An Overview of the ODOT Safety Investigations Manual

Christopher M. Monsere  
*Portland State University*, monsere@pdx.edu

Karen Dixon  
*Portland State University*

Follow this and additional works at: [https://pdxscholar.library.pdx.edu/cengin_fac](https://pdxscholar.library.pdx.edu/cengin_fac)

Citation Details  
[https://pdxscholar.library.pdx.edu/cengin_fac/71](https://pdxscholar.library.pdx.edu/cengin_fac/71)

This Presentation is brought to you for free and open access. It has been accepted for inclusion in Civil and Environmental Engineering Faculty Publications and Presentations by an authorized administrator of PDXScholar. Please contact us if we can make this document more accessible: [pdxscholar@pdx.edu](mailto:pdxscholar@pdx.edu).
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
# 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**

![Diagram](image.png)

**CRASH DATA ANALYSIS**

**SITE INVESTIGATION**

**IDENTIFY CANDIDATE COUNTERMEASURES**

**RECOMMEND IMPROVEMENTS**

**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

<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>

### Process Flow

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

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

Observed "Expected"

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

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

Excel Worksheet
### 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%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Proj</th>
<th>Obs %</th>
<th>Ex %</th>
<th></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%</td>
<td>100%</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

DATA COLLECTION

CRASH DATA ANALYSIS

SITE INVESTIGATION

IDENTIFY CANDIDATE COUNTERMEASURES

RECOMMEND IMPROVEMENTS

DOCUMENT AND IMPLEMENT IMPROVEMENTS

OSU

Portland State University
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: ________
- 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): ________

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

**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>
<tr>
<td></td>
<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>
<td></td>
</tr>
</tbody>
</table>

**Traffic Data:**
- Highway type: ________
- ADT (1000): ________
- Posted Speed: ________

---

Investigator: ____________________ Date: __________
Project Manager: ____________________ Date: __________
Approved by: ____________________ Date: __________
# Roadway Inventory Checklist

<table>
<thead>
<tr>
<th>Traffic Controls:</th>
<th>Pavement Markings:</th>
<th>Auxiliary Lanes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ No Control</td>
<td>□ None</td>
<td>□ None</td>
</tr>
<tr>
<td>□ Traffic Signal</td>
<td>□ Broken Yellow Line</td>
<td>□ Left Turn</td>
</tr>
<tr>
<td>□ Flashing Red Signal</td>
<td>□ Broken Yellow Line &amp; Solid Yellow Line</td>
<td>□ Right Turn</td>
</tr>
<tr>
<td>□ Flashing Yellow Signal</td>
<td>□ Solid Yellow Line</td>
<td>□ TWLTL</td>
</tr>
<tr>
<td>□ Stop Sign</td>
<td>□ Double Solid Yellow Lines</td>
<td>□ Passing</td>
</tr>
<tr>
<td>□ Yield Sign</td>
<td>□ Broken White Line</td>
<td>□ Special Purpose ________</td>
</tr>
<tr>
<td>□ RR Flashing Lights, Signals, Gates</td>
<td>□ Solid White Line</td>
<td></td>
</tr>
<tr>
<td>□ RR Crossbuck with Adv. Signs</td>
<td>□ Edge Lines</td>
<td></td>
</tr>
<tr>
<td>□ RR Crossbuck without Adv. Signs</td>
<td>□ Raised Pavement Markers</td>
<td></td>
</tr>
<tr>
<td>□ School Zone Sign</td>
<td>□ Temporary Pavement Marking</td>
<td></td>
</tr>
<tr>
<td>□ No Passing Zone</td>
<td>□ Other Pavement Markings __________________________</td>
<td></td>
</tr>
<tr>
<td>□ Other Traffic Control _________</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Roadway Geometry:</th>
<th></th>
<th>Access Control:</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Curvature (Centerline Radius = ____) OR □ Straight</td>
<td></td>
<td>□ Interstate</td>
</tr>
<tr>
<td>□ Grade (Approximate Grade in Percent = ____________)</td>
<td></td>
<td>□ Other Limited Access</td>
</tr>
<tr>
<td>□ Superelevation (Approximate Superelevation in Percent = ____________)</td>
<td></td>
<td>□ Controlled Access</td>
</tr>
<tr>
<td>□ Median (Width = ____________) OR □ Undivided</td>
<td></td>
<td>□ Uncontrolled Access</td>
</tr>
<tr>
<td>□ Through Lanes (Describe: ____________________________________)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Lanes (Widths = ________________________)</td>
<td></td>
<td>□ Median Crossover</td>
</tr>
<tr>
<td>□ Shoulder (Type &amp; Width: ____________) OR □ Curb OR □ No Edge Treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Surface Treatment (Describe: ____________________________________)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Other Road Geometry not indicated: ____________________</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adjacent Land Use:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Residential</td>
<td></td>
</tr>
<tr>
<td>□ Commercial</td>
<td></td>
</tr>
<tr>
<td>□ Industrial</td>
<td></td>
</tr>
<tr>
<td>□ Agricultural / Natural</td>
<td></td>
</tr>
<tr>
<td>□ Undeveloped</td>
<td></td>
</tr>
<tr>
<td>□ School</td>
<td></td>
</tr>
<tr>
<td>□ Other ______</td>
<td></td>
</tr>
</tbody>
</table>
## 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>Collisions between vehicles traveling in same direction such as sideswipes, turning or lane changing</td>
<td>• Roadway design for traffic conditions</td>
<td></td>
<td>• Widen lanes</td>
</tr>
<tr>
<td></td>
<td>• Inadequate passing zones</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Passing on shoulder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collisions with parked cars or cars being parked</td>
<td>• Large parking turnovers</td>
<td>• Location and description of traffic islands</td>
<td>• Widen lanes</td>
</tr>
<tr>
<td></td>
<td>• Roadway design inadequate for present conditions</td>
<td>• Pavement widths</td>
<td>• Channelize intersections</td>
</tr>
<tr>
<td></td>
<td></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>
</tbody>
</table>

- Portland State University
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
Identify Candidate Countermeasures

Crash Data Analysis

Site Investigation

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

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
- \( \text{CRF} = (1 - \text{AMF}) \)

- AMF < 1.0
  - CRF > 0
  - Less Crashes
  - AMF > 1.0
  - CRF < 0
  - More Crashes
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