Date October 24, 2014

TO: Surveyor Connect Readers and
Other interested persons

FROM: Earl F. Burkholder, PS, PE, F.ASCE

RE: Localization and the Global Spatial Data Model (GSDM)

This item is written in response to an October 2014 thread on the Surveyor Connect Bulletin Board asking "Exactly what is localization?"

http://surveyorconnect.com/index.php?mode=thread&id=285796

My response (following) was posted as a link to the Global COGO, Inc. web site.

"Localization" can be variously described as:

- Finding a way to use 3-D geospatial data on a 2-D plane of the user's choice.
- Using 3-D geospatial data within an acceptable approximation of a flat earth.
- Using plane surveying latitudes/departures within the context of the global "cloud."
- Other . . .

The end result of "localization" is obtaining ground level horizontal distances/directions and using those vector components as plane surveying latitudes and departures. The user is responsible for choosing the point about which to localize. With due diligence, the value of the third dimension can also be preserved. There is no one "correct" mathematical procedure for localization due to many factors – often involving a map projection. But, it helps to understand that a map projection is strictly a 2-D mathematical model and does not handle the third dimension.

The GSDM provides all the benefits of localization (and of a low distortion projection) using readily understood equations. Furthermore, the three-dimensional integrity of 3-D geospatial data can be readily preserved when using the GSDM. The GSDM equations are all public domain and easily programmed – spreadsheet or otherwise. In fact, spreadsheet programs for using the GSDM are available (www.globalcogo.com/BKpgms.html) for download and/or use.

The following 3-D diagram facilitates understanding and cited articles provide information on how to use the GSDM. The author is happy to answer questions via email from the self-learner. Oh yes, although the information is available on the Global COGO, Inc. web site, (www.globalcogo.com/refbyefb.html) you can also purchase the book, "The 3-D Global Spatial Data Model" by Earl F. Burkholder.

In particular:

- The spreadsheet programs (BKpgms link above) should be used along with the 3-D diagram shown below. The "BK" programs are keyed to the "BK" links between boxes on the 3-D diagram.
- #7 on the (refbyefb) link above contains mapping equations for low distortion projections (LDP's). This is one method for computing LDP's. Other methods also exist.
- #19 on the same list is a series of articles appearing in Professional Surveyor in 1998 and 1999. They were written specifically for surveyors.
- #20 on the same list is a rigorous summary of GSDM equations.

Notes with regard to using the GSDM include:

- Box #12 on the 3-D diagram shows project datum (LDP) coordinates. Not recommended.
- Box #9 on the 3-D diagram includes the 3-D local coordinate differences – $\Delta e/\Delta n/\Delta u$.
- Box #11 on the 3-D diagram is the P.O.B. and is "user-selected" from any/all points in the cloud of points in the project.
- When the local coordinate differences are attached to the P.O.B. then the project has been "localized." The user may select any coordinate values for the P.O.B. Meter units are standard, but foot units can be employed if the local coordinate differences are converted from meters to feet. At no time should geocentric coordinates or geocentric differences be converted to feet. Local coordinate differences in meters may be converted to feet for area computations and for courses shown on a survey plat.

An example project is http://www.globalcogo.com/3DGPS.pdf.

- The survey is "localized" on the SW Corner of Section 31 (selected as the P.O.B.).
- All courses on the plat give 2-D latitudes/departures with respect to the SW Corner.
- As shown in Table 1 of #7 (referenced above), "localized" distances remain valid within 1/1,000,000, for points within about 9 km of the P.O. B.
- Units of feet and meters are both used on this project. Note, in the article that the geocentric coordinates and geocentric coordinate differences are meters. Foot units are applied only to the values written on the final plat – see on following page.

Advantages of using the GSDM include:

- Values on plat are in terms of local tangent plane latitudes/departures.
- No grid scale factors, no elevations factors, and no elevation factors are involved.
- No state plane coordinates, no zones, and no map projections are involved.
- The user views all points from the user-selected P.O. B.

Finally, a manuscript for the Second Edition of the 3-D GSDM book is being written. In addition to current content, the Second Edition will contain sections on least squares, spatial data accuracy, LDP's, and various applications such as drone navigation, intelligent vehicle guidance, underground mapping, localization, development of orthophotos, scale/elevation factors and others.

The 3-D Global Spatial Data Model (GSDM) Diagram

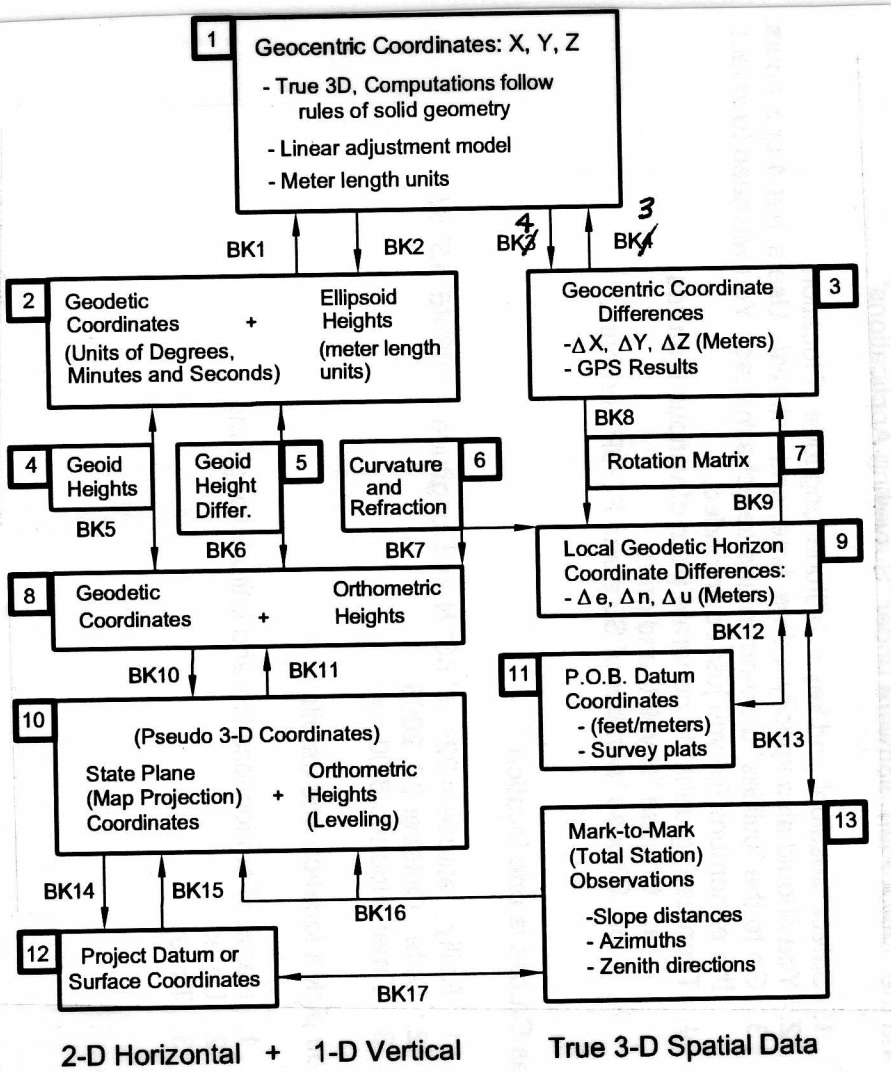

Figure 1.4: Diagram Showing Relationship of Coordinate Systems

From Pt	To Point	Azimuth D M S	St. dev. Seconds	Distance	St .dev
SW Cor	W Qtr Cor	0 00 46.7	+/- 1.5	2,639.357 ft	+/- 0.027 ft
W Qtr Cor	NW Cor	0 02 54.5	+/- 1.4	2,639.889 ft	+/- 0.026 ft
NW Cor	N Qtr Cor	89 32 26.7	+/- 2.1	2,617.399 ft	+/- 0.019 ft
N Qtr Cor	NE Cor	90 28 13.7	+/- 2.1	2,661.492 ft	+/- 0.019 ft
NE Cor	E Qtr Cor	180 02 32.6	+/- 1.5	2,640.808 ft	+/- 0.027 ft
E Qtr Cor	SE Cor	180 01 05.2	+/- 1.5	2,639.222 ft	+/- 0.027 ft
SE Cor	S Qtr Cor	270 02 17.4	+/- 2.1	2,639.807 ft	+/- 0.020 ft
S Qtr Cor	SW Cor	269 59 52.3	+/- 2.1	2,638.955 ft	+/- 0.020 ft

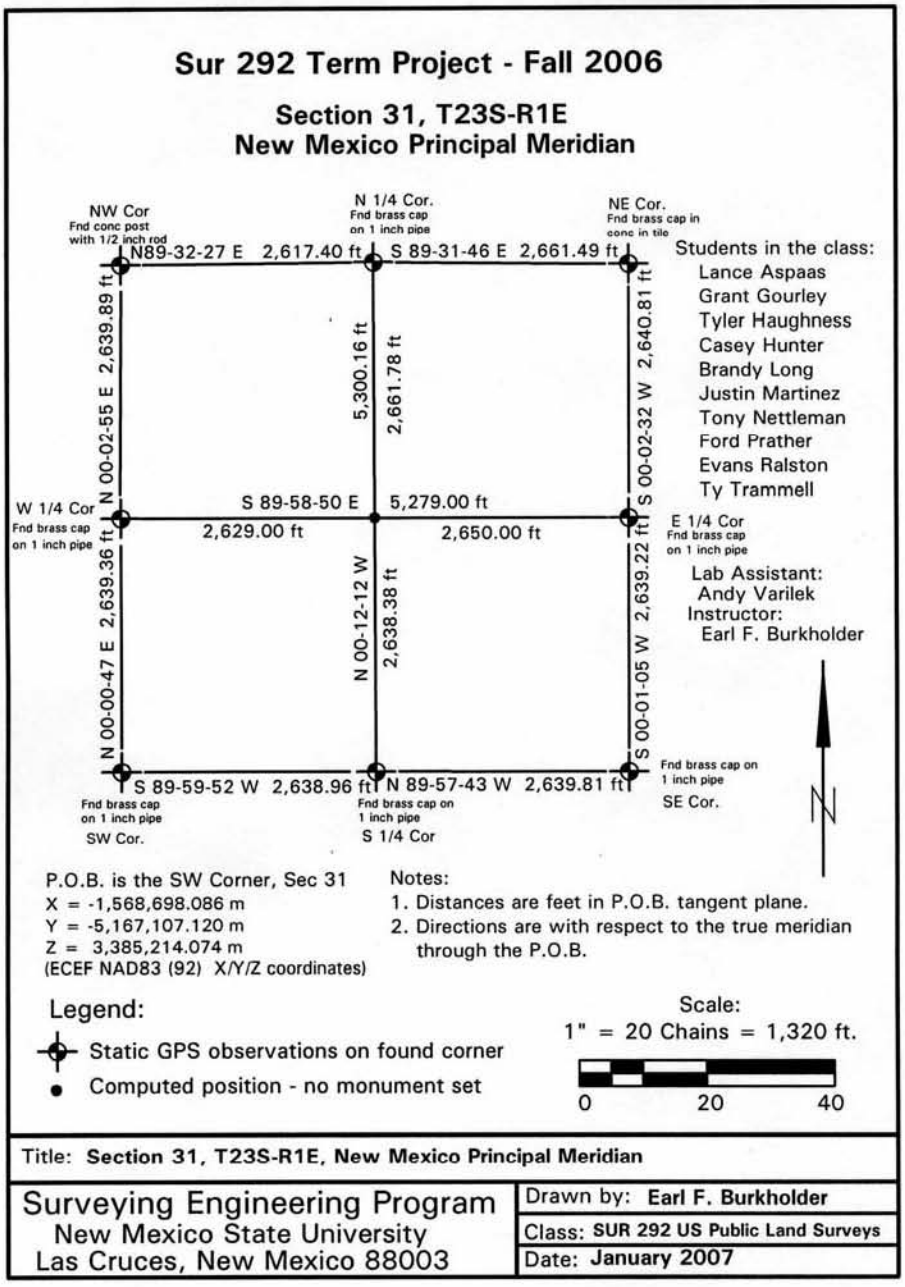

Figure 3 Plat of Survey – Section 31, T23S-R1E, New Mexico Principal Meridian