Designing GIS Databases to Support Mapping and Map Production

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Key Concepts

- GIS base maps that support high-quality cartography
  - Map-driven
  - Spatially integrated
- Understanding maps
  - Themes
  - Graphic marks
- The multi-purpose GIS base map and cartography
  - Basic structure and schema
  - Table design (supporting symbology & labeling)
  - Geoprocessing (supporting symbology & labeling)
- Multi-scale
  - Incorporating scale in the base map database
  - Multi-scale map
Map-Driven

- 1: 5,000 General reference map
- 1: 25,000 Topographic map
- 1: 2,500 Emergency services access map
- 1:1,250 Emergency services imagery map
Organize Base Map Content Using Themes

- Each map portrays or contains major themes of information

- The base map data base, therefore, will have data organized into major themes

- Topological relationships are typically between feature classes within themes in the base map
Organize Base Map Content Using Themes

• Common themes:
  – Transportation
  – Terrain or hypsography
  – Surface water or hydrography
  – Cultural
  – Imagery
  – Boundaries
  – Reference system

• Roads
  – Edge of pavement polygons
  – Center lines
  – Cul de sac points
  – Dissolved road Centerlines

• Railroads
  – Individual tracks
  – Rail lines

• Ferry routes
Organize Base Map Content Using Themes

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- Digital elevation model (DEM)
  - Cartographic hillshade
  - Contour lines
  - Spot elevation points
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- **Hydro areas**
  - All types of surface water

- **Hydro lines**
  - Includes steam channels

- **Shorelines**

- **Hydro points**
  - Wells
  - Springs
  - Gaging stations
  - etc.
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• Common themes:
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  – Terrain or hypsography
  – Surface water or hydrography
  – Cultural
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  – Boundaries
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• Buildings
  • Building complexes
  • Landmarks
  • Structures
  • etc.
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- **Orthophoto base**
- **Aerial photos**
- **Satellite imagery**
- **etc.**
Organize Base Map Content Using Themes

- **Common themes:**
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  - **Boundaries**
  - Reference system

- **Municipal**
  - Areas & lines

- **County**
  - Areas & lines

- **State**
  - Areas & lines

- **Park**
  - Areas & lines

- **PLSS & control**
  - Areas & lines
  - Points/corners

- **Subdivisions**
  - Areas & lines

- **Parcels**
  - Parcel data model
Organize Base Map Content Using Themes

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- **Map series sheet centers or extents**
- **Historic map series**
  - USGS Quad Sheets
  - Townships
- **Grids**
  - UTM
  - MGRS
  - Graticule
  - etc.
Hallmarks of a Multi Purpose GIS
Base Map that Supports Mapping

1. Rich appropriate content for all designed standard products
2. All data are spatially integrated
3. Data are modeled to suit purpose
4. Consistent semantics and attribution
5. Central repository for managing frequently shared or sensitive information
Spatially Integrated Data Example
Hallmarks of a Multi Purpose GIS Base Map that Supports Mapping

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Consistent use of semantics

• Organize data using consistent and easy to understand conventions
• Use geodatabase domains to enforce consistent use appearance of information
• Expose information based on the expectations of your clients
Using Consistent Semantics

CS_ID is my symbol field.

Domains enforce semantics.
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Data Flow during Map Production Workflow

- Data is Extracted, Transferred, and Loaded (ETL) from core database into map product databases
- During production, errors and edits are propagated back to the core database
Base Map Design in Support of Mapping

• *If it is not in the database, it won’t be on the map*

• Data are based on and designed with full understanding of your standard map products

• Without a map specification it won’t be in the database (or pre-existing analog)
Example: Pre-Existing Analog Map

- Existing Public Safety Map
Example: Resulting Map

• New Design (proposed)
Map Specification Contents

• Map purpose and audience

• Inventory of each kind of graphic mark
  – Each unique symbol and label and the features they will apply to
  – How the graphic mark gets assigned
    • ArcMap symbology method and parameters
    • Maplex label placement rule and parameters
    – Interrelations among graphic marks

• Page layout or user interface design
Graphic Marks

• “...primitive building blocks of pictorial representation.”*
  – Point mark
  – Line mark
  – Area mark
  – Text label
  – Pixel
  – TIN facet

Graphic Marks Drive Detailed Data Design

- Subdivision
  - Boundary
  - Name
- Building
  - Residential
  - General case
  - Commercial
- Road
  - Edge
  - Name
  - Address
- Vegetation
  - Trees
- Cultural
  - Recreation area
- Section line
Graphic Marks Drive Detailed Data Design

- **Subdivision**
  - Boundary
  - Name
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  - Residential
  - General case
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  - Name
  - Address
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• Page layout or user interface design
Table Design of Databases that Support Mapping

• Symbolization
  – A single field that tells ArcMap the symbol for each feature
    • Keeps symbology process simple
    • Permits use of “Match to Symbols in a Style”
  – In some cases another field, denoting priority, may be used, for example, to set the size of symbols
Match to Symbols in a Style

Layer Properties

Show:
- Features
  - Categories
    - Unique values
    - Unique values, many
  - Match to symbols in a style

Quantities
- Charts
- Multiple Attributes

Draw categories by matching field values to symbols in a style.
- Value Field
  - SYMBOL

Symbol | Value | Label     | Count
-------|-------|-----------|------
       | <all other values> | Surface Streets | ?
       | 101   | Ramps     | ?
       | 201   |           | ?
       | 203   | Freeways  | ?

Match Symbols | Add Values... | Remove | Remove All | Advanced

OK | Cancel | Apply
Table Design of Databases that Support Mapping

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Table Design of Multi-Purpose Databases that Support Mapping

- **Text Placement**
  - Useful fields to add have:
    - **Label String**: Pre-calculated to avoid performance-detracting label expressions
    - **Shape Type**: For polygon features to help Maplex differentiate between curved and horizontal placement
    - **Label Length**: Help Maplex: set up for overrun or place outside options (really useful when annotation is not an option):
      \[\text{Len}(\text{[<field>]}\text{)}\]
      - Use on short streets (spurs) or small polygons (lakes, cultural areas, etc.)
    - **Label Type**: For example, restricted access highways need to know type of shield
Scale and Information Themes on Maps

- Different kinds of features behave differently as scale changes
  - Goal: represent features as geographic, not geometric (when you can see the vertices)
  - Some data will be used in multiple products and at a wider range of scales
Making Sense of Multi-Scale

• Multi-Scale vs. Scale Range:
  – Multi-scale is multiple predefined scales or Z-heights (i.e., discreet)
  – Scale range is all scales between a defined minimum and maximum scale or Z-height (i.e., continuous)

• ESRI’s products and functionality are multi-scale
  – Design your data to so that scale is managed or assigned as a characteristic of a feature class
    • As a highly tuned/optimized single-scale dataset
    • As a highly tuned/optimized dataset for use within a range of scales
Multi-Scale Map Design

• A multi-scale map is an ordered sequence of single-scale maps
  – Each single-scale map must
    • Stand on its own (store as a group layer)
    • Have a consistent density of information
  – Avoid changing convention or style between maps
    • If possible keep important features stable (not moving around)
    • Maplex: use same font and placement strategies at each scale
    • Use same colors, particularly for area fill symbols and text

• There are scales when the themes of information on the map will change to accommodate more detailed information
  – Evolve cartographic strategies at these points
Multi-Scale Example 1
Labeling: Not as Stable
## Scale Strategy

**Binary Progression**

| Scale   | 1:1,000 | 1:2,000 | 1:4,000 | 1:8,000 | 1:16,000 | 1:32,000 | 1:64,000 | 1:125,000 | 1:250,000 | 1:500,000 | 1:1,000,000 | 1:2,000,000 | 1:4,000,000 | 1:8,000,000 | 1:16,000,000 | 1:32,000,000 | 1:64,000,000 |
|---------|---------|---------|---------|---------|---------|----------|----------|-----------|-----------|-----------|-------------|------------|------------|-------------|--------------|-------------|

**Natural or Content Driven**

<table>
<thead>
<tr>
<th>Scale</th>
<th>1:1,000</th>
<th>1:2,500</th>
<th>1:5,000</th>
<th>1:7,500</th>
<th>1:10,000</th>
<th>1:15,000</th>
<th>1:20,000</th>
<th>1:25,000</th>
<th>1:30,000</th>
<th>1:40,000</th>
<th>1:50,000</th>
<th>1:75,000</th>
<th>1:100,000</th>
<th>1:175,000</th>
<th>1:250,000</th>
<th>1:325,000</th>
<th>1:400,000</th>
<th>1:500,000</th>
<th>1:750,000</th>
<th>1:1,000,000</th>
</tr>
</thead>
</table>

- Binary works for more focused maps that will not function well if too much information is shown; good for thematic or special purpose maps.
- Content driven adds information at earliest natural opportunity, and is susceptible to more traditional cartographic challenges; good for reference or topographic maps.
Thank you

• Questions

• Please fill out your surveys—we appreciate your feedback.