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The Colorado Department of Transportation (CDOT's) Roadway Geodatabase - Project "Stopped "

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Presentation Overview

- Roadway GeoDatabase (RGDB) Project Goals
- Overview of Databases
- Project History
- Technical Difficulties
- Reasons to Stop the Project
- But Wait – There's More!
- Lessons
- The Future

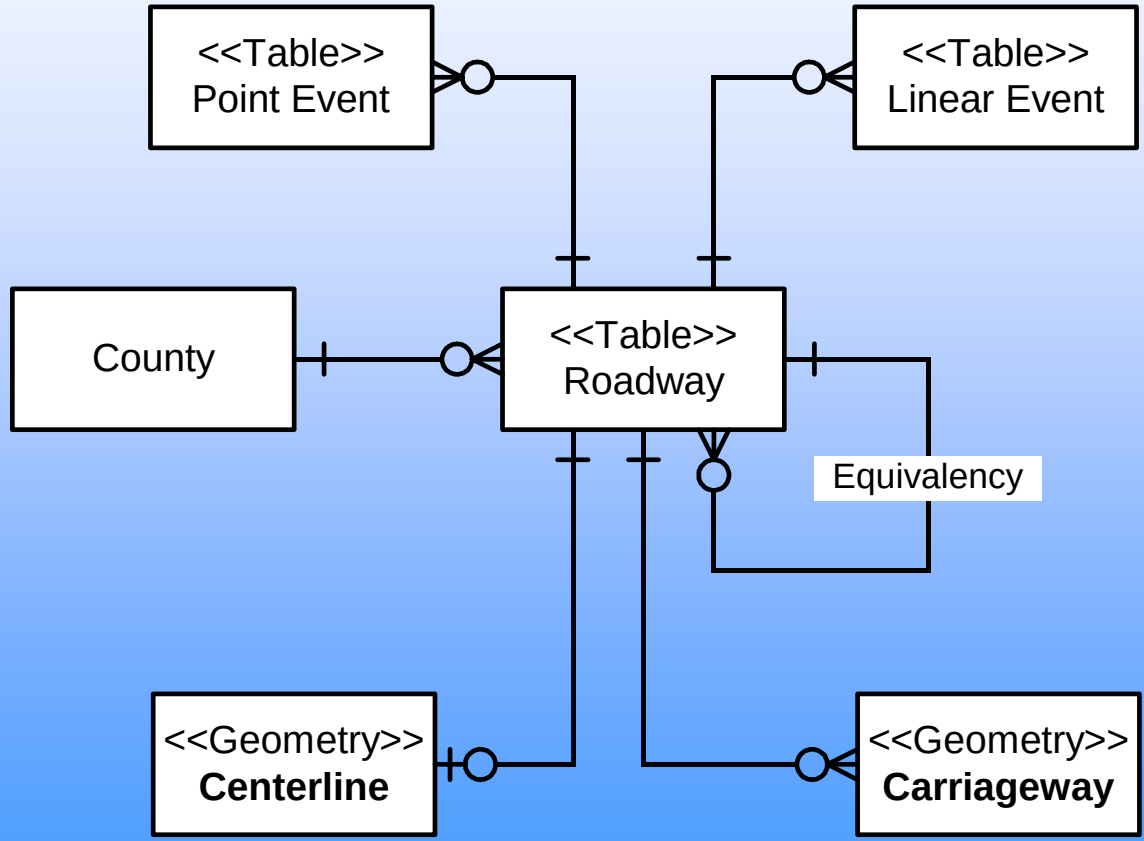
Original Project Goals

- Adhere to principles and business rules
- Data model for the editing environment
- Editing vs. Publication
- Integrate geographic and tabular data for roadways and jurisdictions into one database
- Position the roadway geodatabase to become an enterprise database
- Enable on-going work to continue while migration data model and procedures are developed

Roadway Geodatabase

- Roadway is a facility in the real world
- Fully normalized
  - No redundancies
  - No derived elements
- Reconstruct historical state of database at any point in time using date stamps
- Record-level metadata
- Single format (geodatabase)

Basic Roadway Geodatabase Logical Data Model



Project History

- Geodatabase Logical Data Model – Editing Environment – July ‘03
- Application Requirements & Geodatabase Physical Data Model – Nov. ‘03
- Data Migration Project – June ’05 (Consultant Finished, Project Not Finished)
- Migration Recovery – July ’06 to Oct. ‘06
- Migration Implementation Restarts – Oct. ‘06
- Original Architect Consults on Difficulties – May ‘07
- Project Stopped – May ’07
- Incremental Changes Started – Aug ’07
- Project “X”

Technical Difficulties
Varieties of Roadway Measures

- Reference Points
- Anchor Points, Anchor Segments
- Arc Measures (“M” values)
- Measured Roadway Segment Lengths
- Mile Groups
- Arc Feature Length

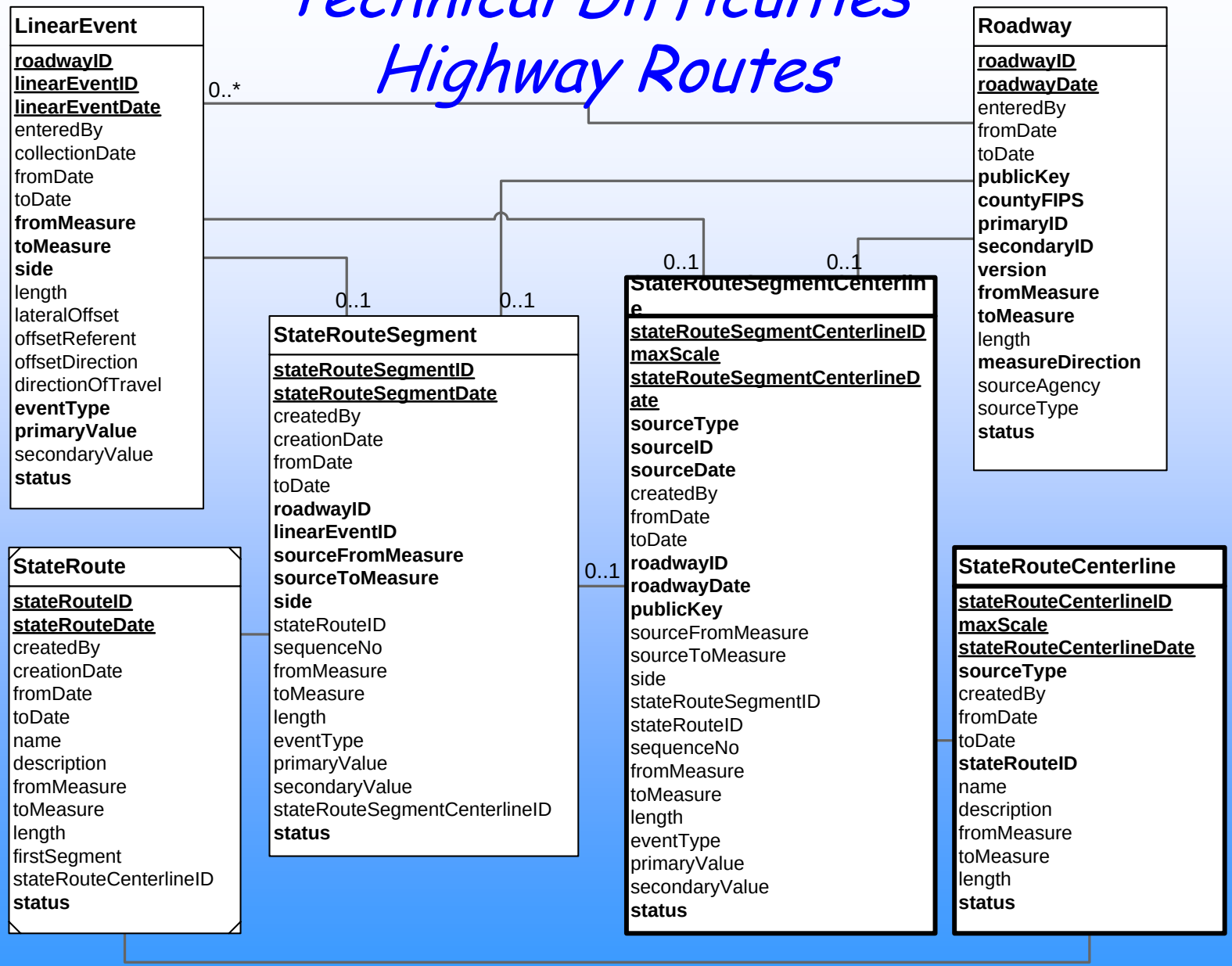
Requirements of and Problems with Roadway Measures

- **Measures *Along* a Roadway**
  - **Reference Points Remain Fixed Once Established**
  - **Calculations Based on Reference Points ***CANNOT*** Be Used as Roadway Length Measures**
  - **These first two requirements are CDOT Business Rules**
- **Measures *Of* a Roadway**
  - **Measured Roadway Segment Lengths Must Be Preserved Across All Kinds of Roadway Segmentation**
  - **Arc Feature Lengths Are Useful Only For Dynamic Segmentation**
- **Measure Control**
  - **Anchor Points Are Not Very Densely Found – Can Increase Length Errors**
  - **Mile Groups – More Dense and Tied to Mile Post Locations**
  - **Calibration Segments – Most Dense, but Termini May Be Hard to Find in the Field or on Aerial Orthophotos**

Technical Difficulties
Highway Routes & Roadways

- **Highway Route – Numbered and signed traversal along a continuous linear sequence of roadways. Has a linear reference system containing reference values assigned along the route. Reference values increase in one travel direction.**
- **Roadway – Physical feature supporting automotive conveyance. Uses a unique public key as its identifier. Highway routes utilize sequences of roadways to define their path through the state.**

Technical Difficulties
Highway Routes



Technical Difficulties
Data Migration

- **The original highway data LRS is based on Route ID and Reference Point**
- **Choose a measure system to which to transform the original data**
  - **Reference Point?**
  - **Cumulative Measure Lengths?**
- **Chose: Ref Point. BUT: Model expected to make calculations using Ref Point measures.**
- **Migration to the data model breaks the data!**
- **Migration uncovered errors in the data.**

Reasons to Stop the Project
Architecture and Design Were Complex

- **Recording and preserving correct measured roadway segment lengths caused migration to break the data.**
- **Using Cumulative Measure Lengths as reference measures caused serious changes to the data. Learned in May '07.**
  - **How to store the measured (ground) lengths of roadway segments in a consistent way.**
  - **How LRS/LRM systems had to be modified.**
- **CDOT decided not to continue using a database model that would break our roadway data.**
- **Integrity of the measured lengths is paramount.**
- **Implementing the physical model was difficult due to the GDB complexity.**
- **Initial Roadway Editor could not be made to work.**
- **As GDB logical and physical problems arose and attempts were made to fix those problems, the Roadway Editor application grew more and more complex.**

Reasons to Stop the Project
Business Requirements Emerged

- **Importance Increased Over Time**
  - **CDOT Highways paramount**
  - **Record and Preserve Correct Measured Roadway Segment Lengths**
  - **HPMS significance**
- **Importance Decreased Over Time**
  - **Implement Off-System roadways**
  - **Multiple representations of roadway geometry**
  - **Combine CDOT and local roadway data**
  - **Use of carriageways**

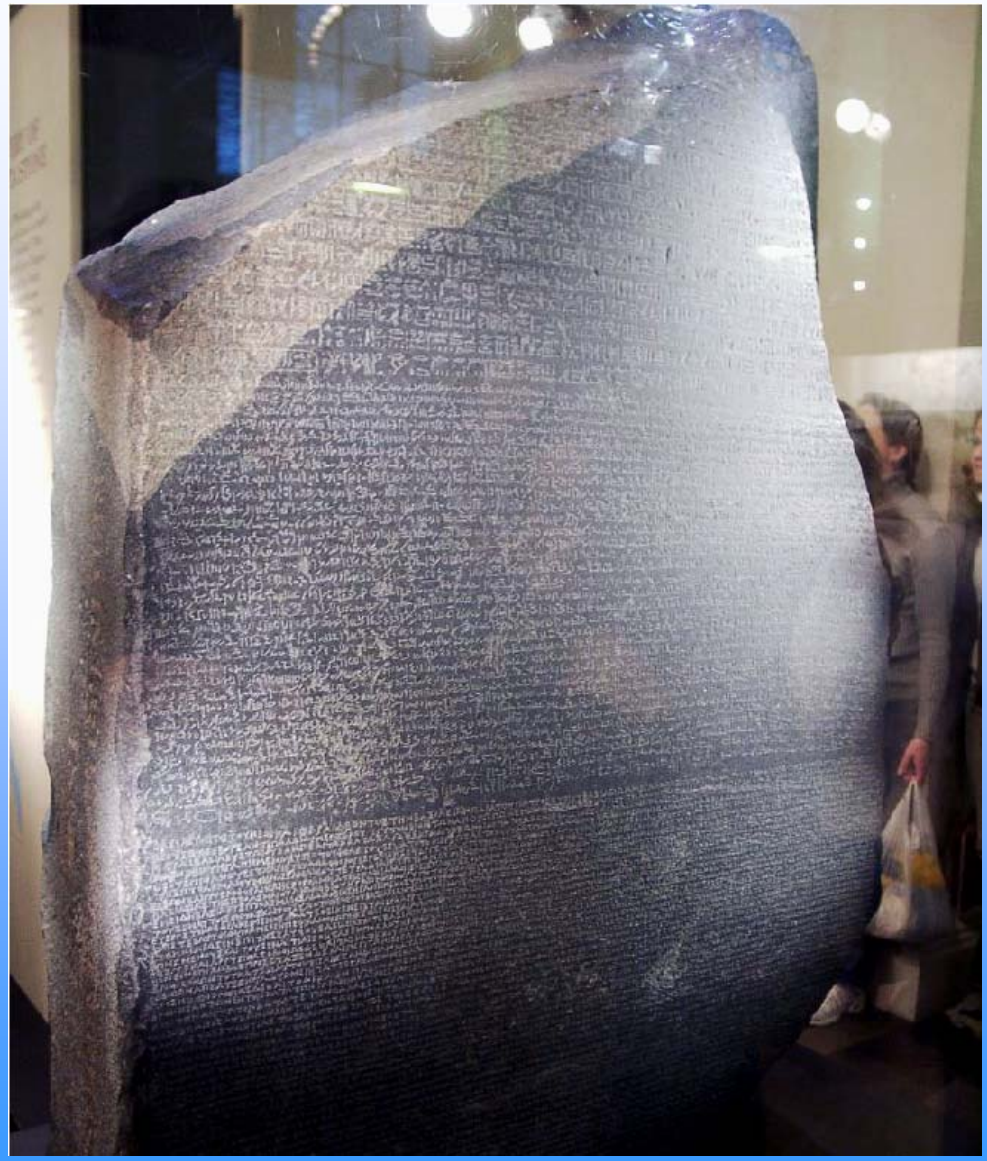
Reasons to Stop the Project
Staffing Changed

- Original staffing of two people edited highway data.
- Replaced by one staff member who could
  - Do both tasks.
  - Develop significant editing tools to strongly improve data quality and consistency.
- Clear separation of responsibilities between consultants and CDOT staff.
- Conceptually difficult data structures and migration process require more of staff.
- New staff focused more on CDOT highway data and HPMS impacts.
- No member of the GIS Section as of 2007 appeared to fully and completely comprehend the entire GDB model.

But Wait – There's More!

- **Taking valuable results as a basis for incremental changes to original database.**
- **CDOT calls this the TranSys Optimization Project.**
- **Implementing experimental project ("X").**
- **Based on much of the original design and uses in-house staff.**
- **Found solution to handling measure lengths and reference points.**

But Wait – There's More!
Rosetta Stone



But Wait – There's More!

- **"Rosetta Stone" provides 1-1 match between reference points and cumulative from and to measures.**

FromM	ToM	CalcLen	<>	BegRP	EndRP	MeasLen
1.075	4.82	3.745		1.204	4.797	3.745

Lesson
Regularly Evaluate Changes in Business Requirements

- **Core issues rise to prominence.**
- **Goals at the beginning of the project may become less significant.**
- **New goals may appear over time.**
- **As the business environment changes, the project needs to evolve.**

Lesson
Retain Organizational Understanding of the Goals and the Technical Methods

- **There must be a “Keeper of the Flame”.**
- **Management must remain convinced that the project is worth the resources.**
- **The Keeper of the Flame may be the only one who can do this.**
- **Had many Keepers over time!**
- **Consultants have been Keepers, too.**
- **Inspired us to move forward as a team.**

Lesson
Changes in Staff and Technology

- **Technology Changes**
  - **Additional Features to GeoDatabases Can Eliminate Some Implementation, especially for the Editor**
  - **Key RDBMS Features Are Not Visible / Accessible Thru GeoDatabase Interfaces**
- **Project documentation, both technical and process management, must be kept relevant, understandable, and current.**
- **Warning: Too Much Documentation Can Be Just As Bad As Having No Documentation!**
- **Staff Changes**
  - **Key Staff Departed**
  - **Contracts and Task Orders End**
  - **Staff Grow Into New Roles and Responsibilities**
  - **New Staff Were Constantly Trying to Catch Up**
- **Made progress when we took ownership of project.**

The Future

- We CAN use the original model, with adjustments.
- Model scrutinized based on real business requirements and LRS.
- This project now uses in-house staff.
- So the original project continues toward producing a roadway database that's usable and normalized!