Opportunity for Surveying Professionals to be Innovative Leaders in the Spatial Data Community

Surveyors and Geomatics Educators Society (SaGES) Conference
Corvallis, Oregon – July 30 to August 3, 2017

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Abstract:

The digital revolution has impacted many sectors of society – one of those, the use of spatial data, is the subject of this paper. Surveyors have used geometry and spatial data for generations to prepare land descriptions, plats, maps, and other graphic displays. The use of computers and other digital devices is pervasive in many surveying practices and the evolution to competent use of 3-D digital spatial data is on-going. However, depending on one's perspective, that impact is a double-edged sword.

The future, and indeed the very survival, of the surveying profession has been the topic of recent discussions – notably, efforts by the National Council of Examiners for Engineering and Surveying (NCEES) to reverse the decline in the number of applicants taking the surveying licensing exams. Simultaneously, baccalaureate surveying programs are coming under increasing pressure to justify their existence and in some cases, have been eliminated. Given that use of 3-D digital spatial data is growing exponentially within various disciplines worldwide - what implications does that have for surveying and geomatics educators? Since angst and hand-wringing are viewed as futile, this paper describes an opportunity for surveying educators to lead the resurgence of the surveying profession and to establish surveying as the "looked-to" discipline in the use of 3-D digital spatial data. The logical basis for that effort is really quite simple – build and use an integrated spatial data model based on the assumption of a single origin for 3-D geospatial data.

Introduction:

The role of surveying is enormously important because various sectors of society depend upon measurement experts to describe where things are and how they move. With such a broad mandate, the scope of surveying encompasses many activities and provides diverse opportunities for those calling themselves "surveyors." That broad scope is both a source of satisfaction and a source of frustration. There are numerous opportunities within surveying to "find one's calling" and to engage in meaningful occupational activities at various levels. Surveyors love what they do. It can also be frustrating because the general public often fails to comprehend and/or appreciate the talent and skills required to "get the job done right." That same diversity helps explain the challenge of "bringing it all under one roof" — one consequence being that boards of licensure are adversely affected by disruptive innovations.

Land surveying includes exclusive custodial responsibility for land boundaries throughout the United States. To their credit, surveyors have rightfully and staunchly defended that responsibility through the licensing process. Whatever the future holds, the role of the professional land surveyor must be maintained at a high level and must never be reduced to that of a technician. But, it seems that some state boards, using a definition of surveying that goes beyond land surveying, seek to bring related measurement activities under the umbrella of licensure and to exclude legitimate related practice because the individual is not licensed (to perform land surveys). The weakness of that philosophical position is a cause of concern within the licensing community – web search "North Carolina dentistry."

Efforts to remove "engineering surveys" from the NCEES Model Law are a case-in-point. Protecting the public against incompetent practice is laudable and promoting the competence of persons performing land surveys is essential. But, a related issue also deserves attention — that is the practice of some boards to issue edicts related to measurement science that fall outside the sphere of land surveying. In practice, the "surveying" umbrella covers both legal issues and competent measurements. Part of the "rub" is that elements of the fundamental body of knowledge for measurement are very different than they are for land surveying. The "catch 22" is that state boards have the right (obligation) to establish policy and minimum standards related to measurement science without adequate knowledge of measurement concepts (see especially pages 5, 6, and 7). It seems that rote directives are used in place of critical analysis and that those two areas of knowledge are sometimes treated as mutually exclusive. For example, a favorite quote from Mulford (1912) is, "It is far more important to have faulty measurements on the place where the line truly exists, than an accurate measurement where the line does not exist at all." Acknowledging some truth in Mulford's statement, that quote should never be used to justify sloppy practices, defective measurements, or a weakness in understanding fundamental measurement concepts.

On-going discussion of turf issues is to be expected but the goal here is to promote a vision built on the talent of many people. Far more can be accomplished through the synergistic effort of all participants than using the foibles of others to promote a given viewpoint. Respectful disagreement can be productive and sometimes it is best to agree to disagree. That said, current arguments and counter arguments are often premised on traditional views of spatial data — that is using separate horizontal and vertical datums. However, given the disruptive innovations arising from the digital revolution, a forward-looking view is that society at large will gravitate to use of an integrated 3-D spatial data model built on the premise of using Earth's center of mass as the (single) origin for geospatial data. The 2nd Edition of "The 3-D Global Spatial Data Model: Principles & Applications" supports that forward-looking view and is scheduled for release in August 2017.

Brief History:

Appendix D of said 2nd Edition contains more detail on development of the global spatial data model (GSDM). Ideas for the GSDM grew out of discussions with Dr. Alfred Leick at the University of Maine and first appeared in a technical article by Burkholder (1993). Those 3-D concepts were flushed out during work for the Southeastern Wisconsin Regional Planning Commission (Burkholder 1997b). The GSDM is formally defined and described in Burkholder (1997a) and an article on the 3-D azimuth was published in the Journal of Surveying Engineering in 1997. Early acceptance by possible users was minimal, in part, because the simplicity of applying rules of solid geometry to the initial assumption belied the future impact that the GSDM could have on the broader spatial data user community.

The teaching appointment at New Mexico State University (NMSU) from 1998 until retirement in 2010 involved teaching mostly upper division surveying classes and provided an opportunity to refine concepts of the GSDM further. A sabbatical leave during the 2005/2006 year was devoted to "finishing the 3-D book." The 1st Edition of "The 3-D Global Spatial Data Model: Foundation of the Spatial Infrastructure" was published by CRC Press in April 2008. A NOAA Request for Information (NOAA 2014) prompted a suggestion to CRC Press to re-advertise availability of the 1st Edition. The response from CRC Press was "write a 2nd Edition." This presentation highlights release of the 2nd Edition of "The 3-D

Global Spatial Data Model: Principles & Applications." The subtitle for the 2nd Edition was stipulated by CRC Press with the idea of enhancing marketability of the book. Both subtitles are appropriate although it could be argued that the first subtitle is more appropriate than the second.

Features of the GSDM:

1. The GSDM includes both a functional model (geometry describes location) and an optional stochastic model (standard deviations describe reliability).
2. The GSDM uses undistorted spatial data measurements rather than modifying the measurements to fit the model.
3. Computations are performed in 3-D space and are results stored in a BURKORD™ database.
4. Equations are the same for all spatial data disciplines worldwide.
5. Local users have the option of working with local flat-Earth components without compromising the geometrical integrity of the stored 3-D data.
6. Various definitions of horizontal distance exist. All are fully supported by the GSDM.
7. The 3-D geodetic azimuth is succinctly defined and applicable worldwide.
8. Map projection models are strictly 2-D. The GSDM is 3-D – see www.tru3d.xyz

Technical integrity:

1. The underlying assumption of a single origin for geospatial data is primary.
2. Long-standing rules of solid geometry are implemented in the ECEF system.
3. No measurements are distorted for purposes of fitting the model.
4. Error propagation computations conform to standard mathematical procedures.
5. A challenge to the concepts of network accuracy and local accuracy was unsuccessful - being refuted in subsequent testing. The 2nd Edition documents and references those tests.

Implementation:

1. The GSDM is already defined.
2. The basic control network (ground monuments & satellites in the sky) is already in place.
3. The geometrical geodesy equations used in the GSDM are all in the public domain.
4. Spatial data measurements are resolved to either X/Y/Z values or to ΔX/ΔY/ΔZ components.
5. ΔX/ΔY/ΔZ components are assembled into a network and adjusted (least squares).
6. Adjusted components are attached to existing X/Y/Z values and stored.
7. A BURKORD™ database stores primary X/Y/Z coordinates, covariances, and correlations.
8. Undistorted geometrical elements are subsequently computed from stored X/Y/Z values. Standard equations (user selected options) are used to compute local coordinates, distances, directions, angles, areas, grades, slopes, heights, and volumes.
9. If optional covariances and correlations are also stored, the standard deviation of any derived quantity is readily available.

Considerations for implementing the GSDM include:

1. The 3-D challenge was summarized in a poster presented at AGU 2016 Fall meeting.
2. A CRC Press flyer describes the 2nd Edition, including reviews, and ordering information.
3. The Coalition of Geospatial Organizations (COGO) is currently working on an update to the Report Card on the U.S. National Spatial Data Infrastructure.

4. Heavy users of 3-D digital spatial data include civil engineers & planners.
5. Future of Surveying is also being studied by NCEES & NSPS.
6. SaGES – what will we do? Surveying & geomatics educators are facing a huge opportunity.
   a. A proposal to WestFed failed to gain traction.
   b. Graduate courses will help establish future competent 3-D policy administration.
7. America is already "great" but efforts to promote better use of 3-D digital data will certainly enhance the stature of the spatial data community in the United States and worldwide.
8. Any worthwhile endeavor includes elements of "process" and "content." It seems the current wave of political attitudes relies heavily on challenging existing processes. On the bright side, a systematic review of existing processes provides an opportunity to re-examine content. The 2nd Edition is heavy on "content."
9. A proper balance of "process" and "content" is essential. A state newsletter article written several years ago, Process/Content, provides additional information.
10. Much could be said about education. Two points are:
    a. Learning how to learn is very important. "Make it Stick" is not easy to read but good!
    b. There is no substitute for genuine motivation as depicted in "Hidden Figures."

References (Standard and Web URLs):

Burkholder, E.F., 1993; ASCE Journal of Surveying Engineering, "Using GPS Results in True 3-D Coordinate System," Volume 119, No. 1, pp 1-21. (No web link provided - ASCE owns copyright.)

Concepts – page 2	http://www.globalcogo.com/ALTAandNSPS.pdf
Mulford – page 2	https://archive.org/details/cu31924004602615
2nd Edition – page 2	https://www.crcpress.com/The-3-D-Global-Spatial-Data-Model-Principles-and-Applications-Second-Edition/Burkholder/p/book/9781498722162
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