Intro to GIS Spatial Analysis
INDOT Office of Traffic Safety

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Agenda
- What is GIS?
- Introduce GIS Applications used by INDOT Office of Traffic Safety
- Summary
- Conclusions
GIS is--

A Geographic Information System

Data Presentation

1. GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.

Data Integration

2. Integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.
Problem Solving

3. GIS helps you answer questions and solve problems by looking at your data in a way that is quickly understood and at the same time easily shared.

What is GIS?


GIS can Help

- You may wish to present a problem to others
- Maps and other data stored as layers of information in a GIS makes it possible to perform complex analyses
GIS can Help

- You may wish to present your solution to others
- Decision makers visualize and thereby understand the results of analyses or simulations of potential events
- Types of Graphics
  - Wall Maps
  - Internet-ready maps
  - Interactive maps on the computer screen

Building a GIS Base Map

GIS can use combinations of mapped variables to build and analyze new variables (See Figure 1)

GIS Information

- Relates information from different sources
- Relates different information in a spatial context to reach a conclusion about that relationship.
- Location Reference
  - Places information at some point on the globe
  - Uses a location reference system, such as longitude and latitude
  - Elevation is sometimes used
- So—Data Capture is defined as:
  - identifying the objects on the map
  - Define absolute location on the Earth's surface
  - Define spatial relationships
Data Capture

• Data can be directly entered into GIS (ArcGIS)
  – Federal Agencies
  – State repositories such as Indiana University
  – Tribal Governments
  – Local Governments
  – Private Companies
  – Academia
  – Non-profit organizations
  – ESRI Resource Center

Data Capture (con't)

• For Data not in Digital Form
  – Maps can be digitized by hand-tracing with a computer mouse
  – A digitizing tablet collects the coordinates of features
  – Electronic scanners convert maps to digital
  – Coordinates from Global Positioning System (GPS) receivers are uploaded into a GIS

GIS is More than a Map

• While a computer-aided mapping system might represent a road simply as a line, a GIS may also recognize that same road as the boundary between wetland and urban development between two census statistical areas.
Building a GIS Base Map

- GIS requires training
- Specific applications must be loaded on your office computer system
- Must connect to a database and known GIS servers for base map construction.

GIS Advantages

- An Engineer can analyze large amounts of data quickly and with great accuracy
- With limited manpower and limited funding, this is important
- INDOT is responsible for state-wide analysis so graphic query tools properly used are very valuable
- GIS makes it possible to link, or integrate, information that is difficult to associate through any other means.

Definitions

- Grid: A pattern of lines representing latitude and longitude
- Latitude: Imaginary lines that cross the surface of the Earth parallel to the Equator, measuring how far north or south of the Equator a place is located.
- Longitude: Imaginary lines that cross the surface of the Earth, running from north to south, measuring how far east or west of the prime meridian a place is located.
Definitions

Rail Highway Crossing Location
+40 2190000 ° Latitude; -85 3736700 ° Longitude
- McGalliard Road at NS Railroad Rail-Highway Crossing in Muncie, Delaware County
  - Indiana Lat is Roughly 37.9 to 41.7 deg
  - Indiana Long is Roughly -84.8 to -87.9 deg

Example- Rail Data

- Use FRA database
- FRA Provides the Latitude and Longitude

<table>
<thead>
<tr>
<th>DISTRICT</th>
<th>RR</th>
<th>STREET</th>
<th>AADT</th>
<th>LATITUDE</th>
<th>LONGITUDE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

With lat and long known, the data is now in the form of geographically referenced information

INDOT Office of Traffic Safety

- **Mission**: To Reduce Crash Rates and Crash Severity on both the State and Local Road Network

- **We must**:
  - Conduct analysis of data on a statewide basis
  - Programmatic studies require an Engineer to analyze large amounts of data

- GIS is an convenient tool to do this
INDOT Office of Traffic Safety

- Provides the "Engineering" Part of the four E's of Safety
  - Engineering
  - Education
  - Enforcement
  - Emergency Services

Four More E's of Safety

GREEN MONEY
ROADWAY SAFETY
EXEMPLARY LEADERS
EFFECTIVE LAWS
EVALUATION

GIS helps with these!

What do we do in Office of Traffic Safety?

- Reduce the crash or other data to tabular form using Lat and Long to get the spatial relationship
- Tie the tabular data to a GIS

That's all there is to it!
The Process in Detail

• Build a GIS Base Map
• Input Tabular Data (Access or Excel)
• Display Tabular Data
• Distribute the GIS map to those needing the data
• GIS maps are sometimes placed in reports prepared by the Engineer

Example INDOT Analysis

• RR Safety
  – Annual process of conducting a statewide safety analysis
• Median Crashes
• Centerline and Edge Line Rumble Strips
• Safe Routes to School Program
• 5% Report Crash Data; Index of crash cost uses TransCAD which is a GIS application

Tabular Data

• Graphic query tools used to present crash data
• Mouse click on GIS will bring up the data in the form of a Table
• Every attribute in table can be viewed
GIS

Allows us to view, understand, question, interpret, and visualize data in many ways

Reveal relationships, patterns, and trends in the form of maps, reports, and charts.

GIS at INDOT

- INDOT already has many GIS applications available to the public and other agencies (ArcGIS)

- I’ll discuss the INDOT Rail Locator

Examples
Note that this FRA data sheet was obtained directly from the GIS map.

• So, you can see that one GIS application can give you tremendous amount of data at your fingertips.
  • For instance:
    - A map
    - Inventory photos
    - Crash records
    - FRA inventory data
    - Aerial Photo
• http://dotmaps.indot.in.gov/apps/RailCrossings/

Example- Adding Tabular Data to a GIS
Example GIS ‘working data’

Example- Opening the Attribute Table

Options for Data Presentation

• Note you can present the data such as the current status of Public at-Grade Crossings
  – As a table
  – As a Pie Chart
  – GIS
• Note that the Tabular data is already embedded into GIS and you can click on the tables at any time, this is what makes GIS a powerful ‘one stop’ analysis tool
• See the following examples--
Example - Rail Highway Crashes

- 16% of crashes occurred in Lake County alone
- 33% of all crashes occurred in Lake, Porter, La Porte, St. Joseph and Elkhart counties
- Roughly half of all crashes occurred in just 9 counties

This data is displayed as a chart - You judge the impact it might have to an audience

Example - Rail Highway Crashes

GIS is displaying the crash statistics as geographically referenced information

Now we can 'see' the nine high frequency counties

Example - Current Status of Public at-Grade Crossings

<table>
<thead>
<tr>
<th>Protection Type</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossbucks or Stop Signs</td>
<td>2,888</td>
</tr>
<tr>
<td>Highway Active Protection</td>
<td>77</td>
</tr>
<tr>
<td>Flashing Lights</td>
<td>1,363</td>
</tr>
<tr>
<td>Passing Lane Exit Signals</td>
<td>1,883</td>
</tr>
<tr>
<td>Total</td>
<td>5,971</td>
</tr>
</tbody>
</table>

Data is Displayed as a Table
Example- Current Status of Public at-Grade Crossings

Data is Displayed as a Pie Chart

Display Data

Now, GIS can display the data as geographically referenced information on various maps

Analysis

Now, the data is easier to view, understand, question, interpret, and visualize
Presentation

Now, the data presentation may reveal relationships, patterns, and any trends.
Other Active Device Protection Crossings Displayed as geographically referenced information.

Recent Section 130 Projects Displayed as geographically referenced information.

Example—2009 Section 130 Projects Displayed as geographically referenced information.
1. Displays geographically referenced information.
2. Easy to view and visualize data in ways that may reveal relationships, patterns, and trends.
3. Problems are solved by looking at data that is quickly understood and at the same time easily shared.

**Example - Indiana Rail System Map from Report**

**Proposed 4Q Gate Locations**
Displayed as geographically referenced information

**4Q Gate Installation**

*Note that 4Q installations are placed in the high volume rail and highway traffic corridors.*
Other Examples of GIS in the Office of Traffic Safety

• Note in all cases, the GIS displays geographically referenced information.
• Easy to view and visualize data to reveal relationships, patterns, and trends.
• Data is quickly understood and at the same time easily shared.

Example—Centerline Crashes Displayed as geographically referenced information

Example—Candidate Project Locations Displayed as geographically referenced information
Example—
Safe Routes to School Locations
Displayed as geographically referenced information

Example—
TransCAD can be used to display HAT data as geographically referenced information as well as crash frequency

Example—
Cross Median Crash Frequency Displayed as geographically referenced information
High Frequency crashes in red; less crashes in green
Example—Cross Median Crash Frequency

- After locating the crash Hot Spots, actual projects can be programmed where the needs are the greatest
- GIS allows the Engineer to converge on a possible solution quickly
- GIS allowed the Engineer to view, understand, question, interpret, and visualize data to reveal relationships, patterns, and trends

Example—Cross Median Crash Frequency

Displayed as geographically referenced information

With use of GIS, Project selection is easy

Summary

- GIS displays geographically referenced information.
- Easy to view and visualize data to reveal relationships, patterns, and trends.
- Data is quickly understood and at the same time easily shared.
Summary (con’t)

- INDOT uses GIS Spatial Analysis tools to display highway crash data
- GIS can display a project location as a map
- INDOT uses GIS to analyze Railroad crash data
- Analyze Railroad Highway Crossing inventory data
- Plot cross median crash history on the interstate system
  - For example, no of crashes per five mile segment of interstate

Summary (con’t)

- GIS is a real time saver in the Office of Traffic Safety
  - Data would have to be processed manually and drawn on a map sheet
  - Manual analysis not practical since we need to do reports on an annual basis
  - GIS reduces manpower needed to analyze a dataset
- Be sure your data table and input is correct
- Our group foresees more and more applications of GIS

Concluding Remarks

- We encourage local government agencies and MPO’s to use GIS Spatial Analysis as a tool to analyze crash data
  - Most local agencies use GIS for utilities so expertise is probably already available
  - This expertise could be tapped and used for crash analysis
- With proper analysis, the limited highway and infrastructure dollars can be spent wisely on the locations where the most crashes occur
- It cannot be over emphasized that GIS Spatial Analysis data is
  - quickly understood
  - and at the same time easily shared
Concluding Remarks (con’t)

• With GIS, displaying geographically referenced information will help any team to converge on the best possible solution quickly and with less chance for error.
• So, we recommend any Agency to use GIS Spatial Analysis tools where practicable.