GIS to Support Transportation Research

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Thank you for including UMTRI on today's program
Presentation Outline

• Brief overview of UMTRI

• UMTRI generated spatial data

• Spatial data provided by state and local agencies to support UMTRI research

• 5 UMTRI projects supported by GIS

• Working with diverse spatial datasets to support transportation research

• Questions
Our Vision
Safe and Sustainable Transportation for a Global Society

Our Mission
Research Advancing Safe and Sustainable Transportation

- Interdisciplinary Transportation Safety Research
- Some $23M in annual funding from the government, foundations and industry
- 120 Full-time staff and students
UMTRI naturalistic driving data

• UMTRI is highly regarded for its field based geospatial data collection, analysis and integration with other spatial data. Projects include:

  • Safety Pilot Model Deployment
  • Road Departure Crash Warning (RDCW)
  • Integrated Vehicle Based Safety Systems (IVBSS)

Spatial data provided to support UMTRI research

• HPMS national and state files that include: Michigan, New York, Ohio, Pennsylvania, Texas, and Washington State among others

• All Michigan public roads-the framework

• Several local agency, sign and signal locations, building footprints, and parcel data

• MDOT system sufficiency data

• High resolution aerial photography and LIDAR data for several Michigan counties

• Michigan statewide crash data
UMTRI Projects Supported by GIS

**2015**

- Factors Associated with Effective Policy: A Geo-Spatial Examination of Teen Driver Policies
  - Teen Driver Behavior & Spatial Statistics

- Measuring, Characterizing & Reporting Pavement Roughness of Low-Speed & Urban Roads
  - Road Roughness & Urban Low Speed

- Safety Pilot Model Deployment
  - Vehicle to Vehicle, Vehicle to Roadside, Deployment of Dedicated Short Range Communication (DSRC)

- Ticketing Aggressive Cars and Trucks (TACT)
  - Driver Behavior & Law Enforcement

**2009**

- SO1 Development of Analysis Methods Using Recent Data: A Multivariate Analysis of Crash and Naturalistic Event Data in Relation to Highway Factors Using the GIS Framework
  - Driver Behavior & Crash Surrogates
Objective:
To provide a validated quantitative link between naturalistic driving data, road departure crashes, and road segment attributes.

Identify common roadway elements that are associated with crash data and driver behavior as captured in the RDCW naturalistic driving data.
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SO1 Development of Analysis Continued

Research Questions

Does naturalistic driving data contain measurable episodes of disturbed control?

Can driving data provide crash surrogates for actual crashes?

Four spatial layers were integrated:
Michigan Framework
HPMS segments
Crash subset
Road Departure Crash Warning FOT driver data
Project Conclusions:
The analyzes provided ample indication that episodes of disturbed control exist in the naturalistic driving data. These episodes can be related to crashes via highway variables.

The integration of spatial data sets made it possible to develop valid surrogates measures for behavioral outcomes.

Time of edge crossing (TTEC)
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Ticketing Aggressive Cars and Trucks (TACT) for the Michigan Office of Highway Safety Planning. Investigator Kostyniuk, L.

Project Goal:
Identify highway sections with high rates of crashes involving large trucks and cars that also reported an aggressive action. Then extract “pairs” of these highway sections for enforcement intervention and as a control.
Highway data was needed to support an in-depth analysis of truck-related crashes. Examples include:
- road segments that are part of the national truck route system
- percent commercial truck volumes (truck and car crash rates computed)
- highway geometry such as shoulder width and number of lanes.

The Michigan DOT sufficiency data provided these fields.

Two spatial layers were integrated:
MDOT Sufficiency Data
Crash
Several pairs of sites were identified as potential candidates.

Project results supported Michigan’s successful application for TACT funding.
Safety Pilot Model Deployment, U.S. Department of Transportation, automobile, and industry partners. Investigator Sayer, J., UMTRI

Research Vision

The vision of the Safety Pilot is to test connected vehicle safety applications in real-world driving scenarios to determine their effectiveness at reducing crashes and to ensure that the devices are safe and do not unnecessarily distract motorists or cause unintended consequences.
The vision is to test connected vehicle safety applications in real world driving scenarios to determine their effectiveness at reducing crashes and to gauge user acceptance.

Approximately 2836 vehicles, including large trucks, motorcycles and a bicycle, are being equipped with dedicated short-range communications (DSRC) devices to enable vehicle to vehicle and vehicle to roadside communication.
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Safety Pilot Model Deployment  Continued

UMTRI envisions the Model Deployment project and its spatial data as a critical step to improving the safety of the national roadway system.

Potential Analysis of Safety Pilot Data

Safety Pilot Kick-Off Event
August 2012 @ UMTRI
U.S. Dept. of Transportation
Secretary Ray LaHood
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Many of the rough features on urban and low-speed roadways are due to the constraints of constructing these roads. For example, curb matching and utility access covers.

Utility access data located in an urban roadway.

<table>
<thead>
<tr>
<th>I_Node</th>
<th>F_X</th>
<th>F_Y</th>
<th>Feature</th>
<th>Func</th>
<th>R_U</th>
<th>Spd</th>
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</thead>
<tbody>
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<td>189167.83</td>
<td>Sewer</td>
<td>3</td>
<td>1</td>
<td>35</td>
<td>15280</td>
</tr>
</tbody>
</table>
The type of roughness that appears on urban and low-speed roadways is different than on high-speed, limited access roads.

The objective of this research is to identify or develop a means for measuring, characterizing, and reporting pavement roughness on low-speed and urban roads.

C = \( c_2/m_s = 6.0 \text{ sec}^{-1} \)

\( K_1 = k_1/m_s = 653 \text{ sec}^{-2} \)

\( K_2 = k_2/m_s = 63.3 \text{ sec}^{-2} \)

\( \mu = m_u/m_s = 0.15 \)

\( B = 250 \text{ mm} \)

The Golden Car Model (Sayers, 1995)
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Factors Associated with Effective Policy: A Geo-spatial Examination of Teen Driver Policies, University of Michigan Injury Prevention Center, Nat’l Center for Injury Prevention and Control. Lipton, R. and Bingham, R.

This project will be the first to evaluate Graduated Driver Licensing (GDL) policy using multilevel spatial models to provide a comprehensive understanding of crash risk factors, and help to understand the association between GDL and spatially distributed crash risk factors for teen drivers.
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Factors Associated with Effective Policy: A Geo-spatial Continued

Project analysis will include:

1) identify spatially distributed risk factors associated with increased involvement of teen drivers in crashes; and

2) examine how those risk factors change when GDL is implemented using a quasi-experimental pre-post – implementation design with adult drivers as a comparison group.
Working with diverse spatial datasets
UMTRI driver data vs. Asset Management Data

- Terabytes of Point Data captured at 10Hz, multi-state travel
- 100 – 500 data channels of vehicle mechanics, motion, driver inputs and experimental system health data (i.e. Lane Departure Warning (LDW) Curve Speed Warning (CSW), among others.
- Data tied to GPS, trip, time stamp (resolution 3 – 10m)
- Mining and drawing subsets requires extensive knowledge of complex SQL database
- Users are required to complete an extensive data request to have access
- Very expensive data to collect
Working with diverse spatial datasets
UMTRI driver data vs. Asset Management Data

- Point, Line and Polygon Data
- Ortho-corrected aerial photo
- High resolution (sub meter) LIDAR – derived DEM, etc.
- Data has one purpose to describe and manage the asset or describe the event (crash)
- Consistent data captured – temporally stable
- Data open to the public (with the exception of some driver ID fields in crash data)

So with all this data you must know everything ..,
Working with diverse spatial datasets

...ah no.

Understand the why, how and when the asset data was created.

Understand every data field.

Before integrating/fusing understand the resolution and projections of the sets. What transformations, if any, are needed?

On which map are you going to base the integration?

How might each dataset be used to “validate” the other?

What are your questions for the data integration?

Can integrated data support heuristically based conclusions?

*Remember asset datasets were not made to support your research.*
Working with diverse spatial datasets

For example: Map matching driver data. How many miles of a trip were driven on interstates?

Thin out on driver data points from 10Hz to 1Hz. Join (append) the trip to the road segments (centerline) add road attributes to the driver data.

Result: Some points joined are too far from the centerline to be valid.

Use a different map or analysis method?

Remember your integrating approximately 250K of points – trip length dependent.

What is next?
Working with diverse spatial datasets

Change the spatial analysis method.

Instead of joining to centerlines; model the interstate polylines as a polygon using the number of lanes, lane and median width.

Rerun and base the join on what points fall within the polygon or real estate of the road.

Stray satellite GPS points are not included in the output. Integrated sets assist in validating the results and addressing the research question.

- **Driver Data**
  - rate of speed (+60 mph)
  - heading East

- **Asset Data**
  - posted speed (70 mph)
  - EB I 94*
  *assumes dual carriageway

Now compute the number of interstate road miles driven by Driver X during Trip A.
GIS will continue to play a key role to improving the safety of the nation’s transportation system through the collection, mining and analysis of spatial data.
Thank you for your interest on how GIS data and tools support transportation research at UMTRI

Also, a special thanks to all who have provided UMTRI with spatial data. It is appreciated!
Questions

Thank You

Presentation - Linear Time System (LTS)