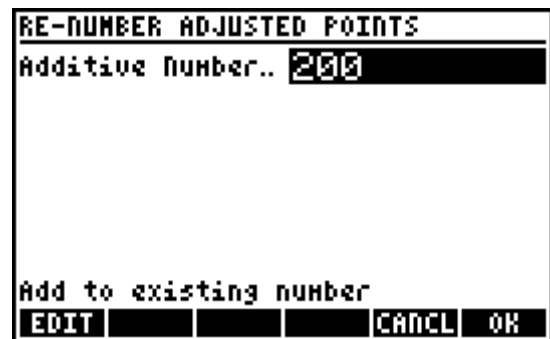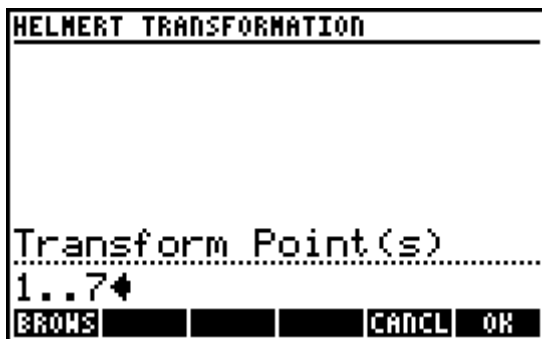
```
HELMERT TRANSFORMATION
L.1 → F.101   3D
L.2 → F.102   3D
L.3 → F.103   3D




 ADD | DEL | EDIT | LOAD | CANCL | CALC
```

1, ie no scaling. Choose 1.00000000000 as the scale factor to continue with the calculation. The solution screen displays the calculated parameters (scale, rotation, translation north, translation east), the standard deviation in the northing and easting, and also the calculated average elevation shift.

```
CHOOSE SCALE
1.00000000000
1.00000599571



              | CANCL | OK
```

```
HELMERT SOLUTION
Scale........ 1.00000000000
Rotation.. 0°00'02"
Trans[N].. 202.725m
StDev[N].. 0.001m
Trans[E].. -136.281m
StDev[E].. 0.001m
Trans[Z].. -0.005m
StDev[Z].. 0.001m
 N<>F RESID EXPRT | CW | BACK | CONT
```

Press ⎣F2⎦ **RESID** to review the residuals for each control pair. This is a good way to catch an outlier within the defined control pairs.

```
Loc:1 -> Fix:101          1/3▼▲
Azimuth.. 323°29'55"
Hz Dist.. 0.001m
⌐North.... 0.001m
⌐East...... -0.001m
⌐Elev...... 0.000m




N<>F B<>A              OK
```

```
Loc:2 -> Fix:102          2/3▼▲
Azimuth.. 242°12'28"
Hz Dist.. 0.001m
⌐North.... 0.000m
⌐East...... -0.001m
⌐Elev...... 0.000m




N<>F B<>A              OK
```

Press ⎣F6⎦ **OK** to return to the solution screen. If satisfied with the results press ⎣F6⎦ **CONT** to continue with the transformation. Next, enter the points you wish to transform, in this case we will transform points 1 to 7. Points 1, 2 and 3 are transformed to allow a post-transformation inverse check to the matching control point. Depending on Adjusted Points setting (Under General Settings) you may or may not see the following screen asking for an additive point number.

```
Loc:3 -> Fix:103          3/3▼▲
Azimuth.. 116°04'34"
Hz Dist.. 0.002m
⌐North.... -0.001m
⌐East...... 0.002m
⌐Elev...... -0.001m




N<>F B<>A              OK
```

```
HELMERT TRANSFORMATION




Transform Point(s)
1..7♦
BROWS              CANCL  OK
```

```
RE-NUMBER ADJUSTED POINTS
Additive Number.. 200





Add to existing number
EDIT               CANCL  OK
```
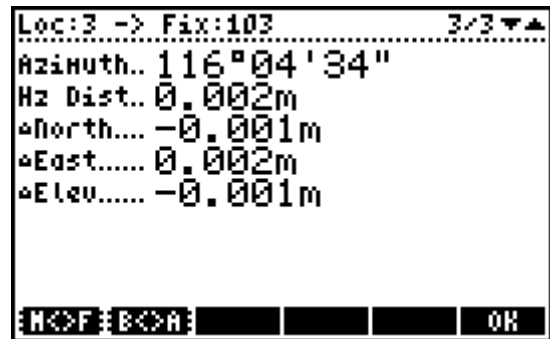
The additive point number allows the adjusted (transformed) points to be saved as new point numbers, leaving the original points unchanged. The alternative is to simply overwrite the transformed points with the new coordinate values. In this example I will use a additive number of 200, meaning Point 1 will be transformed to Point 201, Point 2 to 202 etc.

Finally, once the transformation is complete we can check the inverse between Points 201 and 101, 202 and 102 and 203 and 103. The inverse results should match the residuals as computed.

```
INVERSE POINTS 201-101
Azimuth..323°29'55"
Hz Dist..0.001m
Sl Dist..0.001m
Grade......-23.300 %
..................................
▵North....0.001m
▵East......-0.001m
▵Elev......0.000m
:N<>F:B<>A:COORD:SWAP:LOOP:  OK
```

```
INVERSE POINTS 202-102
Azimuth..242°12'28"
Hz Dist..0.001m
Sl Dist..0.001m
Grade......-42.006 %
..................................
▵North....0.000m
▵East......-0.001m
▵Elev......0.000m
:N<>F:B<>A:COORD:SWAP:LOOP:  OK
```

The inverse results agree with the residuals, a quick check to verify everything went as it should have.

The transformed coordinates are:

```
201,5366557.380,470050.978,22.107
202,5366406.762,470245.235,17.411
203,5366242.318,470456.483,14.638
204,5366414.813,470252.883,-0.005
205,5366489.254,470306.474,-0.005
206,5366322.632,470521.074,-0.005
207,5366247.936,470456.802,-0.005
```

```
INVERSE POINTS 203-103
Azimuth..116°04'34"
Hz Dist..0.0017m
Sl Dist..0.0019m
Grade......38.5581 %
..................................
▵North....-0.0008m
▵East......0.0016m
▵Elev......0.0007m
:N<>F:B<>A:COORD:          OK
```