

# **Civil Engineering, Planning, and the Spatial Data Infrastructure**

**New Mexico Joint Annual Conference  
American Planning Association  
and  
American Society of Civil Engineers**

**Las Cruces Convention Center, 680 University Ave  
Las Cruces, New Mexico 88011**

**September 24, 2015**

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- **Note: page 8 of this presentation revised July 12, 2019**

**Joint NM APA-ASCE Fall Meeting – September 2015  
Spatial Data Infrastructure & COGO Report Card - Burkholder**

**Presenter: Earl F. Burkholder, PS, PE, F.ASCE**

- **Fellow and Life Member of ASCE.**
- **Retired from NMSU Surveying Engineering faculty - July '10.**
- **Wrote book, The 3-D Global Spatial Data Model (GSDM).**
- **Working on Second Edition of the 3-D book.**
- **Currently Past Chair – ASCE Geomatics Division EXCOM.**
- **Aspirations:**
  1. **That various disciplines share common experiences when working with 3-D digital spatial data.**
  2. **That NMSU become a true center for excellence for developing spatial/geospatial science/applications.**

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**Presentation goal is to explore common concepts shared by Planning, Civil Engineering, and Surveying wrt spatial data.**

- **Planning is essential, good planning often taken for granted.**
- **Civil engineers envision and design infrastructure facilities.**
- **Other disciplines use spatial data extensively.**
- **The surveying profession is looked to for maps/design data.**
- **The digital revolution includes convergence of computers, data bases, GPS, remote sensing, LiDAR, GIS, and others.**
- **Spatial (and geospatial) data are typically digital and 3-D.**
- **Importance of spatial data accuracy is rising exponentially.**

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**Resources and exhibits (passed around during presentation):**

- **Report Card on the U.S. National Spatial Data Infrastructure, 2015, Coalition of Geospatial Organizations.**
- **City Planning for Civil Engineers, Environmental Engineers, and Surveyors, CRC Press 2010. Written by Dr. Kurt W. Bauer, Emeritus Executive Director - SEWRPC.**
- **Master Planners: Fifty Years of Regional Planning in Southeastern Wisconsin: 1960 to 2010. Marquette University Press 2010. Written by Paul G. Yeyes .**
- **The 3-D Global Spatial Data Model: Foundation of the Spatial Data Infrastructure, CRC Press 2008. By Earl F. Burkholder.**
- **Definition of a Three-Dimensional Spatial Data Model for Southeastern Wisconsin, SEWRPC 1997. By Earl F. Burkholder**

## **Southeastern Wisconsin Regional Planning Commission (SEWRPC)**

- **One of many success stories of well-planned growth in the US.**
- **Covers 7 counties in southeastern part of state.**
- **Established 1960 and serves as advisory role for constituents.**
- **Success bolstered by horizontal/vertical survey networks.**
- **All 11,753 Section Corners in region have reliable NAD 27 state plane coordinates and NGVD 29 elevations.**
- **1" = 100' topographic maps with 2' contours cover the region.**
- **Cadastral (parcel) maps at 1" = 100' for entire region.**
- **Challenge has been to accommodate new datums:  
(Horizontal - NAD 83 and Vertical - NAVD 88)**
- **Adoption of 3-D Global Spatial Data Model was proposed 1997.**

## Overview of topics - I

- **Spatial data Infrastructure Report Card:**
  - Patterned after ASCE Infrastructure Report Card.
  - Compiled by Coalition of Geospatial Organizations (COGO).
- **Impact of Digital Revolution on professional practice:**
  - Many disciplines worldwide use (geo)spatial data.
  - Characteristics of (geo)spatial data - digital and 3-D.
- **Examples -**
  - Local/regional – planning & infrastructure development.
  - Global/national – data bases, mapping, navigation.

## **Overview of topics - II:**

- **Synergistic benefits between disciplines over time:**
  - **Planning is based upon good data and valid assumptions.**
  - **Facilities are built on reliable maps and engineering plans.**
  - **Operation/maintenance rely on knowledge of location.**
- **View of future (learn from “Innovators” – Isaacson):**
  - **Instead of trying to predict the future, create it.**
  - **Motivation should include:**
    - i). Use of models that are both appropriate and simple.**
    - ii). Stewardship of resources – both physical and human.**
    - iii). Promote quality of life and respect for humankind.**

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- **A “Report Card on the National Spatial Data Infrastructure” was developed by the Coalition of Geospatial Organizations (COGO)**
- **Seemingly, some “official” links to the 2015 Report Card have been disabled. Authors “private” 2015 file can be downloaded from:**  
  
**[www.globalcogo.com/2015COGO-report.pdf](http://www.globalcogo.com/2015COGO-report.pdf)**
- **Worth a try. . . Google “COGO Report Card” and choose possible link(s).**

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**Coalition of 13 Geospatial Organizations (COGO) includes:**

- **American Society of Civil Engineers.**
- **American Society of Photogrammetry & Remote Sensing.**
- **Association of American Cartographers.**
- **Cartography and Geographic Information Society.**
- **Geographic and Land Information Society.**
- **Geographic Information Systems Certification Institute.**
- **International Association of Assessing Officers.**
- **Management Assoc. for Private Photogrammetric Surveyors.**
- **National Society for Professional Surveyors.**
- **National States Geographic Information Council.**
- **U.S. Geospatial Intelligence Foundation.**
- **University Consortium for Geographic Information Science.**
- **Urban and Regional Information Systems Association.**

## **COGO Report Card on National Spatial Data Infrastructure (NSDI):**

- **Published/posted February 6, 2015.**
- **Can be downloaded from various web sites.**
- **Patterned after ASCE Infrastructure Report card on:**
  - **Transportation, Energy, Water & 13 other categories.**
  - **Assessment of status every 4 years.**
  - **Assigns a grade A to F with pluses and minuses.**
  - **Used to justify infrastructure investments.**
  - **Notes grade changes from previous assessment.**
  - **Scorecard to keep track of progress (or lack thereof).**
- **Andrew Herman, former ASCE President, recently discussed the ASCE Report Card at the Domenici Public Policy Conference.**

## Report Card on National Spatial Data Infrastructure (NSDI)

- Grades only the NSDI Framework – best use of resources.
- Framework includes 7 data themes:
  - Cadastral Data. D+
  - Elevation Data. C+
  - Geodetic Control Data. B+
  - Governmental Units Data. C
  - Hydrography Data. C
  - Orthoimagery Data. C+
  - Transportation Data. D

Overall grade = C

## Report Card on National Spatial Data Infrastructure (NSDI)

- Also includes evaluation of 7 management issues:

- Capacity C
- Condition D
- Funding D
- Future need D
- Operation & Maintenance C
- Public Use C
- Resilience C

Comprehensive grade = C-

## **Executive Summary of COGO Report Card (paraphrased):**

- **NSDI created by Executive Order 12906, April 11, 1994.**
- **Create plan for implementation of a national digital geospatial data framework. . & ongoing data maintenance.”**
- **Federal government is no longer dominant data producer.**
- **Stakeholders embrace technology and processes that outpaces what the federal government can provide.**
- **There is an urgent need to reexamine relationships between data providers and users.**
- **Needed – a fair and equitable geospatial data marketplace that serves a full range of applications.**

## **Executive Summary (continued):**

- **“The cornerstone of the program is a common digital base map that would aggregate the best representations of fundamental data from all levels of government. These Framework data layers are intended to serve as the unified foundation upon which all other geographic information could be created and shared. By maintaining a standardized, high-quality series of Framework data the NSDI would provide access to reliable, current from all of the above partners, not just Federal agencies. This would minimize duplication of effort and promote use of the most complete and reliable information.”**

## Executive Summary continued (the clincher):

- “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.”
- *The GSDM is viewed as critical to realizing the vision of those who established the NSDI over 20 years ago!*
- Example – in March 2014, the NOAA issued a request for information (RFI) asking for advice for making its data easier to use. They asked private industry to tell them how to extract commercial value from the vast holdings of agency geospatial data – and to do it without costing the federal gov.
- Global COGO response – [www.globalcogo.com/BIGDATA.html](http://www.globalcogo.com/BIGDATA.html)

## **Traditional view of maps:**

- **Civilizations worldwide have used maps throughout history.**
- **History of maps and cartography is important and fascinating.**
- **Maps are used in geography, navigation, engineering & others.**

## **Impact of Digital Revolution:**

- **Spatial data are now digital and 3-D.**
- **Abstract view of maps and 3-D data in award-winning paper –**  
<http://www.globalcogo.com/setepaper.pdf>
- **Description of Global Spatial Data Model (GSDM) found at:**  
<http://www.globalcogo.com/gsdm-eos.pdf>
- **GSDM book describes opportunity to use a new bottle model to accommodate characteristics of 3-D digital spatial data.**



## Local/Regional Examples:

- City of Las Cruces and Dona Ana County development of VRS
- Union Pacific Intermodal Rail Yard Project – private capital.
- Space Port – public funds.
- Supreme Court mandated Rio Grande boundary NM & Texas.  
(Esoteric/forward looking, [www.globalcogo.com/TX-NM.pdf](http://www.globalcogo.com/TX-NM.pdf))

## Global/National Examples:

- Google Earth and Google Maps
- Geodetic control – National Spatial Reference System (NSRS).
- Geographic Coordinate Data Base (BLM Cadastral Framework).
- Intelligent transportation systems.
- FAA administration of airspace for UAS (drones)

## **Synergistic benefits supported by reliable Spatial Data Infrastructure**

- **Land use planning is based on valid data and good assumptions.**
  - **Demographics, where people live & anticipated mobility.**
  - **Transportation – modes, systems, facilities.**
  - **Economic and social activities supporting quality of life.**
  - **Natural resources and movement of goods/services**
- **Facilities are built on reliable information & well-designed plans.**
  - **Base maps are essential. Retrofitting is costly & inefficient.**
  - **Conflicts of use and costly delays need to be avoided.**
  - **Mixing datums and/or units is bane of project management.**
  - **What makes location information lose its value?**

## **Synergistic benefits – continued:**

### **Operation and maintenance of constructed facility (life cycle)**

- **As-built data becomes more critical as time moves on.**
  - **Where is the buried pipe?**
  - **Is there a conflict between water lines, gas lines, & sewer pipes?**
- **Inventory of cracks in highway pavement, size and location.**
  - **Mobile mapping at “highway” speeds.**
  - **Compatibility with other features (signage/safety) & data bases.**
  - **Bridge defects – where on structure and where in “system.”**
- **What about monitoring movement of dams and levies?**
  - **At what point is “project” reference system needed?**
  - **Concepts of “absolute” and “relative” related to accuracy.**

**View of the future – GSDM supports comprehensive vision:**

- **One system of proven geometry equations worldwide.**
- **Rules of solid geometry utilizing rectangular coordinates.**
- **Vector algebra & matrices (not req'd but) enhance computations.**
- **Standard deviation of computed quantities readily available.**
- **In local applications, no zone constants or projection parameters.**
- **Grid/ground distortion avoided, no elevation factors are needed.**
- **“Flat-earth” computations directly provide –**
  - **Local tangent plane horizontal distances.**
  - **Bearings/azimuths related to true north.**
- **Geodetic quantities remain valid and can be used.**

**View of the future – GSDM supports comprehensive vision:**

- **Issues of spatial data accuracy well supported by the GSDM.**
  - **Network accuracy associated with absolute positions.**
  - **Local accuracy associated with relative positions.**

**(Most spatial data applications rely on relative positions.)**
- **Ultimately, ellipsoid height will be used as third dimension.**
  - **Geoid modeling still legitimate but need will be reduced.**
  - **Current practice is backward to efficient spatial data modeling.**
    - i). **Example of equation of time.**
    - ii). **Example of polar motion.**
    - iii). **Example of tuning a piano.**

## **Motivation for using the GSDM should include:**

- **Best model for a given application:**
  - **Data must not be distorted by the model.**
  - **Model should be both correct and simple to use.**
- **Stewardship of professional/educational efforts:**
  - **High level geodesy and cartography still needed in research.**
  - **Flat-earth computations are sufficient for many applications.**
- **A common vision of technical application is warranted.**
  - **Different talent/aptitude are appropriate at all levels.**
  - **Well-defined distinction between spatial and geospatial.**
- **Respect/recognition for those needing/using flat-earth math.**
- **Standards and specifications supported by GSDM at all levels.**

**Transition will not occur instantaneously but . . . .**

- **Many knowledgeable professionals are already using 3-D.**
- **Standardization/operational efficiencies will drive the transition.**
- **Educational efforts can provide huge opportunities/benefits.**
- **Known obstacles include:**
  - **Proprietary considerations.**
  - **Gate-keeper attitudes.**
  - **Investments in the status quo.**
  - **Reluctance to have users “think for themselves.”**
  - **Temptation to “buy” solutions rather than to “own” them.**

**The GSDM can help raise the Report Card grades!**

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- Thank you for opportunity to participate!
- A pdf file of this presentation can be accessed at:

[www.globalcogo.com/APA-ASCE-Spatial.pdf](http://www.globalcogo.com/APA-ASCE-Spatial.pdf)

- The power point presentation file is posted at:

[www.globalcogo.com/APA-ASCE-Spatial.pptx](http://www.globalcogo.com/APA-ASCE-Spatial.pptx)

- 2<sup>nd</sup> Edition status – [www.globalcogo.com/SecEd.html](http://www.globalcogo.com/SecEd.html)