Development and Implementation of a Transportation Geodatabase

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Geographic Context
City of Colorado Springs

• Population: 415,000
• 195 square miles
• 1,891 Miles of roadway
• Elevation difference: 3,506’
• Highest North American professional baseball park
Typical Questions

• How many lane miles do we have?
• Where are the snow plow routes?
• Which streets are City maintained?
• Which streets are under probationary status?
• How much paint is required to stripe our streets?
• What are the planned projects within the public right-of-way?
• How many miles of missing sidewalk along major arterials?
Prior Situation

• Relied upon a copy of the street centerline data maintained by the Springs Utilities
• City departments segmented the centerline by attributes
• The need for additional attribution led to additional copies
• An untenable situation: Public transportation infrastructure system is a core part of City business
Transportation Geodatabase Goals

- Secure data centrally
- Serve data to multiple users concurrently
- Collaborative editing and versioning
- Enterprise focus
- Avoid segmentation of centerlines
Project Plan

- In-house development effort
- Initiated in 2007
- First step - Needs survey and business needs analysis
- Work Breakdown Structure (WBS)
- Conceptual Design
- Data Model
- Standards and specifications
- Conversion
- Maintenance work flow
Business Process and Needs Assessment
Transportation and address themes

- Asset management
- Street ownership, maintenance, and warranty status
- HUTF reporting
- View of current and planned projects
- Transportation analysis
- Routing
- Street address information
Conceptual Design

• High-level initial thinking about the data model
• Based on business requirements
• Guidance found in outside resources:
  – Al Butler’s Designing Geodatabases for Transportation
  – UNETRANS
  – Other municipalities (Richmond, VA)
  – LRS Focus Group meetings
  – ESRI documentation
Key Concepts

• Multi-use, multi-purpose data
• Separate maintenance and publishing databases
  – Normalized maintenance geodatabase
  – Publish for users and applications
• Utilize SDE
• Logical and physical street centerline feature classes
• Minimize centerline segmentation
• Store history
• LRS-ready
Data Model

• A critical component!
• First developed a data model oriented towards initial conversion process
• After conversion, modified it for maintenance purposes
• Prototyped with file geodatabase
• Used Geodatabase Diagrammer to output to pdf document
Data Model

Logical centerline feature class

- Core attributes
- Subtypes
- Locus of attribution
Data Model

Street name attribution
Data Model

Physical centerline feature class

- Many-One
- Subtypes
- Oneway
Data Model - Topology

- Maintains coincident feature class geometry
- Control by subtype

### Topology Rules

<table>
<thead>
<tr>
<th>Origin Feature Class</th>
<th>Rule</th>
<th>Comparison Feature Class</th>
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</thead>
<tbody>
<tr>
<td>Carriageway</td>
<td>Must Not Intersect Or Touch Interior</td>
<td></td>
</tr>
<tr>
<td>Carriageway</td>
<td>Must Not Have Dangles</td>
<td></td>
</tr>
<tr>
<td>Carriageway</td>
<td>Must Not Have Psuedos</td>
<td></td>
</tr>
<tr>
<td>Carriageway</td>
<td>Must Be Single Part</td>
<td></td>
</tr>
<tr>
<td>Carriageway</td>
<td>Must Not Self-Intersect</td>
<td></td>
</tr>
<tr>
<td>Carriageway: Aligned</td>
<td>Must Be Covered By Feature Class Of:</td>
<td></td>
</tr>
<tr>
<td>Roadway</td>
<td>Must Not Intersect Or Touch Interior</td>
<td></td>
</tr>
<tr>
<td>Roadway</td>
<td>Must Not Have Dangles</td>
<td></td>
</tr>
<tr>
<td>Roadway</td>
<td>Must Not Have Psuedos</td>
<td></td>
</tr>
<tr>
<td>Roadway</td>
<td>Must Be Single Part</td>
<td></td>
</tr>
<tr>
<td>Roadway</td>
<td>Must Not Self-Intersect</td>
<td></td>
</tr>
<tr>
<td>Roadway, Primary</td>
<td>Must Not Intersect Or Touch Interior</td>
<td></td>
</tr>
<tr>
<td>Roadway, Primary</td>
<td>Must Not Have Dangles</td>
<td></td>
</tr>
<tr>
<td>RoadwayRoutes</td>
<td>Must Not Have Psuedos</td>
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</tr>
<tr>
<td>RoadwayRoutes</td>
<td>Must Be Single Part</td>
<td></td>
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<td>RoadwayRoutes</td>
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<td>Must Be Covered By Feature Class Of:</td>
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<tr>
<td>RoadwayRoutes</td>
<td>Endpoint Must Be Covered By:</td>
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</tr>
<tr>
<td>RoadwayEndPoints</td>
<td>Must Be Covered By Endpoint Of:</td>
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<tr>
<td>Intersections</td>
<td>Must Be Covered By Endpoint Of:</td>
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<tr>
<td>ThoroughfarePlan</td>
<td>Must Be Single Part</td>
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<td>Must Not Self-Intersect</td>
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<tr>
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<td>Must Not Intersect Or Touch Interior</td>
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</tr>
<tr>
<td>ThoroughfarePlan: Existing</td>
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<td></td>
</tr>
</tbody>
</table>
Standards and Specifications
Rules for every feature class and table

- Inclusion and exclusion of features
- Extent
- Source data
- Feature positioning
- Positional accuracy
- Topology rationale
- Considerations for linear referencing
- Centerline configurations at street intersections
- Rules for core attributes
Conversion

- Limited funding
- Interns and temporary employees
- Developed VBA tools
- Utilized existing data sources
- Validated against plats and orthophotography
- Phased the work
- Work cessation during economic down-turn
- Core feature classes now complete within City limits – goal is Utilities’ service area
Intersection Configuration
Traffic Circle
Linear Referencing Implementation

- LRS: solves segmentation problem
- Each Roadway segment is a route
- Routes simply provide a way to avoid segmentation; they serve no other purpose
- RoadwayRoutes feature class with measures
- Critical tool: Digitize Events developer sample
- Event tables for:
  - Address ranges
  - Speed limits
  - HUTF
  - CAD Geofile
LRS – Address Ranges
LRS – Speed Limits

• Speed limit events all tied to logical centerline
• Offset symbology by left/right side
• Attribute physical centerline (in green) during publishing
Publishing Scripts

- Only editors work with the maintenance geodatabase
- Python scripts used to export to non-versioned SDE geodatabase or file geodatabase
- Customize for end users and applications
Maintenance Workflow

• Identify processes that affect street centerlines
  – Plat/Replat
  – City agency Master Plans
  – Capital projects
  – CDOT/State agency project
  – Annexations
  – Street name changes
  – Street vacations

• Develop notification procedures

• Need better tools
Future Development

• Expand coverage area
• Integrate with E911 authority
• Integrate trails and pedestrian facilities
• Using LRS, develop additional attribution identified in business needs study
• ESRI’s new extension for Streets and Roads