Wisconsin Safety Certification Mapping

Crash Map Automation

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Introduction

Safety Certification Mapping

• Develop an application with which users can quickly and easily identify, analyze, and map the most dangerous* segments of highway
  • Where can resources be dedicated most efficiently to reduce safety concerns related to roadway geometry rehabilitation?
  • “Sites of Promise”
• Ready access to data brought together from multiple sources.
  • State Trunk Network (STN), Linear Referencing System (LRS)
  • MetaManager – WisDOT data product

Safety Problem Flags (Crashes/100 million VMT)

• Crash Rate: All crashes
• KAB Crash Rate: Fatalities, Incapacitating Injury, Non-incapacitating Injury

• WisTransPortal Crash Database
• Self Service and easy. Limited or no special training
• Central and accessible storage location
**Status Quo Ante**

- Manually Created Maps
- Involved lookups to a variety of data sources – Inaccessible in some cases
  - As-built drawings, Asset Management, Crash Data

- Time consuming to make, Not readily reproducible, Stored in “silos”
Data Sources
WisDOT STN
Wisconsin Department of Transportation State Trunk Network

- Interstates
- US Highways
- State Highways

Pioneer of Linear Referencing

Position in terms of:
- Reference Points, Landmarks
- Link and Offset
- Route and Cumulative Mileage

Base linear referencing system for roadway features and operations
**WisDOT STN**

- **Routes**
  - Directional routes by highway and direction, concurrent routes addressed

- **Links**
  - Tabular representation of segments representing a complete route, directional but not meaningful spatial features

- **Chains**
  - Spatial representation (geometry) of the roadway centerlines
  - No inherent direction. Travel-Digitization direction mismatches

- **Cumulative Mileages**
  - Mileage at the start of each link relative to the parent route

- **Link History** – handles realignment and name changes

Hard to use for mapping out of the box
WisDOT STN

Lookup tables – Route -> Link, Link -> Chain

• Route to Links - one to many, ordered relationship
• Link to chain lookup is more involved, relationship attributes
  • A given link can be entirely within a single chain or can encompass all of several chains and overlap adjacent
  • Participation of a chain in a link is represented as from and to percentages. Ex. 0.2 - 0.6 or 0.2 – 1, 0.0 -1.0, ... , 0.0 – 0.4
  • Travel/digitization direction inversion represented as from percentage greater than to direction
• Database solution wherein a link’s geometry is generated as a merge of portions of participating chains with travel direction matching digitization direction (PostgreSQL/PostGIS)
WisDOT STN – API

https://transportal.cee.wisc.edu/gis/webmaps/api/

Collection of web services with usage and URL parameters described

**STN API**

**STN Year** 2017

**https://transportal.cee.wisc.edu/api/stn/years**

Get the number of STN year versions in the database

JSON structure

- `years`: number array

**https://transportal.cee.wisc.edu/api/stn/routes**

Get the STN routes near a specified coordinate

**URL parameters**

- `lon`: number
- `lat`: number
- `year`: number
- `distance`: number Search Distance, *Optional* Defaults to 500 feet

JSON structure

- `routes`: object
- `error`: text, not present if successful

**Example**

https://transportal.cee.wisc.edu/api/stn/routes?lon=89.516883&lat=43.134362&year=2017

**https://transportal.cee.wisc.edu/api/stn/snapped**

Get a point snapped to the STN route
WisDOT STN – API

URL endpoints to query STN features, get snapped points, and derive segments based on user specified coordinates or route and mileage.

Snapped point from route, user coordinates and search radius

```
/snapped?year=2017&route=111&lon=-92.28&lat=45.19&distance=500
```

Segment from route and start - end miles

```
/segment?year=2017&route=111&startMile=57.1&endMile=57.6
```
<table>
<thead>
<tr>
<th>MetaManager</th>
</tr>
</thead>
<tbody>
<tr>
<td>• WisDOT data product</td>
</tr>
<tr>
<td>• Updated 3 times a year</td>
</tr>
<tr>
<td>• ~20,000 segments with a typical length of ¾ mile, covers 15K miles</td>
</tr>
<tr>
<td>• Over 200 attributes per segment, several categories</td>
</tr>
<tr>
<td>• Spatially enabled dataset derived from the STN</td>
</tr>
<tr>
<td>• Distributed as a zip file with one ESRI shapefile and one Excel document for each of 5 WisDOT regions - loaded into a relational database</td>
</tr>
<tr>
<td>• Selected Tables</td>
</tr>
<tr>
<td>• Base – Segment start/end reference points, highway, direction</td>
</tr>
<tr>
<td>• Roadway – AADT, Roadway Attributes, Curve, No-passing zones</td>
</tr>
<tr>
<td>• Pavement – Current and projected pavement conditions</td>
</tr>
<tr>
<td>• Safety – Crash Counts, Accident Flags (last 5 years*)</td>
</tr>
<tr>
<td>• Mobility – Level of service, deficiencies, suggested Improvements</td>
</tr>
<tr>
<td>• Bridge – Attributes, current and projected conditions,</td>
</tr>
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</table>
MetaManager

- Unit of analysis is the PDP segment
- Reverse lookup to the STN needed to be created
- Route attribute can be derived from MetaManager attributes
- Lookup table generated by parsing start and end Reference Point (RP) definition given for each segment
  - Reference Point and offset to make start and end cumulative mileages for each PDP segment
- Route and cumulative mileage is the common linear reference for all data in the application
WisTransportal – Many Services, Applications

- Crash Database
- 1994 to present
- Crash attributes (100+)
  - Location
  - Vehicles Involved
  - Injury severity(ies)
  - Road Conditions
  - Derived Route and cumulative mileage
- Link to full crash report
- Purposes
  - Service to WisDOT, law enforcement
  - Valuable for research
Photolog

- Precise XYZ location at 1/100\textsuperscript{th} mile intervals
- Used for curve identification and visibility analysis

Example of Photographs Associated with Each Photolog Point
Under the Hood
**Architecture**

**Database**
- Oracle
- PostGIS

**Server**
- Main Application
  - Java
  - Python
- STN API
  - Spring
  - Flask
- Hibernate
- SQLAlchemy

**Client/Browser**
- OpenLayers
- React + Redux
- jQuery
- Bootstrap
- HTML & CSS
SCM Project Creation
Project Definition

- Reference to project database to automatically populate SCM project attributes
  - Project title, construction IDs, primary route
  - User defined crash date (year) range
Project Extent

- Definition of a project by the selection of start and end segments for one or more corridors – Highway route and direction and county
- Point-Click interface with interactive popups

Project create or modification triggers queries against available data (Crashes)
Project Editing

Summarize the contributing factors for ALL crashes in the flagged segment or intersection.

Which geometric features contribute to the type and severity of the crashes?

Possible Countermeasures for Safety Mitigation Process

Define SCM Segment(s)

- Crashes
“Sites of Promise”

- Web Interface for definition of extent of segments
- Can be the full PDP segment but are typically shorter
- Utilizes the STN API previously described
Map View

Visualization of MetaManager flagged segments and user defined segments

Popup windows with crash summary by user defined segments
Map View

SCM project extent with crash points symbolized by severity (K, A, B, C, other)

Crash information popup window with crash report download link
### System Screening - Sites of Promise

<table>
<thead>
<tr>
<th>PDP ID</th>
<th>From FIP</th>
<th>FIP Description</th>
<th>To FIP</th>
<th>Length (PDP Mile)</th>
<th>Crash Rate Flag</th>
<th>KABL Crash Rate Flag</th>
<th>Intersection Crash Rate Flag</th>
<th>Intersection KABL Crash Rate Flag</th>
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### Crash Vetting Sites of Promise

- Summarize the contributing factors for ALL crashes in the flagged segment or intersection.
- Which geometric features contribute to the type and severity of the crashes?
- Possible Countermeasures for Safety Mitigation Process

### Contributing Geometric Analysis

- SC/M/Seg 1: Shoulder Width - Offset to curb location
- Asphal t
- Curve

### PDP Segment Information
- From and to cumulative mileages
- MetaManager Flags
- User entered data
Safety Certification Mapping (SCM) Tool

Design ID: 1550-04-02
Construction ID(s): 1550-04-72

Project Title: CLEAR LAKE - CUMBERLAND
Project Description: CTH J TO USH 8

SCM Comment
Comments

Meta Manager Version: 2016-09
Meta Manager Crash Years: 2010-2014
SCM Crash Years: 2012-2017

Sites of Promise

<table>
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<tr>
<th>Corridor #</th>
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13412: SCM Segment
13414: KAB, Crash Rate
13416: Crash Rate
13419: Crash Rate
13421: Crash Rate
13424: SCM Segment
13425: Crash Rate
13426: KAB
# PDF Output

## Corridor #1: US 63 NB - 063N069 104 - 063N088M000

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## Manner of Collision

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<th>SS SAME</th>
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</tbody>
</table>
Crash Summary Download

- Automated means to summarize crash information within the SCM Project as a CSV
- Indicates to which PDP a crash corresponds
- Crashes specially identified where an intersection with an SCM segment occurs

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
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</tbody>
</table>
SCM Safety Certification Mapping

Search Existing SCMs

Create New SCM

Manage Users

The WiTransPortal Safety Certification Mapping (SCM) tool is maintained by the Wisconsin Traffic Operations and Safety Laboratory in partnership with Wisconsin Department of Transportation. Send questions or comments to crash-data@topslab.wisc.edu. Refer to the Contact page for support staff contact information.

You are logged in as gavorhes (ADMIN). Reset.

SCM Version: 1.1.0 (SCM) R20190308
Conclusion

• Considerable time savings
  • Safety Certification Map is a required component of new projects
• Central storage and distribution center
• Map and report must be present in Design Study Report
• As an interactive web map, provides more (organized) information than is feasible on a static map

Thank you for coming!
Questions?