An Overview of the ODOT Safety Investigations Manual

Presented at Traffic Day
Eugene, Oregon
October 20, 2009

Karen K. Dixon
Associate Professor

Christopher M. Monsere
Assistant Professor
Outline of the Manual

1. Manual Overview
2. Safety Investigation Basics
3. Overview of Data Sources
4. Diagnosing Crash Patterns
5. Site Investigations
6. Countermeasure Selection and Recommend Improvement Analysis
7. Document Implementation
   • Appendix
     – Worksheets, Instructions, Example Problems, Case Studies
Purpose

• Resource for traffic investigators
  – Both experienced & new
• Training material
• Standardized approach
• Useable by local agencies
Principles of Investigation

• The doctor is in!

• Crashes are rare events

• Most users prefer to avoid a crash

• Trying to detect a pattern of crashes that are “out of the ordinary”
Basic Concepts

- Factors that “cause” crashes
- Rates
- Duration
- Severity

[Diagram showing the overlapping percentages between Roadway, Driver, and Vehicle factors]
## In Office Data

<table>
<thead>
<tr>
<th>Crash</th>
<th>Geometry</th>
<th>Exposure</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Data</td>
<td>Highway Inventory</td>
<td>Functional Class</td>
<td>Web TransGIS</td>
</tr>
<tr>
<td>SPIS</td>
<td>Digital Video Log</td>
<td>Traffic Volumes</td>
<td>Traffic Signal Timing</td>
</tr>
<tr>
<td>SIP</td>
<td>Google Maps</td>
<td>As Built Plans</td>
<td></td>
</tr>
</tbody>
</table>

### Data Collection

1. **CRASH DATA ANALYSIS**
2. **SITE INVESTIGATION**
3. **IDENTIFY CANDIDATE COUNTERMEASURES**
4. **RECOMMEND IMPROVEMENTS**
5. **DOCUMENT AND IMPLEMENT IMPROVEMENTS**
Crash Data

- Reporting process
- Data structure
- Severity
- Coding manual
- Location
- Accessing the data
Digital Video Log

- ODOT’s Digital Video Log provides street level views which can be used to identify signal types, milepoints, driveways, and roadside objects.
Google Earth can provide a good aerial view for:

LT and RT lanes,

Center TWLT lane,

Has an easy measuring tool in “My Maps”
Functional Class

RURAL
- Rural interstate
- Rural other principal arterial
- Rural minor arterial
- Rural major collector
- Rural minor collector
- Rural local

URBAN
- Urban interstate
- Urban other freeways and expressway
- Urban other principal arterial
- Urban minor arterial
- Urban collector
- Urban local
# In Office Data

<table>
<thead>
<tr>
<th>Crash</th>
<th>Geometry</th>
<th>Exposure</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Data</td>
<td>Highway Inventory</td>
<td>Functional Class</td>
<td>Web TransGIS</td>
</tr>
<tr>
<td>SPIS</td>
<td>Digital Video Log</td>
<td>Traffic Volumes</td>
<td>Traffic Signal Timing</td>
</tr>
<tr>
<td>SIP</td>
<td>Google Maps</td>
<td>As Built Plans</td>
<td></td>
</tr>
</tbody>
</table>

## Data Collection

1. **Crash Data Analysis**
2. **Site Investigation**
3. **Identify Candidate Countermeasures**
4. **Recommend Improvements**
5. **Document and Implement Improvements**
Crash Patterns

- Compare actual crash distribution for some average facility
- Find unusual patterns
- May lead to solution
Normative distributions for each functional class

- Collision type (all)
- Collision type (fatal & severe injury)
- Number of vehicle
- Residence of driver
- Sex of driver
- Time of day
- Light condition
- Weather

- Surface
- Day of the week
- Driver age
- Location
  - On roadway
  - Off roadway
- Cause codes
## Excel Worksheet

### Data Summary

<table>
<thead>
<tr>
<th>Column</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Integer</td>
<td>Number of Vehicles</td>
</tr>
<tr>
<td>B</td>
<td>String</td>
<td>Accident Type</td>
</tr>
<tr>
<td>C</td>
<td>String</td>
<td>Time of Day</td>
</tr>
<tr>
<td>D</td>
<td>Boolean</td>
<td>Day of Week</td>
</tr>
<tr>
<td>E</td>
<td>Float</td>
<td>Speed</td>
</tr>
</tbody>
</table>

### Traffic Volumes

<table>
<thead>
<tr>
<th>Month</th>
<th>Day</th>
<th>Total Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>10</td>
<td>5000</td>
</tr>
<tr>
<td>Feb</td>
<td>20</td>
<td>4000</td>
</tr>
<tr>
<td>Mar</td>
<td>30</td>
<td>3500</td>
</tr>
</tbody>
</table>

### Collision Types

<table>
<thead>
<tr>
<th>Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rear End</td>
<td>45</td>
</tr>
<tr>
<td>Head On</td>
<td>25</td>
</tr>
<tr>
<td>Side Impact</td>
<td>32</td>
</tr>
</tbody>
</table>

### Location Details

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highway</td>
<td>100% Highway</td>
</tr>
<tr>
<td>Rural</td>
<td>50% Rural</td>
</tr>
</tbody>
</table>

### Accident Severity

<table>
<thead>
<tr>
<th>Severity</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>80%</td>
</tr>
<tr>
<td>Moderate</td>
<td>15%</td>
</tr>
<tr>
<td>Severe</td>
<td>5%</td>
</tr>
</tbody>
</table>

### Additional Information

- **OSU** Oregon State University
- **Portland State University**

---
<table>
<thead>
<tr>
<th>Route Number:</th>
<th>OR-97</th>
<th>Hwy Name:</th>
<th>THE DALLES-CALIFORNIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Character:</td>
<td>RURAL</td>
<td>Facility Type:</td>
<td>RURAL PRINCIPAL ARTERIAL</td>
</tr>
<tr>
<td>County:</td>
<td>DESCHUTES</td>
<td>City:</td>
<td>NA</td>
</tr>
</tbody>
</table>

![Excel Worksheet Image]
## CRASH TOTALS

<table>
<thead>
<tr>
<th>Severity</th>
<th>Proj</th>
<th>Obs %</th>
<th>Ex %</th>
<th>P(Norm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal+ Inj A</td>
<td>6</td>
<td>9.8%</td>
<td>8.2%</td>
<td>23.2%</td>
</tr>
<tr>
<td>Injury B+C</td>
<td>27</td>
<td>44.3%</td>
<td>41.4%</td>
<td>27.8%</td>
</tr>
<tr>
<td>PDO</td>
<td>28</td>
<td>45.9%</td>
<td>50.4%</td>
<td>71.7%</td>
</tr>
<tr>
<td></td>
<td>61</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Proj</th>
<th>Obs %</th>
<th>Ex %</th>
<th>P(Norm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head-on</td>
<td>5</td>
<td>8.2%</td>
<td>3.8%</td>
<td>2.8%</td>
</tr>
<tr>
<td>NonCollision</td>
<td>0</td>
<td>0.0%</td>
<td>7.0%</td>
<td>98.8%</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>9.8%</td>
<td>8.0%</td>
<td>21.5%</td>
</tr>
<tr>
<td>Parked</td>
<td>0</td>
<td>0.0%</td>
<td>0.3%</td>
<td>18.3%</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>1</td>
<td>1.6%</td>
<td>0.5%</td>
<td>4.3%</td>
</tr>
<tr>
<td>Rear</td>
<td>20</td>
<td>32.8%</td>
<td>18.9%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Sideswipe-Meet</td>
<td>1</td>
<td>1.6%</td>
<td>3.5%</td>
<td>62.7%</td>
</tr>
<tr>
<td>Sideswipe-Over</td>
<td>1</td>
<td>1.6%</td>
<td>2.8%</td>
<td>51.0%</td>
</tr>
<tr>
<td>Turn</td>
<td>13</td>
<td>21.3%</td>
<td>13.2%</td>
<td>2.6%</td>
</tr>
<tr>
<td></td>
<td>61</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
</tr>
</tbody>
</table>
Collision Diagrams

- Automated or hand drawn
Site Investigations

• Safe Data Collection Procedures
• General Data Collection
• Identifying Unique Site Features and Supplemental Analyses
• Identifying Appropriate Field Studies Specific to Crash Patterns
• Performing Data Collection for Specific Field Studies
Site Investigation

Crash Data Analysis

Review Digital Video Log and Highway Inventory Reports

Complete the top portion of the Field Site Investigation Form

Conduct field investigation and document effort with the completed Field Site Investigation Form, a completed Roadway Inventory Checklist, and supplemental worksheets as needed

Identify Candidate Countermeasures
General Site Investigation Items

- General Road
- Road Surface
- Road Geometry
- Intersection
- Signs & Markings
- Traffic Signals
- Pedestrians/Bicycles
- Lighting
- Parked Vehicles
- Speed
- Environment
- Roadside
- Visibility
- Evidence of Problems
# Field Site Investigation Form

**Location:**

City/Town/County: __________

- Rural
- Urban
- Suburban

- Tangent
- Curves

**Reason for Investigation:**

- SPIS Investigation
- Response to complaint or inquiry
- Project Request
- Fatal Crash Reports
- Other: ________

**Route no. or Street name:** __________

**State highway no.:** __________

**Mile Point(MP):** ________

At intersection with (if applicable):

**Route no. or name:** __________

**State highway no.:** __________

**Mile Point(MP):** ________

**Crash Summary:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Fat.</th>
<th>Severe Inj.</th>
<th>Other Inj.</th>
<th>PDO</th>
<th>Crash Patterns to Investigate (see Pattern Diagnostics Worksheet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Traffic Data:**

- Highway type: ______
- ADT(1000): ______
- Posted Speed: _____

**Investigator**

<table>
<thead>
<tr>
<th>Date</th>
<th>Project Manager</th>
<th>Date</th>
<th>Approved by</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OSU Oregon State University

Portland State University
## Roadway Inventory Checklist

### Traffic Controls:
- No Control
- Traffic Signal
- Flashing Red Signal
- Flashing Yellow Signal
- Stop Sign
- Yield Sign
- RR Flashing Lights, Signals, Gates
- RR Crossbuck with Adv. Signs
- RR Crossbuck without Adv. Signs
- School Zone Sign
- No Passing Zone
- Other Traffic Control ________

### Pavement Markings:
- None
- Broken Yellow Line
- Broken Yellow Line & Solid Yellow Line
- Solid Yellow Line
- Double Solid Yellow Lines
- Broken White Line
- Solid White Line
- Edge Lines
- Raised Pavement Markers
- Temporary Pavement Marking
- Other Pavement Markings ________

### Auxiliary Lanes:
- None
- Left Turn
- Right Turn
- TW/LTL
- Passing
- Special Purpose ________

### Access Control:
- Interstate
- Other Limited Access
- Controlled Access
- Uncontrolled Access
- Median Crossover

### Roadway Geometry:
- Curvature (Centerline Radius = __________) OR □ Straight
- Grade (Approximate Grade in Percent = ____________)
- Superelevation (Approximate Superelevation in Percent = ____________)
- Median (Width = ____________) OR □ Undivided
- Through Lanes (Describe: ____________________________)
- Lanes (Widths = ________________)
- Shoulder (Type & Width: __________) OR □ Curb OR □ No Edge Treatment
- Surface Treatment (Describe: ____________________________)
- Other Road Geometry not indicated: ____________________________

### Adjacent Land Use:
- Residential
- Commercial
- Industrial
- Agricultural / Natural
- Undeveloped
- School
- Other ________
# Example Diagnosis & Countermeasures (Midblock)

<table>
<thead>
<tr>
<th>Crash Pattern</th>
<th>Probable Cause</th>
<th>What to Document</th>
<th>General Countermeasures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sideswipe collisions between vehicles traveling in opposite directions or head-on collisions</td>
<td>• Roadway design for traffic conditions</td>
<td>• Number of lanes / lane widths / lane usage</td>
<td>• Install/improve pavement markings</td>
</tr>
<tr>
<td></td>
<td>• Location / description / measurement of median</td>
<td>• Location and visibility of advance warning signs</td>
<td>• Channelize intersections</td>
</tr>
<tr>
<td></td>
<td>• Shoulder type / width and condition</td>
<td>• Roadway type and condition</td>
<td>• Create one-way streets</td>
</tr>
<tr>
<td></td>
<td>• Passing on shoulder</td>
<td></td>
<td>• Restrict parking</td>
</tr>
<tr>
<td>Collisions between vehicles traveling in same direction such as sideswipes, turning or lane changing</td>
<td>• Roadway design for traffic conditions</td>
<td>• Location and description of traffic islands</td>
<td>• Install median divider / barrier</td>
</tr>
<tr>
<td></td>
<td>• Inadequate passing zones</td>
<td>• Pavement widths</td>
<td>• Widen lanes</td>
</tr>
<tr>
<td></td>
<td>• Passing on shoulder</td>
<td>• Lane widths</td>
<td></td>
</tr>
<tr>
<td>Collisions with parked cars or cars being parked</td>
<td>• Large parking turnovers</td>
<td>• Number of lanes / lane widths / lane usage</td>
<td>• Widen lanes</td>
</tr>
<tr>
<td></td>
<td>• Roadway design inadequate for present conditions</td>
<td>• Parking configuration type</td>
<td>• Channelize intersections</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Add capacity (other program)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Right/left turn lane</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Provide turning bays</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Install advance route or street signs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Install/improve pavement lane lines</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Restrict parking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reduce speed limit</td>
</tr>
</tbody>
</table>

23
Countermeasure Selection

• Select the “cure” for the crash
• Good countermeasure should reduce either the frequency or severity of dominant crashes types.
• Tradeoffs between safety and other competing decision elements should be expected
Select potential countermeasures based on data analysis and site investigation findings

Does the potential countermeasure meet sound engineering principles

Recommend Improvements
1. Recommend Improvements

2. Identify Candidate Countermeasures
   - Determine CRF for each candidate countermeasure
   - Conduct Benefit-Cost Analysis

3. Is this cost feasible?
   - NO
     - Evaluate Alternative Options or Incremental Improvements
   - YES
     - Select best alternative or set of alternatives

4. Document and Implement Improvement
Countermeasure Catalogs

• ODOT’s
  – Research publication
  – Tables from Previous Chapter
  – Excel lists

• FHWA’s Countermeasure Clearinghouse

• Highway Safety Manual, Part 4: Knowledge

• AASHTO’s Strategic Highway Safety Plan Guidebooks
CRF or AMF?

- Crash (accident) reduction factor or CRF
  - a percent reduction in the “before” crashes after implementing the countermeasure
- Accident (crash) Modification Factor (AMF) [or CMF]
  - the fraction of the total crashes expected after the countermeasure
- CRF = (1-AMF)

CRF > 0
- Less Crashes
- AMF < 1.0

CRF < 0
- More Crashes
- AMF > 1.0
Selecting the Best Alternative

- Benefit cost worksheet
- For each alternative
- Lookup values for crash costs
Documentation

• *Highway Safety Investigations Report* HSIR

• Action:
  – Maintenance
  – Quick-hit
  – Part of larger project
  – Stand-alone project
Appendix Worksheets

• Highway Safety Investigations Report
• Crash Pattern Worksheets
• Field Site Investigation Form
• Roadway Inventory Checklist
• Equipment Checklist
• Intersection Sight Distance Worksheet
• To-be-determined
Next Steps

• Finish case studies
• Test with investigators for feedback
• Finish examples
• Publish
• Develop training
Questions
Acknowledgments

• Oregon Department of Transportation
• Portland State University
• Oregon State University

• M. Mouse and A. Jolie for testing forms