4-hr Seminar Outline (Part 1 of 2)
Datums, Map Projections, and Coordinate Systems – 2 hr.

2015 PLSS Rocky Mountain Summit Conference - February 26, 2015

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I. Introduction – The scope of Surveying includes two important components.
   A. Mathematical delineation of features and lines – focus of this seminar.
   B. Reconciliation of cadastral records with monuments ground measurements.
   C. The relationship between measurements and boundaries is fascinating and critical.

II. Surveyors work with spatial data and make maps to show (among other things) boundaries.
   A. Geometry: distances, angles (horizontal and vertical). What about units?
   B. What is the definition of horizontal, vertical? With respect to what?
   C. Every survey needs a starting place. Should position be absolute or relative?
   D. A datum provides "context" and helps answer the questions above.
      1. Horizontal – NAD27 and NAD83 (which one). What about WGS84?
      2. Vertical – NGVD29, NAVD88, and WGS84(?).
      3. What is a 3-D datum?

III. Plane geometry and solid geometry:
   A. We live in a three-dimensional (3-D) world and use 3-D measurement systems.
   B. What percentage of our maps (deliverables) are two-dimensional?
   C. What does it take to portray a 3-D world on a 2-D map? Is the world flat?
   D. A map projection facilitates use of 2-D plane Euclidean geometry for maps.
   E. Graphical projections provide visualization while computations are mathematical.
      a. Graphical – Gnomic, rays originate from center of earth.
      b. Graphical – Stereographic, rays originate from opposite "pole."
      c. Graphical – Orthographic, rays arrive perpendicular to projection surface.
      d. Conformal – preserves angles so it is very popular for surveying & mapping
      e. Equal Area – used by some cartographers
   F. There are problems associated with any map projection – even conformal ones.
      a. Distance on map is not the same as the distance on the ground (grid/ground).
      b. Strictly 2-dimensional – no vertical representation. We work with 3-D data.
      c. Choice of distortion tolerance limits area to be covered by a given projection.

IV. Coordinate systems:
   A. Geodetic – latitude, longitude, ellipsoid height, units are curvilinear/linear
   B. Geocentric – Rectangular X/Y/Z in meters with origin at Earth center of mass
   C. Local Relative - East, north, and up (elevation) – many "assumed" systems.
   D. State plane – unique to each state and requires various "zones"
   E. UTM – Worldwide (except @ poles), 60 metric zones used by military
   F. Low Distortion Projections – local option that is gaining popularity. Why?

4-hr Seminar Outline (Part 2 of 2)
Low Distortion Projections: Design/Application/Computation – 2 hr.

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I. Cartography (Wikipedia) is the study and practice of making maps and includes:
   A. Setting the agenda by deciding what is to be mapped.
   B. Representing the terrain of mapped objects/features.
   C. Eliminating characteristics that are not relevant to the map – generalization.
   D. Reducing complexity of characteristics to be portrayed – also generalization.
   E. Orchestrating elements to best convey message of map – map design.

II. Considerations important to Cartographers
   A. Topology concerns the property of being adjacent.
   B. Thematic maps (or charts) show a particular theme associated with a place.
   C. Discrete Global Grids, Focus is on pixels of varying sizes & managing data (raster).
   D. Geometrical integrity is needed by surveyors/photogrammetrists/engineers (vector)
   E. Impacts of digital revolution? Philosophical issues (i.e., 2D vs. 3D) to be considered!

III. Definition of a map projection – elements
   A. Underlying ellipsoid
   B. Selection of projection type
   C. Location of map origin and orientation of axes.

IV. Map projections commonly encountered by surveying & mapping professionals
   A. State Plane:
      1. Transverse Mercator
      2. Lambert conic conformal
      3. Oblique Mercator
   B. UTM – meter units, used by military worldwide (except at poles)
   C. GPS Localization – Is this a map projection?
   D. Low Distortion Projections – both formal and informal

V. Example "Special" Projections:
   A. Michigan Geo-Ref and Michigan State Plane Coordinate System 1964
   B. Minnesota and Wisconsin County Systems
   C. State of Oregon LDP's
   D. Other

VI. Designing and Using a Low Distortion Projection:
   A. Selection of design parameters.
   B. Computation of Zone constants.
   C. Computations on a LDP.
   D. Computing latitude/longitude from LDP coordinates.