Numerical Example Showing Distance Distortion
And Portraying Benefits of Using the
Global Spatial Data Model (GSDM)

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A significant driving force behind adoption of an integrated 3-D global spatial data model arises in the engineering, surveying, mapping communities in attempts to portray a curved earth on a flat map. In the past, that has been approximated using a map projection. It is impossible to map a curved earth on a flat map without distorting two of three geometrical elements - distance, angle, or area. A conformal map projection – used by many disciplines worldwide - preserves angles. An angle on the ground is the same as the corresponding angle on the map. Distances and areas are distorted but angles are preserved on a conformal projection. The challenge is to limit the amount of distortion – especially distances - to an acceptable level.

The philosophical reasoning behind justification for using a 3-D spatial data model is discussed at www.globalcogo.com/setepaper.pdf.

The challenge for spatial data users in many disciplines worldwide is set forth at www.globalcogo.com/challenge.pdf.

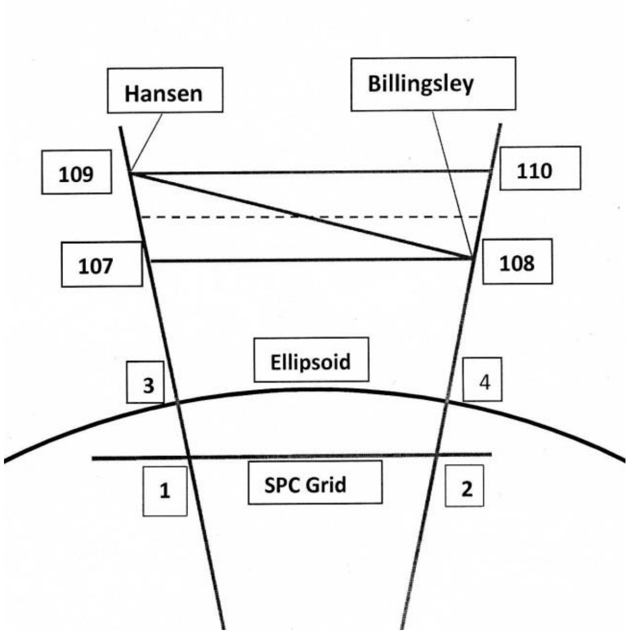
A high-level description of the genesis of the Global Spatial Data Model (GSDM) is given at www.globalcogo.com/gsdm-eos.pdf.

A technical definition of the GSDM is posted at www.globalcogo.com/gsdmdefn.pdf.

A dramatic example of costly consequences that could have been avoided by adopting and using a model that accommodates the characteristics of 3-D digital spatial data is given at http://www.globalcogo.com/sub.pdf

A recommendation to NOAA in response to a request for information (RFI) about capturing more commercial values from vast spatial data holdings is shown at: www.globalcogo.com/BIGDATA.html.

Following is an example of two actual survey points near and northwesterly of Boulder, Colorado. Point "Hansen" lies at a significantly higher elevation than Point "Billingsley." The dilemma in plane surveying is to find and report the correct horizontal distance between two points. The answer lies in one's choice of geometry. Is horizontal counted at the elevation of the higher point, at the lower point, a mean elevation, on the mathematical ellipsoid, or on some (state plane) mapping grid? Prior to the advent of electronic measuring devices (including GPS) a distance represented on the mapping grid was often acceptable and used extensively. With more accurate measuring instruments, the difference between a horizontal distance on the ground and its representation on the mapping grid becomes a significant consideration. The challenge is to choose and use a standard geometrical spatial data model that can be used worldwide by all spatial data users. That benefit is called "interoperability."



Understand, not all examples are as dramatic as the following. But, modern measurement systems (GPS, LiDAR, and others) routinely collect 3-D data that are used by various disciplines in numerous applications. Inherent value is lost to the extent non-standard practices are employed when manipulating, displaying, reporting, and archiving spatial data.

Stations Hansen and Billingsley are both described in the data base of the National Geodetic Survey (NGS). Billingsley is at 1,876.842 meters above the ellipsoid while Hansen, 4.45 kilometers distant, is at 2,309.508 meters. The difference in ellipsoid height is 432.666 m. Geodesists perform computations on the ellipsoid; mappers often use the state plane grid, while homeowners, engineers, contractors, and others like knowing the actual horizontal distance between points. The question a user must answer is "what horizontal distance do I use?" Various options are given below. The GSDM provides the tools for the computations to be performed in 3-D space – giving each user the option.

A philosophical question to be answered (or not) is, "When is a foot not a foot?"

With exceptions, geodesists work exclusively in meters worldwide. Standard surveying and mapping practice in the United States employs foot units – even that choice is muddled by definitions of International Foot or U.S. Survey Foot. The GSDM works in meters while providing local users the option of reporting foot units of choice. But the point is that the distance comparisons shown are in metric units. The goal is to have all users on the same page, to speak the same geometrical language, and to know specifically what distance values are being used. The GSDM accommodates that standardization.

Points	Distance separation	Description of geometry
Pt. 1 to Pt. 2	4,453.744 m	State Plane Coordinate Inverse.
Pt. 3 to Pt. 4	4,453.899 m	Ellipsoid distance used by geodesists.
Pt. 107 to 108	4,455.210 m	Horizontal distance at elevation of Billingsley.
Pt. 109 to 110	4,455.512 m	Horizontal distance at elevation of Hansen.
Pt. 108 to 109	4,455.361 m	Mean horizontal distance used by many.

Depending upon how it is counted, the distance distortion in this case is:

High	4,455.512 m – 4,453.744 m or 1.768 m in 4,455 m, as a ratio is 1:2,520	
Mean	4,455.361 m – 4,453.744 m or 1.617 m in 4,455 m, as a ratio is 1:2,755	
Low	4,455.210 m – 4,453.744 m or 1,466 m in 4,455 m, as a ratio is 1:3,039	

None of these distortions is acceptable for surveying, engineering, or mapping. Landowners and clients are not willing to tolerate a "foot not being a foot" by such an amount.