

GPS localization – with Carlson Software

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A New Angle on Surveying

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GPS Localization with Carlson Software

-- Agenda --

- Definition of GPS Localization
 - Land Surveying and Construction Surveying
- Geoids, Projections and Grid-to-Ground
 - Overview Video (Nick Ford, PLS – Alfred State College)
- Localization with SurvCE/SurvPC
 - Best Practices and Maybe I Shouldn't have done that...
- Processing your Localization File within SurvCE/SurvPC
 - Where is this and how-too's, reports and more...
- Live Presentation – and... as time allows, we will process real world data
- Q&A



GPS Localization with Carlson Software

GPS Localization – What and Why?

Definition of GPS Localization...

Localization is performed to fit the observed GPS positions to the project datum at the land surveying or construction job site site. Mathematically, localization is a coordinate transformation between the GPS and the job coordinately specific system.

When GPS RTK techniques are used to help us '*get our GPS equipment on the job...*' (mathematically), localization is crucial as it adjusts our GPS equipment (mathematically) to make up for the in-accuracy's that are inherent errors in the GPS equipment and you and the mathematical information given to us for any job site...



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GPS Localization – What and Why?

Definition of GPS Localization... (cont)

Localization uses a set of coordinates of points in your coordinate system. Commonly, the number of points that can be used in localization depends on the size of project area and the type of the adopted GPS hardware and/or software.

These points should be well distributed in the project area. One measure of the quality of localization is the maximum values of horizontal and vertical residuals, which depend on the accuracy of the GPS-derived coordinates of the points.

Bottom Line... Get your GPS 101 Skills Mastered as they will be tested with GPS Localization



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GPS Localization – What and Why?

There is no perfect technique to accomplish this transformation. Several methods exist, but none are exact in the conversion and all have limitations.

In this session we will discuss GNSS coordinates in general and then look more closely at the method of calibrating multiple points on the ground to GNSS measurements.

Bottom Line... Get your GPS 101 Skills Mastered as they will be tested with GPS Localization



GNSS Ground Localizations - Best Practices

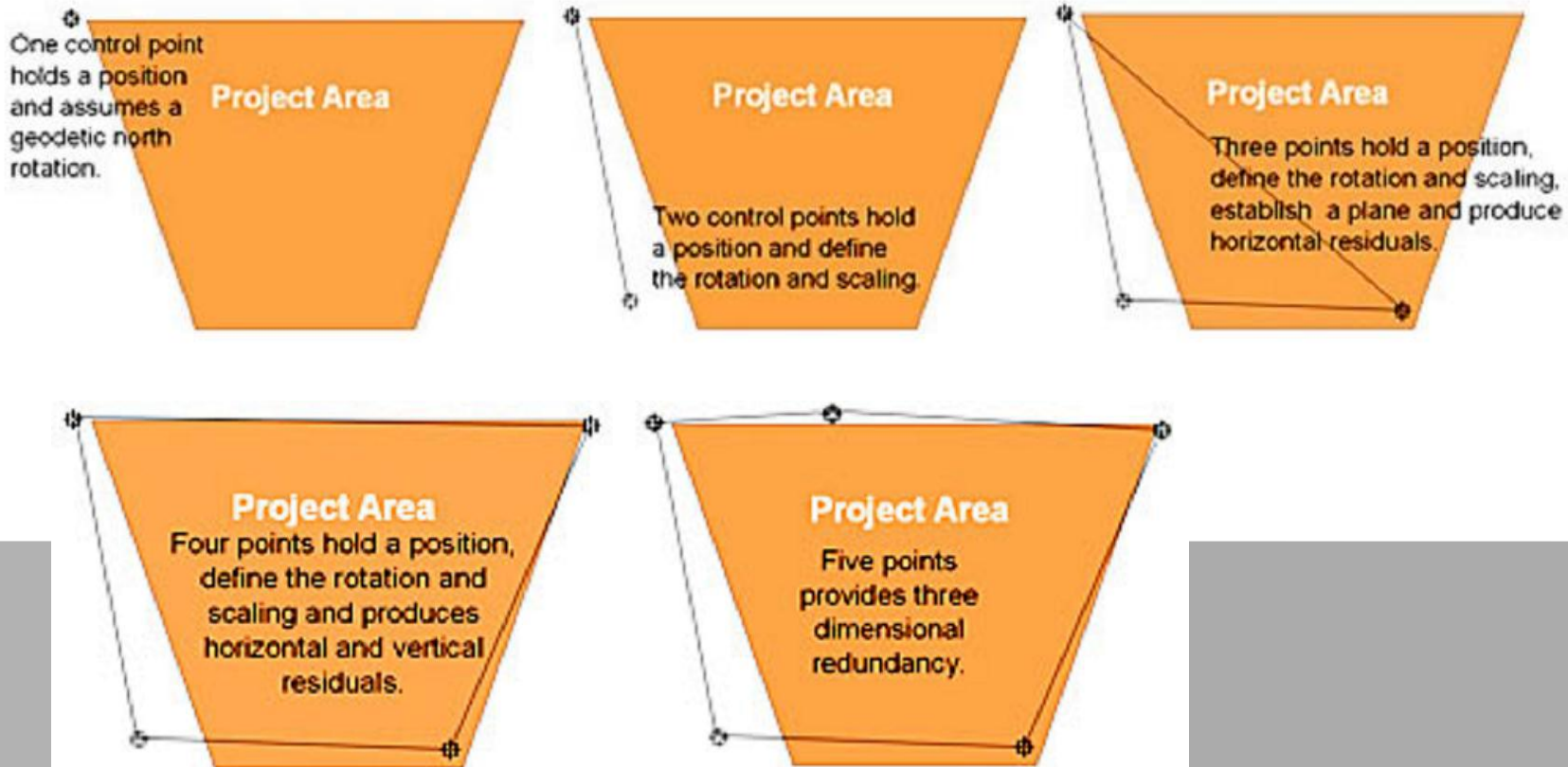
The *key* ingredients for a successful one-step transformation are:

- 1) One, Two or Five or more, three dimensional control points surrounding or within the job site. These points should have a clear view of the sky in all directions
- 2) GNSS measurements on the control points with 1 to 2 centimeters of precision
- 3) Application software that does a good job of calibrating your site
- 4) Validation on additional control points throughout the job site to verify coordinate conversions



GNSS Ground Localizations - Best Practices

A multi-point transformation relies on having good local coordinate values for the control points, having these points spread evenly around the perimeter or even outside of the project area and with a great view of the sky for the GNSS measurements.



GNSS Ground Localizations - Best Practices

If a **single control point** is compared to a GNSS measurement, an exact association can be made between the control northing, easting and elevation and the measured latitude, longitude and ellipsoid elevation. The rotation of the coordinate system would probably assume a geodetic north orientation and differences between grid and ground distances would likely exist

Recommend using... Coordinate values you are comfortable using for Your Job

One control point holds a position and assumes a geodetic north rotation.

Project Area

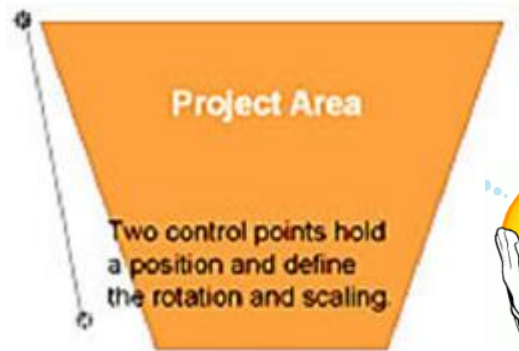


Is 'Grid-to-Ground' and option for your right now...?

Localization				
System	TS	GPS	Points	By Helmert
Localization Method				
Multi Point Method:	Plane Similarity ▼			
One Point Azimuth:	State Plane Grid ▼			
Geoid File:	None			
Geoid Interpolation Method:	Quadratic ▼			
☒ Use Grid to Ground:	1.000076699355			

GNSS Ground Localizations - Best Practices

If there are two control points being compared against GNSS measurements, this manages correctly the rotation of the coordinate system and adjusts the scale difference between grid and ground distances. But it does not lock in a three dimensional plane for the elevations. Even though elevations are held at the two points, this does not prevent the mapping plane from tilting transverse to the line created by these points.



Is 'Grid-To-Ground' and option for your right now...?

Localization

System	TS	GPS	Points				By Helmert
Pt ID	Northing	Easting	Elevation(ft)	H Res(ft)	V Res(ft)	H On	V On
1	5453.7051	5121.6631	843.0300	0.000	-1.823	Y	N
2	5070.9509	5007.8104	841.2000	399.315	0.000	Y	Y

Scale:1.000000 ☒ 2pt Rotate Only

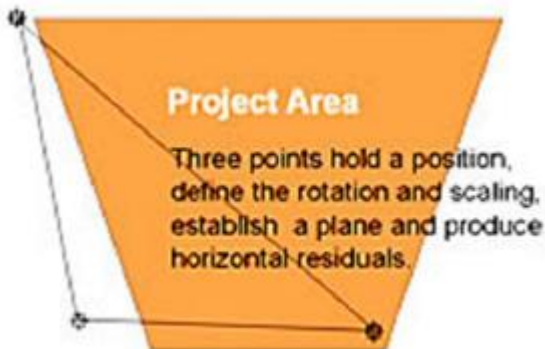
Avg HRes:0.0000 Avg VRes:0.0000

Add	Delete	Edit	On/Off
Load	View	Monitor	Save

GNSS Ground Localizations - Best Practices

When three control points are used, this checks the orientation and scaling of the project and the software should begin to show residuals of the best fit for the northings and eastings.

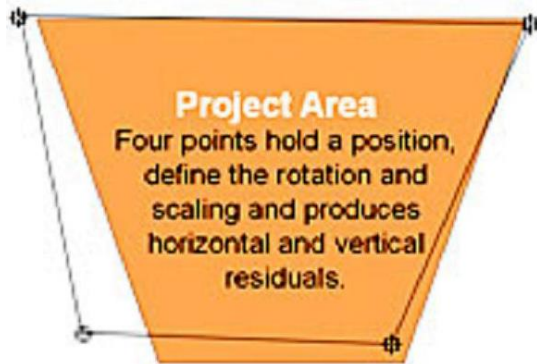
Three control points also locks in the mapping plane.



GNSS Ground Localizations - Best Practices

As the fourth point is added to the localization, a truer picture of the overall horizontal fit can be observed through the residual values generated obey the software.

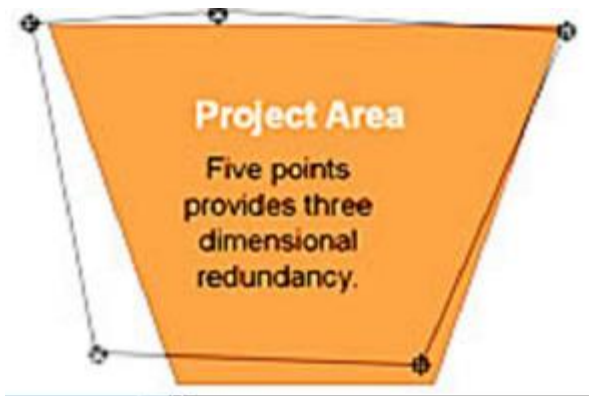
Depending upon the presentation of the data, these should be very small values. When expressed in RMS, a user should generally expect values in the centimeter or sub-centimeter range. This fourth point in the localization not only tightens up the best fit horizontally, it also gives an indication of how well the fit is going vertically by producing vertical residuals.



GNSS Ground Localizations - Best Practices

As five or more points are added to the localization, a reliable indication of both the control values and the measured values begins to emerge.

Five points provides redundancy for both the vertical and horizontal components of the localization. This redundancy exposes any misfits in the systems. You now have values needed to assess the quality of your calibration. Most software packages allow each localization point to be held in a horizontal and/or vertical sense.



GNSS Ground Localizations - Best Practices

Type of Localization within Carlson SurvCE/SurvPC

There are 3 types of Localization Methods within Carlson SurvCE/SurvPC:

1. Plane Similarity:

- Let's have a short discussion on this... 'Best Fit' But, lets be careful
- Plane similarity does a rotation, translation and scale

2. Rigid Body:

- Plane Similarity and Rigid Body both use a best-fit least-squares transformation. The difference is that the rigid body method does a transformation with a translation and rotation, without scale.



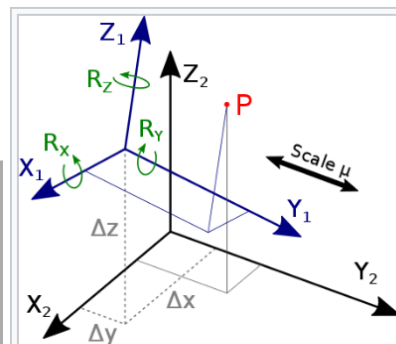
GNSS Ground Localizations - Best Practices

Type of Localization within Carlson SurvCE/SurvPC

3. Helmert (7 Param):

- The **Helmert transformation** (named after Friedrich Robert Helmert, 1843–1917) is a transformation method within a three-dimensional space. It is frequently used in geodesy to produce distortion-free transformations from one datum to another. The Helmert transformation is also called a **seven-parameter transformation** and is a similarity transformation.
- Often used by other manufactures for 3D Machine Control Localization

- All of this and more can be found within the [SurvCE/SurvPC Manual](#)
- www.survce.com



The transformation from a reference frame 1 to a reference frame 2 can be described with three translations Δx , Δy , Δz , three rotations R_x , R_y , R_z and a scale parameter μ .

GNSS Ground Localizations - Best Practices

-- Final Thoughts --

There will always be misclosure when using a one-step transformation with more than two points. The goal is to manage the misclosure down to acceptable levels.

With a GNSS receiver whose specification is 1 centimeter horizontally, this is a good target. Let's assume that a calibration was performed using five points and all of the reported residuals are less than one centimeter.

Does this mean that the localization is good to that precision throughout the job site? The answer depends upon the location of the calibration points. If the five points were scattered throughout the interior of the job site, the localization is not as strong as if all of the points surround the project area as in the example above.



GNSS Ground Localizations - Best Practices

-- Final Thoughts --

The misclosure of the localization is a statement about the amount of error at each particular point. This error can be interpolated and shrink when approaching the center of the localization or it can be extrapolated and grow when leaving the bounds of the localization points. This is the reason that calibration points need to be at the perimeter or even outside the project area. All the error is interpolated down to zero at the center of the localization.



THANK YOU | CONTACT INFO

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