An Overview of the ODOT Safety Investigations Manual

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An Overview of the ODOT Safety Investigations Manual

Presented at  Traffic Day
Eugene, Oregon
October 20, 2009

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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
# 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

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

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DATA COLLECTION

- CRASH DATA ANALYSIS
- SITE INVESTIGATION
- IDENTIFY CANDIDATE COUNTERMEASURES
- RECOMMEND IMPROVEMENTS
- DOCUMENT AND IMPLEMENT IMPROVEMENTS
Crash Patterns

- Compare actual crash distribution for some average facility
- Find unusual patterns
- May lead to solution

Observed  “Expected”

[Diagram with steps and icons, including:
- Data Collection
- Crash Data Analysis
- Site Investigation
- Identify Candidate Countermeasures
- Recommend Improvements
- Document and Implement Improvements]
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
Route Number: **OR-97**  
Hwy Name: **THE DALLES-CALIFORNIA**

Road Character: **RURAL**  
Facility Type: **RURAL PRINCIPAL ARTERIAL**

County: **DESCHUTES**  
City: **NA**
## Excel Worksheet

### 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>
<tr>
<td>Head-on</td>
<td>5</td>
<td>8.2%</td>
<td>3.8%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Non-Collision</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

<table>
<thead>
<tr>
<th>Location:</th>
<th>Rural</th>
<th>Urban</th>
<th>Suburban</th>
<th>Tangent</th>
<th>Curves</th>
<th>Reason for Investigation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>City/Town/County:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>□ SPIS Investigation</td>
</tr>
<tr>
<td>□ Rural</td>
<td>□ Urban</td>
<td>□ Suburban</td>
<td>□ Tangent</td>
<td>□ Curves</td>
<td></td>
<td>□ Response to complaint or inquiry</td>
</tr>
<tr>
<td>□ Rural</td>
<td>□ Urban</td>
<td>□ Suburban</td>
<td>□ Tangent</td>
<td>□ Curves</td>
<td></td>
<td>□ Project Request</td>
</tr>
<tr>
<td>□ Rural</td>
<td>□ Urban</td>
<td>□ Suburban</td>
<td>□ Tangent</td>
<td>□ Curves</td>
<td></td>
<td>□ Fatal Crash Reports</td>
</tr>
<tr>
<td>Reason for Investigation:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>□ Other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Route no. or Street name:</th>
<th>State highway no.:</th>
<th>Mile Point(MP):</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Rural</td>
<td>□ Urban</td>
<td>□ Suburban</td>
</tr>
<tr>
<td>□ Rural</td>
<td>□ Urban</td>
<td>□ Suburban</td>
</tr>
</tbody>
</table>

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<th>State highway no.:</th>
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</thead>
<tbody>
<tr>
<td>□ Rural</td>
<td>□ Urban</td>
<td>□ Suburban</td>
</tr>
<tr>
<td>□ Rural</td>
<td>□ Urban</td>
<td>□ Suburban</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crash Summary:</th>
<th>Number of Crashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>Total</td>
</tr>
<tr>
<td>Year</td>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Traffic Data:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highway type:</td>
</tr>
<tr>
<td>ADT(1000):</td>
</tr>
<tr>
<td>Posted Speed:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investigator</th>
<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>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# 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></td>
<td>• Location / description / measurement of median</td>
<td>• Channelize intersections</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Shoulder type / width and condition</td>
<td>• Create one-way streets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Location and visibility of advance warning signs</td>
<td>• Restrict parking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Roadway type and condition</td>
<td>• Install median divider / barrier</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Widen lanes</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>• Widen lanes</td>
</tr>
<tr>
<td></td>
<td>• Inadequate passing zones</td>
<td>• Pavement widths</td>
<td>• Channelize intersections</td>
</tr>
<tr>
<td></td>
<td>• Passing on shoulder</td>
<td>• Lane widths</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>
<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>• Prohibit parking or move off-street</td>
</tr>
<tr>
<td></td>
<td>• Roadway design inadequate for present conditions</td>
<td></td>
<td>• Change from angle to parallel parking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Evaluate back in angle parking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Re-route through traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Create one-way streets</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reduce speed limit</td>
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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?

YES

Recommend Improvements

NO

Discard countermeasure
Recommend Improvements

Identify Candidate Countermeasures

Evaluate Alternative Options or Incremental Improvements

Determine CRF for each candidate countermeasure

Conduct Benefit-Cost Analysis

Is this cost feasible?

YES

Select best alternative or set of alternatives

NO

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)
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