

Information Item – Request for Help!

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RE: Soliciting input for Second Edition of “The 3-D Global Spatial Data Model”

The non-exclusive intended audience for this request for help includes NOAA, FAA, NGS, FGDC, FHWA, ASPRS, ASCE, NSPS, WestFed, MAPPS, NCEES, and others.

The whole issue of 3-D digital spatial data and spatial data accuracy is huge and deserves serious consideration by spatial data professionals in various disciplines worldwide.

This initiative attempts to look at the Big Picture and requests feedback from both federal agencies and professional organizations related to the use of 3-D digital spatial data. Many users in various disciplines worldwide have a vested interest in efficient procedures for handling geospatial data but society at large stands to realize enormous benefits achieved through collaborative standardized practices. The Global Spatial Data Model (GSDM) is viewed as an appropriate mechanism for achieving some of those benefits.

A step in the right direction is gathering information for that Second Edition:

1. A book, “The 3-D Global Spatial Data Model: Foundation of the Spatial Data Infrastructure,” was published by CRC Press in 2008. The manuscript for the Second Edition of that book is due to the publisher on April 1, 2016.
2. In March 2014, NOAA issue a request for [information](#) (RFI) “intended to inform NOAA about the current state of industry sources, business practices, technical capability, and operational capability. . .” The suggestion made in the Global COGO, Inc. response was that “The best thing NOAA can do is adopt a standard model that accommodates 3-D digital geospatial data and supports continued use of any/all derivative (existing) models.”
3. Subsequent email exchanges with NOAA resulted in a submission of an unsolicited proposal by Global COGO, Inc. to identify a more complete list and summary of issues related to use of an integrated 3-D model and material to be included in the Second Edition of the 3-D book. That proposal has not been funded but feedback from this inquiry and the user community will be considered in preparing material for the Second Edition of the book as noted in #1 above.
4. According to an “Inside GNSS” item by Dee Ann Davis dated November 28, 2014 the FAA is working to establish aviation standards for detect-and-avoid (DAA) procedures for UAS. Here too, the GSDM can provide significant efficiencies when performing [DAA](#) computations. The distance separation is a very quick computation in the ECEF reference frame and the covariance information stored in a BURKORD™ data base enables instantaneous computation of the standard

deviation of that separation. In such a case, speed of computation and spatial data accuracy are both critical!

5. According to their Ten-Year Strategic Plan 2013-2023, the mission of the National Geodetic Survey (NGS) is “to define, maintain, and provide access to the National Spatial Reference System to meet our nation’s economic, social, and environmental needs.” As a relatively small federal agency, the NGS has done a yeoman’s job of serving the surveying/mapping/photogrammetry/remote sensing user communities. The Ten-Year plan demonstrates their continued commitment. Given their mission, the impact of the digital revolution, and the manner in which 3-D spatial data can be used, it is conceivable that the GSDM will provide a bridge between agencies and user communities as well as between disciplines. Hopefully a description of such interoperability (that is compatible with the NGS Strategic Plan) can be part of the Second Edition material.
6. From their web page, “The Federal Geographic Data Committee (FGDC) is an interagency committee that promotes the coordinated development, use, sharing, and dissemination of geospatial data on a national basis. The nationwide data publishing effort is known as the Spatial Data Infrastructure (NSDI).” The Coalition of Geospatial Organizations (COGO - not be confused with the corporation Global COGO, Inc.) recently published a “NSDI [report card](#)” that “is a qualitative assessment of the status of the Framework data components of that program.” Within the same Executive Summary of the report, it states, “While Framework data have been collected and made available for use over the past two decades, a digital geospatial Framework that is national in scope is not yet in place and may never exist.” A case being made (starting at the local [level](#)) is that the GSDM supports interoperability between disciplines/users and can provide the foundation for such a national Framework.
7. The FHWA establishes policies that find implementation, among others, in the various state transportation departments. As a significant user of spatial data in numerous transportation projects (planning, analysis, design, construction) the DOTs are on the front lines in the grid/ground distance difference discussions. Feedback from a questionnaire sent to all 50 state DOTs 25 years ago showed evidence of existing disparate practices with regard to how spatial data are used in most project life cycles and provided motivation to search for efficiencies supported by the digital revolution. A follow-up [inquiry](#) was recently sent to all 50 state DOTs asking for feedback with regard to current practice and possible consideration of an integrated model for handling 3-D digital spatial data. That information will be an important part of the Second Edition.
8. As a professional organization, members of the ASCE use spatial data in many applications and projects. Those uses include a large range of sophistication and technical diversity. On one hand, routine use of flat-earth geometrical relationships is a simple technical operation but, in many other cases, efficient use of 3-D digital spatial data is an integral many solutions requiring rigorous applications of science, math, and engineering principles. Several points are to be made with regard to ASCE’s goal to “raise the bar” and continued excellence in a broad range of civil engineering activities:
 - A. As a minimum, an upper level course devoted to the geometrical and stochastic characteristics of geospatial data should be included in all CE programs. Support for that recommendation is found at <http://www.globalcogo.com/ASCE3D2012.pdf>.
 - B. In a way, the U.S. economy is beholding to the energy sector – oil/gas/mineral exploration/extraction. Modern technology is being implemented in many ways. But, spatial data records management (including collection, use, storage, display, sharing, accuracy

assessment, and archiving) in support of efficiency, safety, standardization, and other activities needs serious attention. See a paper on “Underground (Well) Mapping Revisited” along with the power point presentation on same at [#65](#) on list of articles. Down-hole mapping using a map projection or local coordinate system at the well-head really should be replaced by a 3-D system that provides geometrical integrity of location in all reaches of a well.

9. Surveying is a proud and noble profession. Yes, surveyors provides routine technical data collection services to civil engineers and other disciplines but the surveying profession (like CEs) also faces a broad range of services - ranging from simple to rather sophisticated applications. Since the dissolution of ACSM, the National Society of Professional Surveyors (NSPS) has made enormous strides in promoting the surveying profession and is to be commended for championing the causes of traditional surveying practice. However, that does not exempt NSPS from the need to embrace modern uses of 3-D digital spatial data. NSPS members also stand to benefit from adopting the 3-D GSDM. As a specific example, the concept of the low distortion projection (LDP) has gotten much attention in the recent past. Regretfully, map projections are strictly 2-D mathematical models. The 3-D GSDM provides benefits exceeding those available through the use of LDP. See <http://www.globalcogo.com/LDPvsGSDM.pdf>.

The Western Federation of Professional Surveyors ([WestFed](#)) is a regional organization espousing similar values/services as NSPS. As a delegate to WestFed representing New Mexico Professional Surveyors several years ago, I had the opportunity to put the 3-D concept on the table for consideration – see <http://www.globalcogo.com/WestFed.pdf>.

In my 40+ years of involvement, I have witnessed (and even participated in) an on-going “contest” between surveying/engineering professionals – often regarding who can do what. Each side makes legitimate points quoting anecdotal cases. I believe such effort misses the point. My aspiration is that spatial data professionals in multiple disciplines can realize synergistic benefits through adoption and use of the GSDM. I remain convinced that education is appropriate at all levels in many disciplines but make the point that learning fundamentals of the GSDM is less challenging (either formal or self-education) than learning to use geodesy or map projection concepts competently.

10. ASPRS publishes Photogrammetric Engineering & Remote Sensing (PE&RS) which is a high-quality journal for imaging and geospatial information science and technology. ASPRS and its members are leaders and, to a large degree, define the leading edge of digital technology. For example, the March 2015 issue of PE&RS highlights the 2015 ASPRS Positional Accuracy Standards for Digital Geospatial Data which represents a significant step forward from the previous (primarily analog) standards. Undoubtedly, those standards will be used beneficially for years to come. However, those standards are prefaced primarily on 2-D/1-D concepts of separating horizontal and vertical issues. A surveying analogy may be helpful. Years ago the electronic distance meter (EDM) was added to the surveyors’ tool box. Early implementation of the EDM left the theodolite on the tripod for angle measurements. The theodolite was then removed and the EDM placed on the tripod for distance measurements. The next step had the EDM and theodolite being combined such that separate EDM and theodolite occupied the tripod simultaneously. Productivity was enhanced accordingly. Ultimately the two devices were integrated into a “total station” which makes angle and distance measurements along the axis of the same telescope. Other technological advances such as wireless data collectors are married with units (having GPS embedded) that provide reflectorless measurements to sighted objects - remarkable 3-D systems.

Photogrammetric mapping highlights passive measurements in that no signal other than light emanating from the object is recorded. Spatial resolution is achieved by carefully analyzing the angular resolution to features in the image. Conventional stereo image pairs combined with traditionally surveyed control points provides 3-D positioning along with corresponding productivity enhancements. Separately laser pulse ranging known as Light Detection and Ranging (LiDAR) came along in which the distance to an object is measured very quickly as the beam scans the landscape. Marriage of angle measurements (photogrammetric image) with distance measurements (LiDAR scanning) can provide a very accurate 3-D measured position of any/all features in the field of view (when incorporating appropriate control). The GSDM and the associated BURKORD™ data base support such ultimate positioning:

1. The 3-D position of each object/pixel is defined by its ECEF coordinate values.
 2. Spatial data accuracy, both network and local, is stored in the covariance matrix of each point and the correlation covariance matrix between points. See - <http://www.globalcogo.com/burkord.html>
11. The Management Association of Private Photogrammetric Surveyors (MAPPS) is the only national association of firms in the surveying, spatial data, and geographic information systems field in the United States. According to their web site, MAPPS is dedicated to the business aspects of surveying, mapping, remote sensing, and GIS. Here too, the GSDM can provide significant efficiencies and benefit to current practices. For example, generation of an ortho-photo map consists of plotting each pixel in the data base (cloud) with respect to the chosen P.O.B. See last paragraph of [EOS](#) article.
12. The National Council of Examiners for Engineering and Surveying (NCEES) is made up of members of the various state boards for licensure for surveying/engineering. The NCEES “gatekeeper” role of developing and administering examinations for establishing a consistent measure of minimum competence for professional practice is critical to maintaining the health, safety, and welfare of the public.

In a way, the NCEES is in a position to provide the best input for the Second Edition. As a reminder, the goal of the 3-D book is to provide a reliable bridge between scientific and technological advances and professional practices that serve the public. Although concepts of ethics and good business practice remain in vogue and actively pursued by most boards, it is too easy for persons in practice (including board members) to place too much reliance on the “black box” at times to the detriment of the public being served. A goal for the GSDM is to gain more insight into the contents of that “black box.” Fundamentally, the GSDM is based upon standard solid geometry relationships (functional model) and the equations for performing computations in 3-D space are less complex than using geodesy equations on the ellipsoid or conformal mapping equations. It really is easier to learn and understand. Admittedly, the tools of spatial data accuracy (stochastic model) are more challenging but I honestly believe most practicing spatial data users are capable of learning to use those tools competently and responsibly. Yes, I wholeheartedly support rigorous educational requirements – including the ASCE policy of an MS or equivalent for professional licensure.

For information on progress of Second Edition effort see <http://www.globalcogo.com/SecEd.html> .