Data-Driven Safety Training
Rural Multilane Safety Analysis
Part 2 Example

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Outline

1 Introduction to RML HSM

2 Input data

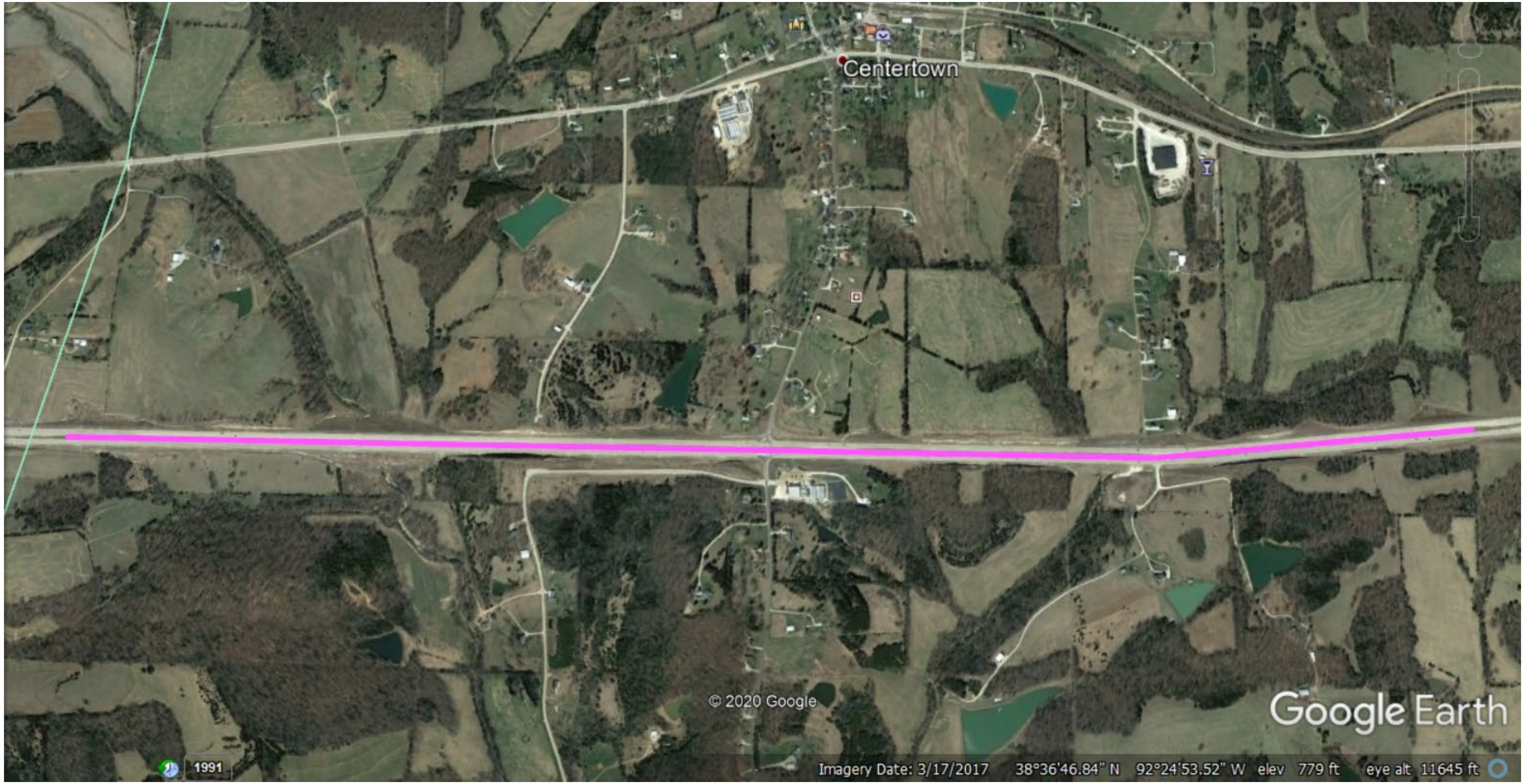
3 Centertown US-50 sample exercise

4 Centertown US-50 sample solution

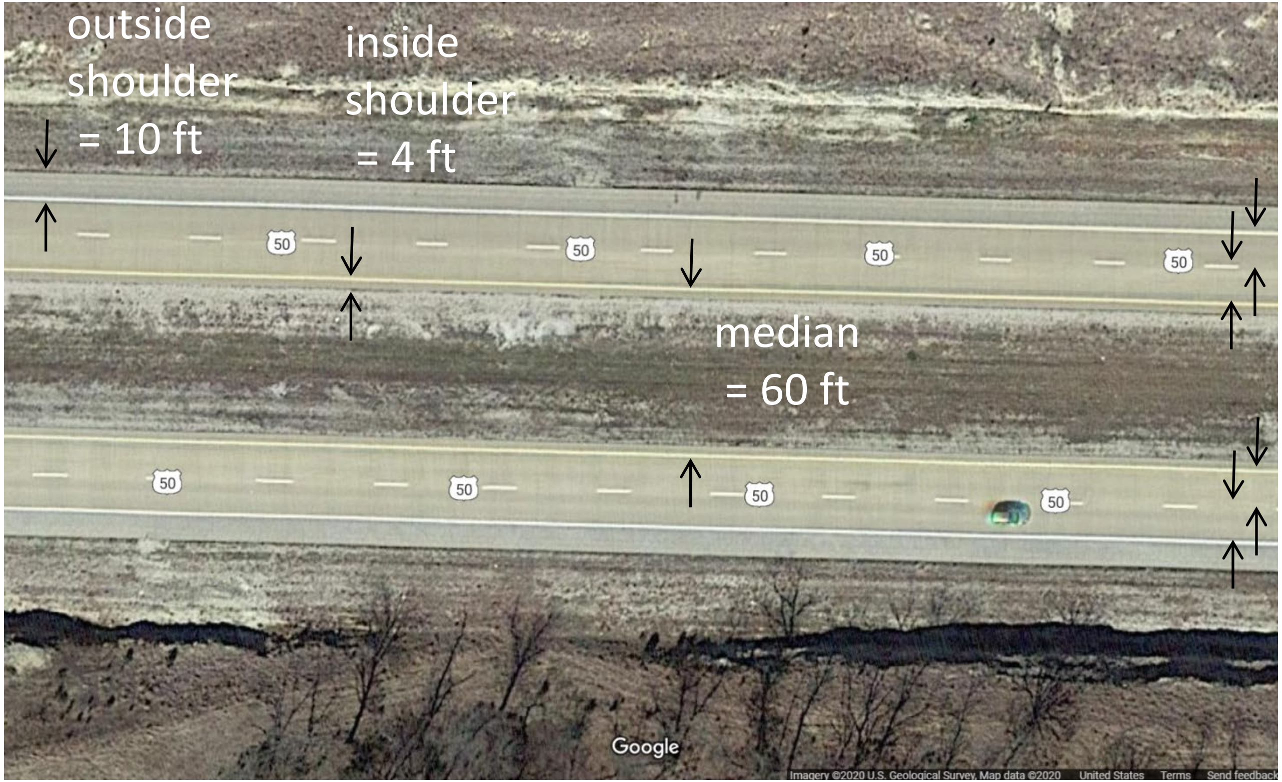
Centertown US-50 Exercise

- Rural multilane divided highway
- Near City of Centertown, Cole County
- Beginning log mile 134.43
- End log mile 136.61
- Length 2.18 mile

Centertown US-50



Data Collection Example



left & right lanes = 12 ft

check opposing also = 12 ft

Data for US-50

Description	Site Condition
Year	2013-2015
Length	2.18 mi
AADT	8,016 vpd
Lane Width	12 ft
Right Paved Shoulder Width	10 ft
Median Width	60 ft
Lighting	None
Automated Speed Enforcement	None
Calibration	0.74
Observed Crashes	9 over 3 years

US-50 Exercise

Learning recommendation

- Given data collected for Centertown US-50 site, attempt the modeling on your own first
- Review the modeling performed by the instructor
- Compare and note any differences

HSM Spreadsheet

- HSM_CPM_RuralMultilaneRoads_v3.0.xlsx
- Download from
  - http://www.highwaysafetymanual.org/Pages/Tools.aspx
- **Instructions** worksheet provides an overview of the spreadsheet
  - e.g. colors indicate info needed

Color Used	Type of Information Required from User
(yellow)	Required input information as identified in the HSM.
(blue)	Input data required from the user but restricted to options provided in pull-down boxes.
(orange)	Optional input information that can be used to supplement the analysis if this information is available. This optional input

HSM Spreadsheet Solution

- Spreadsheet set up to model entire rural segment, including intersections
- Our example focuses on rural multilane divided
- Use worksheet **Segment_Divided_1**
- Enter General Information

2	Worksheet 1A -- General Information and Input Data for Rural Multilane Roadway Segments				
3	General Information			Location Information	
4			Carlos Sun	Roadway	US 50 W
5			University of Missouri	Roadway Section	MM134.43 to MM136.61
6			01/19/20	Jurisdiction	MoDOT
7				Analysis Year	2015

Enter Site Conditions

- Length = 2.18
- AADT = 8,016
- Lane width = 12
- Shoulder width, right = 10
- Shoulder type = paved
- Median width = 60
- Lighting and Automated Enforcement = not present
- Calibration factor = 0.74

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HSM Spreadsheet Solution

Input Data	Site Conditions
Roadway type (divided / undivided)	Divided
Length of segment, L (mi)	2.18
AADT (veh/day)	8,016
Lane width (ft)	12
Shoulder width (ft) - right shoulder width for divided [if diffe	10
Shoulder type - right shoulder type for divided	Paved
Median width (ft) - for divided only	60
Side Slopes - for undivided only	Not Applicable
Lighting (present/not present)	Not Present
Auto speed enforcement (present/not present)	Not Present
Calibration Factor, Cr	0.74

CMF Results

- Since many values are the same as default values (CMF=1)
- Note the 60 ft median had a small reduction, 0.96
- CMFs are multiplicative, so total CMF=0.96
  - HSM assumption of CMF independence

Worksheet 1B (a) -- Crash Modification Factors for Rural Multilane Divided Roadway Segments					
(1)	(2)	(3)	(4)	(5)	(6)
CMF for Lane Width	CMF for Right Shoulder Width	CMF for Median Width	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1rd	*CMF 2rd*	*CMF 3rd*	*CMF 4rd*	*CMF 5rd*	*CMF comb*
from Equation 11-16	from Table 11-17	from Table 11-18	from Equation 11-17	from Section 11.7.2	(1)*(2)*(3)*(4)*(5)
1.00	1.00	0.96	1.00	1.00	0.96

Predicted Crashes

- SPF predicts base crashes = 3.267
- Multiply by CMFs and calibration factor,
  - total crashes = 2.321 crashes/year
- FI crashes also predicted

Worksheet 1C (a) -- Roadway Segment Crashes for Rural Multilane Divided Roadway Segments

(1)	(2)			(3)	(4)	(5)	(6)	(7)
Crash Severity Level	**SPF Coefficients** from Table 11-5			**N spf rd** from Equation 11-9	**Overdispersion Parameter, k** from Equation 11-10	**Combined CMFs** (6) from Worksheet 1B (a)	**Calibration Factor, Cr**	**Predicted average crash frequency, $N_{predicted\ rs(d)}$** (3)*(5)*(6)
	a	b	c					
Total	-9.025	1.049	1.549	3.267	0.097	0.96	0.74	2.321
Fatal and Injury (FI)	-8.837	0.958	1.687	1.740	0.085	0.96	0.74	1.236
Fatal and Injury[a] (FI[a])	-8.505	0.874	1.740	1.140	0.081	0.96	0.74	0.810
Property Damage Only (PDO)	--	--	--	--	--	--	--	$(7)_{TOTAL} - (7)_{FI}$ 1.085

By Collision Type

- Countermeasures could be specific to collision types
- e.g. RML divided, majority SV, probably runoff the road
- e.g. runoff the road, consider edgeline rumble
- e.g. head-on & angle, consider guard cable

Worksheet		
(1)	(2)	(9)
Collision Type	Proportion of Collision Type(TOTAL) from Table 11-6	N predicted rs(d) (PDO) (crashes/year) (7)PDO from Worksheet 1C (a)
Total	1.000	1.085
		(8)*(9) PDO
Head-on collision	0.006	0.002
Sideswipe collision	0.043	0.058
Rear-end collision	0.116	0.095
Angle collision	0.043	0.044
Single-vehicle collision	0.768	0.859
Other collision	0.024	0.026

Empirical Bayes Adjustment

- Expected crashes from observed and predicted
- Here, w=0.816, prediction has high reliability
- From prediction = 2.321 adjust up to expected = 2.446

Worksheet 3A -- Predicted and Observed Crashes by Severity and Site Type Using the Site-Specific EB Method

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Site type	**Predicted average crash frequency (crashes/year)**			**Observed crashes, $N_{observed}$ (crashes/year)**	**Overdispersion Parameter, k**	**Weighted adjustment, w**	**Expected average crash frequency,**
	$N_{predicted}$ (TOTAL)	$N_{predicted}$ (FI)	$N_{predicted}$ (PDO)			Equation A-5 from Part C Appendix	Equation A-4 from Part C Appendix
ROADWAY SEGMENTS (DIVIDED)							
Segment_Divided_1	2.321	1.236	1.085	3.000	0.097	0.816	2.446

Empirical Bayes Adjustment Mechanics

- Overdispersion parameter, k
- $k = \frac{1}{e^{(c+ln(L))}}$, c=1.549 for RML divided
- $w = \frac{1}{1 + k\ x \sum_{all\ study\ years} N_{predicted}}$
- $N_{expected} = w\ x\ N_{predicted} + (1 - w)\ x\ N_{observed}$
- $k = 0.097$ and $w = 0.816$
- Spreadsheet automates HSM equations