



An Enhanced Systemic Approach to Safety

Presented by
Offer Grembek, Joy Pasquet, Catalina Vanoli
UC Berkeley SafeTREC

Where does a systemic safety approach fit in?

Reactive  *Proactive*

Where does a systemic safety approach fit in?



Spot approach:

Improvement at a specific location in response to a higher-than-expected crash rate at a site

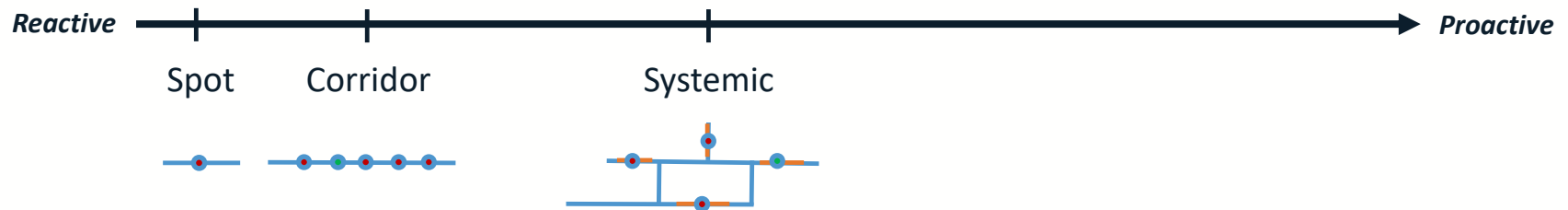
Where does a systemic safety approach fit in?



Corridor approach:

Improvement across a corridor in response to a-higher-than-expected crash rate, or recurring safety concerns along a corridor

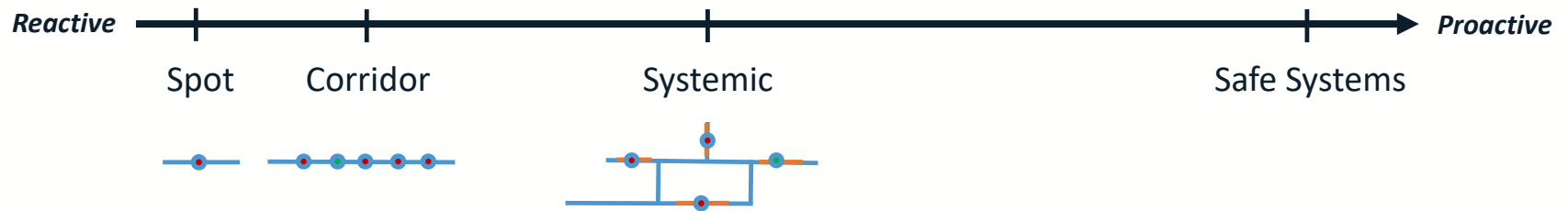
Where does a systemic safety approach fit in?



Systemic approach:

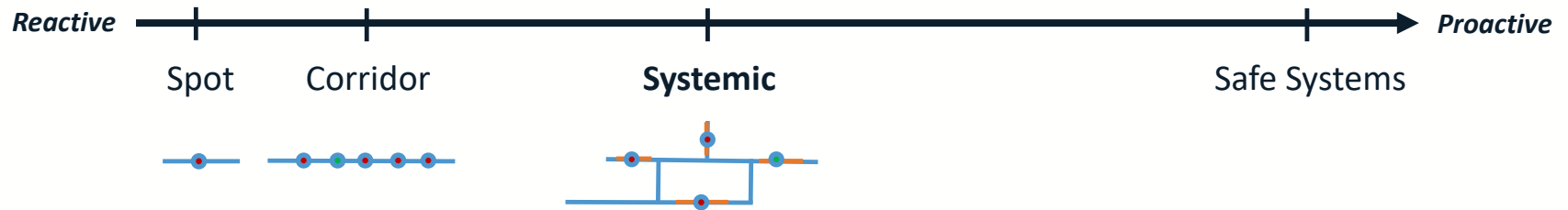
“An improvement that is widely implemented based on high-risk roadway features that are correlated with particular crash types” *FHWA*

Where does a systemic safety approach fit in?



Safe Systems approach:
“Building a system in which people cannot be fatally or severely injured on despite human error” *Soames Job*

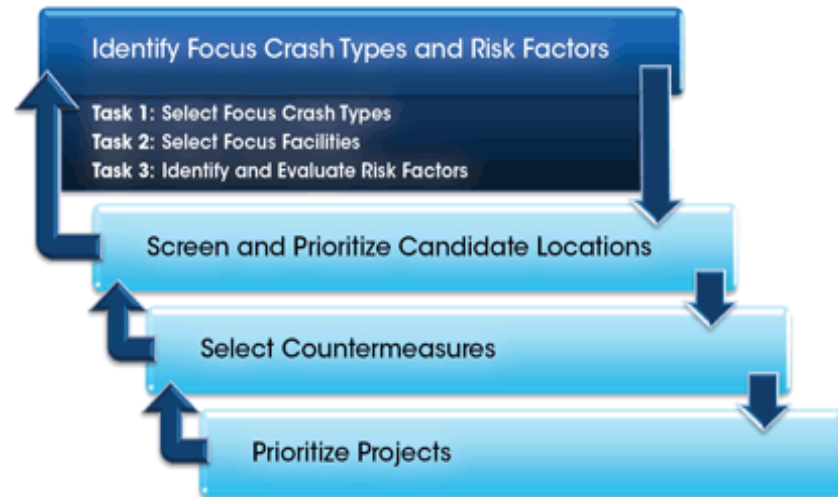
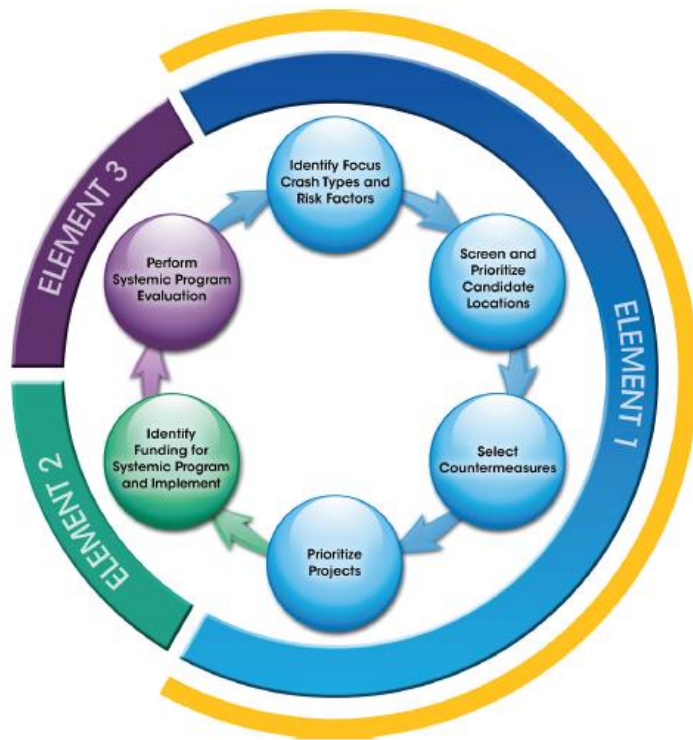
Where does a systemic safety approach fit in?



Systemic approach:

- reactive - it uses historical crash data to identify priorities
- proactive - make improvements also at low or non-crash sites

FHWA's Systemic Safety Program



A systemic matrix approach

Example of a pedestrian safety matrix

Urban and Urbanized, Conventional Highway and City One-Way Street, 2009-2013	Control Type	STEP 2 FILL IN MATR	Unsignalized					STEP 3 MIC					Signalized					Total		
	# of Lanes - Main		<=3		>3			<=3		>3			<=3		>3					
	# of Lanes - Cross		<=3		>3			<=3		>3			<=3		>3					
	AADT - Main		<50,000	>=50,000	<50,000	>=50,000	<50,000	>=50,000	<50,000	>=50,000	<50,000	>=50,000	<50,000	>=50,000	<50,000	>=50,000				
# of Intersections			1197	15	2347	335	3	166	22	23	21	901	54	148	15	271	208	56	67	5876
Pedestrian Movements	Primary Collision Factors																			
Xing Xwalk - Intersection	Influence of Alcohol																			
	Following too close																			
	Failure to Yield																			
	Improper Turn																			
	Speeding																			
Xing - Not Xwalk	Other Violations																			
	Influence of Alcohol																			
	Failure to Yield																			
	Improper Turn																			
	Speeding																			
Roadway - Include Shoulder	Other Violations																			
	Influence of Alcohol																			
	Failure to Yield																			
	Improper Turn																			
	Speeding																			
Not in Roadway	Other Violations																			
	Influence of Alcohol																			
	Failure to Yield																			
	Improper Turn																			
	Speeding																			
Total																				
Rate (crashes/intersection)																				

* Systemic pedestrian matrix developed by SafeTREC for Caltrans

A systemic matrix approach

What type of crashes are happening on what type of facilities?

Urban and Urbanized, Conventional Highway and City One-Way Street, 2009-2013	Control Type	STEP 2 FILL IN MATR	Unsignalized					STEP 3 MIC					Signalized					Total			
	# of Lanes - Main		<=3		>3			<=3		>3			< 50,000		>= 50,000						
	# of Lanes - Cross		<=3		>3			<=3		>3			< 50,000		>= 50,000						
	AADT - Main		<50,000		>=50,000			<12,000		>=12,000			<12,000		>=12,000						
AADT - Cross	<12,000		>=12,000			<12,000		>=12,000			<12,000		>=12,000								
# of Intersections			1197	15	2347	335	3	166	22	23	21	901	54	148	15	271	208	56	67	5876	
Crash Types	Pedestrian Movements	Primary Collision Factors																			
	Xing Xwalk – Intersection	Influence of Alcohol	1		1					1						1					4
		Following too close			1																1
		Failure to Yield	45	1	67	5	2	34	3	1	3	94	4	12	1	28	28	4	16	348	
		Improper Turn			6							2					2		1	11	
	Xing – Not Xwalk	Speeding	1		2						2		1							6	
		Other Violations	12		36	1		12		4	2	35	3	9	2	14	14	4	8	156	
		Failure to Yield			2	1			1										2	6	
		Improper Turn			1															1	
	Roadway – Include Shoulder	Other Violations			1						1									2	
		Influence of Alcohol			1															1	
		Failure to Yield	6		10	2					3					1				22	
		Improper Turn			1								1	1					1	4	
	Not in Roadway	Speeding	4		2						1					1				8	
Other Violations		31		51	1	2	3	2	1		22	1	4		16	3	1	4	142		
Influence of Alcohol		3									1				1		1		6		
Failure to Yield		1		1	1								1				2		6		
Total	Improper Turn	4		3						1									8		
	Speeding	5		4						1									10		
	Other Violations	11	1	9	1				1		5			1	2	3		1	35		
	Influence of Alcohol														1		1		2		
Rate (crashes/intersection)	Failure to Yield	3		1	1						7				1	2		3	18		
	Improper Turn	2		1	1										3				7		
	Speeding	2		4			1								2				9		
	Other Violations			2			1				6	1	2		1	1			14		
Total	131	2	207	14	4	51	6	8	6	180	10	32	3	68	59	10	36	827			
Rate (crashes/intersection)	0.11	0.13	0.09	0.04	1.33	0.31	0.27	0.35	0.29	0.20	0.19	0.22	0.20	0.25	0.28	0.18	0.54	0.14			

* Systemic pedestrian matrix developed by SafeTREC for Caltrans

A systemic matrix approach

What type of crashes are happening on what type of facilities?

Urban and Urbanized, Conventional Highway and City One-Way Street, 2009-2013	Control Type	STEP 2 FILL IN MATR	Unsignalized					STEP 3 MIC					Signalized					Total								
	# of Lanes - Main		<=3		>3			<=3		>3			<=3		>3											
	# of Lanes - Cross		<=3		>3			<=3		>3			<=3		>3											
	AADT - Main		<50,000	>=50,000	<5,000	>=5,000	<12,000	>=12,000	<12,000	>=12,000	<12,000	>=12,000	<12,000	>=12,000	<12,000	>=12,000	<12,000		>=12,000							
AADT - Cross	<12,000		<12,000			>=12,000			<12,000		>=12,000			<12,000		>=12,000										
# of Intersections	1197	15	2347	335	3	166	22	23	21	901	54	148	15	271	208	56	67	5876								
Crash Types	Pedestrian Movements	Primary Collision Factors																								
	Xing Xwalk - Intersection	Influence of Alcohol	1								1								1							4
		Following too close																								1
		Failure to Yield	45	1	67	5	2	34	3	1	3	94	4	12	1	28	28	4	16							348
		Improper Turn																								11
		Speeding	1		2							2			1											6
		Other Violations	12		36	1		12		4	2	35	3	9	2	14	14	4	8							156
	Xing - Not Xwalk	Failure to Yield			2	1				1																6
		Improper Turn			1																					1
		Other Violations			1						1															2
		Influence of Alcohol			1																					1
		Failure to Yield	6		10	2						3				1										22
		Improper Turn			1								1													4
	Roadway - Include Shoulder	Speeding	4		2							1				1										8
		Other Violations	31		51	1	2	3	2	1		22	1	4		16	3	1	4							142
		Influence of Alcohol	3									1				1										6
Failure to Yield		1		1	1									1											6	
Improper Turn		4		3							1														8	
Speeding		5		4							1														10	
Not in Roadway	Other Violations	11	1	9	1				1		5			1	2	3		1							35	
	Influence of Alcohol														1										2	
	Failure to Yield	3		1	1						7				1	2									18	
	Improper Turn	2		1	1										3										7	
	Speeding	2		4														2							9	
	Other Violations			2			1				6	1	2		1	1									14	
Total	131	2	207	14	4	51	6	8	6	180	10	32	3	68	59	10	36							827		
Rate (crashes/intersection)	0.11	0.13	0.09	0.04	1.33	0.31	0.27	0.35	0.29	0.20	0.19	0.22	0.20	0.25	0.28	0.18	0.54							0.14		

Facility Types

Systemic hotspots

* Systemic pedestrian matrix developed by SafeTREC for Caltrans

A systemic matrix approach

What are the relevant countermeasures for each matrix cell?

Urban and Urbanized, Conventional Highway and City One-Way Street, 2009-2013	Control Type # of Lanes - Main # of Lanes - Cross AADT - Main AADT - Cross	STEP 2 FILL IN MATR	Unsignalized										Signalized										Total														
			<=3					>3					<=3					>3																			
			<=3					<=3					<=3					>3																			
			<50,000		>=50,000		<50,000	<12,000		>=12,000		<12,000		>=12,000		<12,000		>=12,000		<12,000		>=12,000															
# of Intersections		1197	15	2347	335	3	166	22	23	21	901	54	148	15	271	208	56	67	5876																		
Pedestrian Movements		Primary Collision Factors																		Counter Measures																	
Xing Xwalk - Intersection	Influence of Alcohol	30	30	31	31	30	30	33	33	30	30	33	33	28	28	31	31	30	30	31	31	30	30	32	32	30	30	32	32	28	28	31	31				
	Following too close	27	27	27	27	27	27	29	29	27	27	29	29	25	25	27	27	22	22	22	22	22	22	22	23	23	22	22	22	22	20	20					
	Failure to Yield	16	16	16	16	16	17	17	16	16	17	17	14	14	16	16	13	13	13	13	13	13	13	14	14	13	13	14	14	11	11						
	Improper Turn	19	19	19	19	19	21	21	19	19	21	21	17	17	19	19	13	13	13	13	13	13	13	14	14	13	13	14	14	11	11						
	Speeding	30	30	31	31	30	30	33	33	30	30	33	33	28	28	31	31	30	30	31	31	30	30	32	32	30	30	32	32	28	28						
Xing - Not Xwalk	Other Violations	25	25	25	25	25	26	26	25	25	26	26	24	24	25	25	23	23	23	23	23	23	23	23	23	23	23	23	22	22							
	Failure to Yield	23	23	22	22	23	23	23	23	23	23	23	22	22	22	22	16	16	15	15	16	16	15	15	16	16	15	15	15	15							
	Improper Turn	12	12	11	11	12	12	11	11	12	12	11	11	11	11	11	7	7	6	6	7	7	6	6	7	7	6	6	6	6							
	Speeding	16	16	15	15	16	16	16	16	16	16	16	15	15	15	10	10	9	9	10	10	9	9	10	10	9	9	9	9								
	Other Violations	25	25	25	25	25	28	28	25	25	28	28	24	24	25	25	23	23	23	23	23	23	23	23	23	23	23	23	22	22							
Roadway - Include Shoulder	Influence of Alcohol	23	23	23	23	23	24	24	23	23	24	24	22	22	23	23	22	22	22	22	22	22	22	22	22	22	22	22	21	21							
	Failure to Yield	23	23	23	23	23	24	24	23	23	24	24	22	22	23	23	22	22	22	22	22	22	22	22	22	22	22	22	21	21							
	Improper Turn	20	20	19	19	20	20	20	20	20	20	20	18	18	19	19	13	13	13	13	13	13	13	14	14	13	13	13	13								
	Speeding	9	9	8	8	9	9	8	8	9	9	8	8	8	8	8	5	5	4	4	5	5	4	4	5	5	4	4	4	4							
	Other Violations	14	14	13	13	14	14	14	14	14	14	14	13	13	13	13	9	9	8	8	9	9	8	8	9	9	8	8	8	8							
Not in Roadway	Influence of Alcohol	23	23	23	23	23	24	24	23	23	24	24	22	22	23	23	22	22	22	22	22	22	22	22	22	22	22	21	21								
	Failure to Yield	14	14	14	14	14	14	14	14	14	14	14	13	13	14	14	14	14	14	14	14	14	14	14	14	14	14	13	13								
	Improper Turn	2	2	1	1	2	2	1	1	2	2	1	1	1	1	2	2	1	1	2	2	1	1	2	2	1	1	1	1								
	Speeding	5	5	4	4	5	5	4	4	5	5	4	4	4	4	4	5	5	4	4	5	5	4	4	5	5	4	4	4	4							
	Other Violations	14	14	14	14	14	14	14	14	14	14	14	13	13	14	14	14	14	14	14	14	14	14	14	14	14	14	13	13								
Total		33	33	34	34	33	33	36	36	33	33	36	36	31	31	34	34	33	33	34	34	33	33	35	35	33	33	35	35								
Rate (crashes/intersection)		27	27	27	27	27	29	29	27	27	29	29	25	25	27	27	22	22	22	22	22	22	22	23	23	22	22	23	23								

* Systemic pedestrian matrix developed by SafeTREC for Caltrans

An Enhanced Systemic Approach to Safety

Three overarching objectives:

1

Enhance methods to identify systemic safety concerns

2

Enhance countermeasure scope to include engineering and non-engineering improvements

3

Enhance process to determine high priority locations

Project goals and activities

1

Enhance methods to identify systemic safety concerns

Develop method to determine crash types and the facility types that need to be included in a matrix for a specific mode

Urban and Urbanized Conventional Highways and City One Way Drive, 400-500	General Type of Facility	STEP 1 Unsignalized	STEP 2 Facility Types										STEP 3 Signalized	Total																																																																													
			1	2	3	4	5	6	7	8	9	10			11	12																																																																											
1234	5678	91011	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

Matrix Structure

populate mode-specific crash matrices using the data from multiple states

Urban and Urbanized Conventional Highways and City One Way Drive, 2000-3000	General Type of Facility	STEP 1 Unsignalized	STEP 2 Facility Types										STEP 3 Signalized	Total																																																																													
			1	2	3	4	5	6	7	8	9	10			11	12																																																																											
1234	5678	91011	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

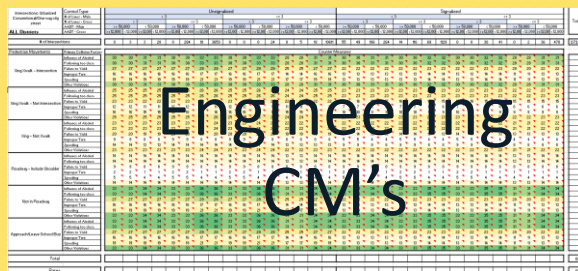
System snapshot

Project goals and activities

2

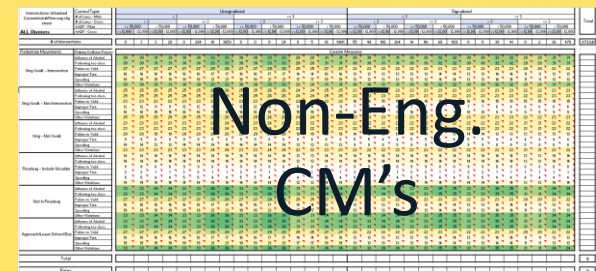
Enhance countermeasure scope to include engineering and non-engineering improvements

develop a list of engineering safety countermeasures to address crash profiles identified for the different matrices



The image shows a screenshot of a data table with a grid of colored cells (green, yellow, orange, red) representing data points. The text "Engineering CM's" is overlaid in the center of the grid. The table has a header row with columns for "All Items", "Engineering", and "Non-Engineering". The left side of the table has a list of categories: "All Items", "Engineering", "Non-Engineering", "Safety", "Traffic", "Roadway", "Signage", "Lighting", "Sound Barriers", "Noise", "Vibration", "Air Quality", "Water Quality", "Soil Quality", "Cultural Resources", "Historic Resources", "Biological Resources", "Archaeological Resources", "Paleontological Resources", "Geological Resources", "Seismicity", "Cumulative Impacts", "Other".

develop a list of non-engineering improvements to address crash profiles identified for the different matrices



The image shows a screenshot of a data table with a grid of colored cells (green, yellow, orange, red) representing data points. The text "Non-Eng. CM's" is overlaid in the center of the grid. The table has a header row with columns for "All Items", "Engineering", and "Non-Engineering". The left side of the table has a list of categories: "All Items", "Engineering", "Non-Engineering", "Safety", "Traffic", "Roadway", "Signage", "Lighting", "Sound Barriers", "Noise", "Vibration", "Air Quality", "Water Quality", "Soil Quality", "Cultural Resources", "Historic Resources", "Biological Resources", "Archaeological Resources", "Paleontological Resources", "Geological Resources", "Seismicity", "Cumulative Impacts", "Other".

Project goals and activities

3

Enhance process to determine high priority locations

explore the advantages and disadvantages of different methods to identify systemic hotspots

Urban and Suburban Commercial Highway and City Center Way Street - 2000-2010 Mile Mile	Control Type	STEP 1 of 2000-2010 Mile	STEP 2 of 2000-2010 Mile										Total			
			1	2	3	4	5	6	7	8	9	10				
1007	15	1295	110	3	6	108	22	23	11	92	14	108	13	101	108	47

Systemic priorities

define guidelines for determining upper and lower thresholds for systemic projects

Refine location list

Expected outcomes

1

Guidelines for determining matrix structure across different modes

Modal matrices

2

Basic toolbox for engineering and non-engineering improvements

CM matrices

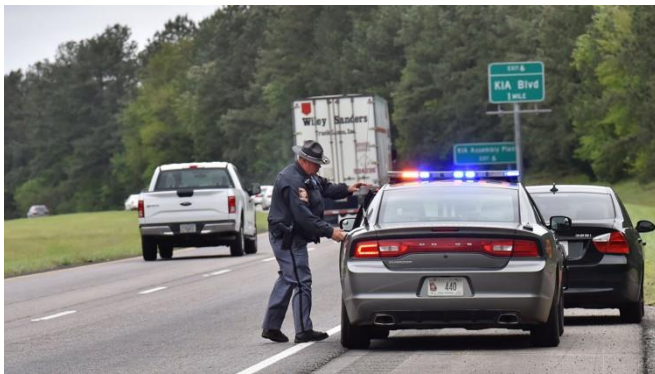
3

Considerations for screening criteria for systemic projects

Priorities

Enforcement countermeasures

- How can it be used?
 - Police enforcement targeted at the identified problematic facilities
- What is the promise?
 - Filling the gaps in the driving code
- What are the limitations?
 - Burdensome state by state legislative analysis
- Guidelines for future considerations



Education countermeasures

- How can it be used?
 - Elaborating an educational countermeasures matrix
- What are the limitations?
 - Multitude of entities involved in road safety trainings
- What is the promise?
 - Lead the development of learning modules
- Guidelines for future considerations



Data requirements

- Three categories of data
 - Crash data (rows)
 - Roadway data (columns)
 - Operations data (columns or risk)
 - Source: HSIS (Highway Safety Information System) files
 - accident subfile
 - vehicle/occupant subfiles
 - roadway file
 - intersection file
- } Challenge: linking the data

Data collection

HSIS Data for 5 years across 7 states:

- California 2010 - 2014
- North Carolina 2010 - 2014
- Ohio 2011 - 2015
- Washington 2011 - 2015
- Illinois 2006 - 2010
- Minnesota 2006- 2010
- Maine 2011 - 2015

name	year	info	numb_records	numb_variables	variables						
ca10acc	2010	acc	154438	56	'acc_date'	'acctype'	'accyr'	'alch_flg'	'bike_flg'	'caseno'	'cause1'
ca11acc	2011	acc	150465	56	'acc_date'	'acctype'	'accyr'	'alch_flg'	'bike_flg'	'caseno'	'cause1'
ca12acc	2012	acc	145776	56	'ACC_DATE'	'ACCTYPE'	'ACCYR'	'ALCH_FLG'	'BIKE_FLG'	'CASENO'	'CAUSE1'
ca13acc	2013	acc	146529	56	'ACC_DATE'	'ACCTYPE'	'ACCYR'	'ALCH_FLG'	'BIKE_FLG'	'CASENO'	'CAUSE1'
ca14acc	2014	acc	150587	56	'ACC_DATE'	'ACCTYPE'	'ACCYR'	'ALCH_FLG'	'BIKE_FLG'	'CASENO'	'CAUSE1'
ca10int	2010	int	17795	38	'cntyrte'	'county'	'district'	'hwy_grp'	'int_dte'	'int_popgrp'	'int_prf'
ca11int	2011	int	17484	38	'cntyrte'	'county'	'district'	'hwy_grp'	'int_dte'	'int_popgrp'	'int_prf'
ca12int	2012	int	17224	38	'cntyrte'	'county'	'DISTRICT'	'HWY_GRP'	'int_dte'	'INT_POPGRP'	'int_prf'
ca13int	2013	int	0	0							
ca14int	2014	int	17145	38	'cntyrte'	'county'	'DISTRICT'	'HWY_GRP'	'int_dte'	'INT_POPGRP'	'int_prf'
ca10road	2010	road	47399	54	'aadt'	'acc_dte'	'access'	'begmp'	'city'	'cntyrte'	'county'
ca11road	2011	road	49523	54	'aadt'	'acc_dte'	'access'	'begmp'	'city'	'cntyrte'	'county'
ca12road	2012	road	54354	54	'AADT'	'ACC_DTE'	'ACCESS'	'BEGMP'	'CITY'	'cntyrte'	'COUNTY'
ca13road	2013	road	54721	54	'AADT'	'ACC_DTE'	'ACCESS'	'BEGMP'	'CITY'	'cntyrte'	'COUNTY'
ca14road	2014	road	55196	54	'AADT'	'ACC_DTE'	'ACCESS'	'BEGMP'	'CITY'	'cntyrte'	'COUNTY'
ca10veh	2010	veh	308297	29	'accyr'	'caseno'	'cause'	'contrib1'	'contrib2'	'defect'	'dir_trvl'
ca11veh	2011	veh	304266	29	'accyr'	'caseno'	'cause'	'contrib1'	'contrib2'	'defect'	'dir_trvl'
ca12veh	2012	veh	293992	29	'ACCYR'	'CASENO'	'CAUSE'	'CONTRIB1'	'CONTRIB2'	'DEFECT'	'DIR_TRVL'
ca13veh	2013	veh	301104	29	'ACCYR'	'CASENO'	'CAUSE'	'CONTRIB1'	'CONTRIB2'	'DEFECT'	'DIR_TRVL'
ca14veh	2014	veh	307395	29	'ACCYR'	'CASENO'	'CAUSE'	'CONTRIB1'	'CONTRIB2'	'DEFECT'	'DIR_TRVL'

Data cleaning in Python

Choosing the Rows and Columns

Facilities

Intersections: Urbanized Conventional/One-way city street	Control Type # of Lanes - Main # of Lanes - Cross AADT - Main AADT - Cross	Unsignalized												Signalized												Total							
		> 3				<= 3				> 3				<= 3																			
		>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000																		
ALL Districts		>= 12,000	< 12,000	>= 12,000	< 12,000	>= 12,000	< 12,000	>= 12,000	< 12,000	>= 12,000	< 12,000	>= 12,000	< 12,000	>= 12,000	< 12,000	>= 12,000	< 12,000	>= 12,000	< 12,000	>= 12,000	< 12,000	17114											
# of Intersections		0	3	3	28	0	284	10	3859	0	0	0	24	0	5	18	10611	55	49	186	264	14	116	69	1129	0	0	30	41	0	2	36	478
Crash Types	Pedestrian Movements	Primary Collision Factors																															
		Influence of Alcohol Following too close Fails to Yield Improper Turns Speeding Other Violations																															
	Xing Xwalk - Intersection	Influence of Alcohol Following too close Fails to Yield Improper Turns Speeding Other Violations																															
	Xing Xwalk - Not Intersection	Influence of Alcohol Following too close Fails to Yield Improper Turns Speeding Other Violations																															
	Xing - Not Xwalk	Influence of Alcohol Following too close Fails to Yield Improper Turns Speeding Other Violations																															
	Roadway - Include Shoulder	Influence of Alcohol Following too close Fails to Yield Improper Turns Speeding Other Violations																															
	Not in Roadway	Influence of Alcohol Following too close Fails to Yield Improper Turns Speeding Other Violations																															
	Approach/Leave School Bus	Influence of Alcohol Following too close Fails to Yield Improper Turns Speeding Other Violations																															
Total																																	
Rates																																	

Iterative, data-driven process to determine:

- **ROWS: representation of the crash dynamics**
 - collision factors, violations, collision type, movements, etc.
- **COLUMNS: built-environment conditions**
 - traffic controls, volume, speed, number of lanes, median presence, parking, crosswalk, etc.

Decision-making factors: road safety expertise, share of blank cells, kurtosis, table size, etc.

The Countermeasure Matrix

Intersections, Zone: All, Road: Conventional/One-way city street	Control Type # of Lanes - Main # of Lanes - Cross AADT - Main AADT - Cross	Unsignalized												Signalized																			
		> 3				<= 3				> 3				<= 3				> 3				<= 3											
		>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000	>= 50,000	< 50,000												
ALL Districts		>=12,000	<12,000	>=12,000	<12,000	>=12,000	<12,000	>=12,000	<12,000	>=12,000	<12,000	>=12,000	<12,000	>=12,000	<12,000	>=12,000	<12,000	>=12,000	<12,000	>=12,000	<12,000												
# of Intersections		0	3	3	28	0	284	10	3659	0	0	0	24	0	5	18	10611	55	49	186	264	14	116	69	1129	0	0	30	41	0	2	36	428
Primary Collision Factors																																	
Xing Xwalk - Intersection	Influence of Alcohol																																
	Following too close																																
Xing Xwalk - Not Intersection	Failure to Yield																																
	Improper Turn																																
Xing - Not Xwalk	Speeding																																
	Other Violations																																
Roadway - Include Shoulder	Influence of Alcohol																																
	Following too close																																
Not in Roadway	Failure to Yield																																
	Improper Turn																																
Approach/Leave School Bus	Speeding																																
	Other Violations																																
SUMMARY																																	
District # or All	ALL																																
Total # of crashes in district	1302																																
# of Null crashes (not counted)	125																																

Countermeasures	Locations													
	Urban	Rural	Intersect	Midblock Crossings	Along roadways	Expressway/Freeway	Conventional/One-way city street	Signalized	Unsignalized	High design speed	Low design speed	High volume	Low volume	
1 Install sidewalks and walkways	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
14 Widen sidewalks	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
59 Maintain a sidewalk level across the	Y	Y	N	N	Y	N	Y	N	N	Y	Y	Y	Y	Y
18 install bike lanes	Y	Y	N	N	Y	N	Y	N	N	Y	Y	Y	Y	Y
2 Curb ramps	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
11 Curb-extensions	Y	N	Y	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y
23 Curb radius reduction	Y	N	Y	N	N	N	Y	Y	Y	N	Y	Y	Y	Y
3 Marked crosswalks at signalized	Y	N	Y	N	N	N	Y	Y	N	Y	Y	Y	Y	Y
6 Marked crosswalks at unsignalized	Y	N	Y	N	N	N	Y	N	N	Y	Y	Y	Y	Y
12 marked crosswalks at midblock crossings	Y	Y	N	Y	N	N	Y	N	N	Y	Y	Y	Y	Y
4 Non-motorist guiding signs	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
5 warning signs for motorists (school zones, speed)	Y	N	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y
53 Adult Crossing Guards	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
52 School zone signals	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
54 Safe routes to school	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
7 Advanced "STOP" markings	Y	N	Y	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y
44 Advanced stop line	Y	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
45 Sign "Stop here for pedestrians"	Y	N	Y	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y

Creating Systemic Matrices

		Divided Highway Paved shoulder up to 4ft				Paved shoulder 5ft or more				L/R Independent Alignment Paved shoulder u Paved shoulder 5ft or more				Undivided Highway Paved shoulder up to 4ft				Paved shoulder 5ft or more				
		2 lanes	3 lanes	4 lanes	5 lanes	2 lanes	3 lanes	4 lanes	5 lanes	2 lanes	4 lanes	2 lanes	3 lanes	4 lanes	5 lanes	2 lanes	3 lanes	4 lanes	5 lanes	2 lanes	3 lanes	4 lanes
Single vehicle	Improper Turn																					
	Hit Object	14	2	386	48	1	593	471	11	20	17	11	1315	37	5	218	17	6				
	Overturned	7	1	333	18	2	552	198	11	21	8	7	786	20	118	13	2					
	OtherAccType			4	1	1	14	8	1				25	3	5	1						
	Speeding																					
	Hit Object	1		118	22		177	149	1	10	7	1	602	33	3	60	8	4				
	Overturned	4	2	53	3	1	89	65	2	7	7	1	453	18	3	56	13	2				
	OtherAccType	1		6			10	2					19	1	4	1						
	Alcohol																					
	Hit Object	6		124	14	1	121	98		3	2	5	513	13	72	8	2					
Overturned	4		48	3	1	70	40	1	3			184	4	38	2	1						
OtherAccType			4		1	4	2					7		1								
OtherFactors																						
Hit Object	6		50	9	1	93	58	1	2	3	2	328	12	1	52	8	3					
Overturned	2		29	10		76	20	1	3	2		167	2	2	30	3	1					
OtherAccType	2		14	1		24	7		3		3	77	3	1	28	3						
Two vehicles	Alcohol																					
	OtherCrashType	3	2	22	2		24	13			2		92	4	4	37	5	4				
	Sideswipe	1	1	12	1		14	22					23			12	2	3				
	Rear End	11		30	11	1	50	58		4	1	1	37	1	25	1	3					
	OtherFactors																					
	OtherCrashType	32	5	66	2	3	51	21		4		1	494	20	9	215	13	15				
	Sideswipe	10	1	12	5	1	20	16			1		176	4	1	45	2	1				
	Rear End	8	1	35	12	3	42	39		1		1	60			33	4	4				
	Improper Turn																					
	OtherCrashType	8		67	12	1	80	76		6		6	181	1		85	1	3				
Sideswipe	3		35	10	1	55	71		2	3	2	62	2		20	1						
Rear End	4		13	4		24	35		1	1	2	19	3	1	7							
Lane Change																						
OtherCrashType		1	24	17	1	50	55		5		3	1			5	3						
Sideswipe	1		71	9	1	91	127		10	2	11	5			3	1						
Rear End			15	10		37	31	1	2		2	1		1	2		1					
3 or more vehicles	Speeding																					
	OtherCrashType	4		49	3		63	49		3	1	5	222	9	1	35	8	4				
	Sideswipe	11		2			23	30		1	3	2	46	1		10	2	3				
	Rear End	71	5	325	76	16	485	482	1	26	8	41	580	18	15	337	20	13				
	Speeding																					
	Rear-end	95	5	914	4261	10	791	6610	22	15	37	23	309	5	49	10	218	8	46	4		
	Sideswipe	2		17	105		19	197	1	1	3	1	12		1	8		1				
	OtherAccType	2		25	84		15	186				1	31	2		5			1			
	OtherFactors																					
	Rear-end	19	1	177	340	2	100	600	7	3	3		48	2	13	2	26	7	7	1		
Sideswipe	5		60	242	1	34	360	2		5	1	69	2	3	1	32		9	1			
OtherAccType	8		78	186		44	315		3	1	107	5	3		67	4	3					
Lane Change																						
Sideswipe			27	485	1	51	820	2		6	5			1	3	1	2	1				
Rear-end			11	123		10	227		1	2	1			1								
OtherAccType			14	77		9	140	1														

Creating Systemic Matrices

	Divided Highway				L/R Independent Alignment				Undivided Highway											
	Paved shoulder up to 4ft		Paved shoulder 5ft or more		Paved shoulder up to 4ft		Paved shoulder 5ft or more		Paved shoulder up to 4ft			Paved shoulder 5ft or more								
	2 lanes	3 lanes	4 lanes	5 lanes or r 2 lanes	3 lanes	4 lanes	5 lanes or r 2 lanes	4 lanes	2 lanes	3 lanes	4 lanes	5 lanes	2 lanes	3 lanes	4 lanes					
Improper Turn																				
Hit Object	14	2	386	48	1		599	471	11		20	17	11	1315	37	5		218	17	6
Overturned	7	1	333	18	2	1	552	198	11		21	8	7	786	20			118	13	2
OtherAccType			4	1	1		14	8	1					25	3			5		1
Speeding																				
Hit Object	1		118	22			177	149	1	10	7	1	602	33	3		60	8	4	
Overturned	4	2	53	3	1		89	65	2	7	7	1	459	18	3		56	13	2	
OtherAccType	1		6				10	2				1	19		1		4		1	
Alcohol																				
Hit Object	6		124	14	1	1	121	98		3	2	5	513	13			72	8	2	
Overturned	4		48	3		1	70	40	1	3			184	4			38	2	1	
OtherAccType			4		1		4	2					7				1			
OtherFactors																				
Hit Object	6		50	9	1		93	58	1	2	3	2	328	12	1		52	8	3	
Overturned	2		29	10			76	20	1	3	2		167	2	2		30	3	1	
OtherAccType	2		14	1			24	7		3		3	77	3	1		28		3	

Creating Systemic Matrices

	Divided Highway				L/R Independent Alignment				Undivided Highway									
	Paved shoulder up to 4ft			Paved shoulder 5ft or more			Paved shoulder up to 4		Paved shoulder 5ft or more			Paved shoulder up to 4ft		Paved shoulder 5ft or more				
	2 lanes	3 lanes	4 lanes	5 lanes or r 2 lanes	3 lanes	4 lanes	5 lanes or r 2 lanes	4 lanes	2 lanes	3 lanes	4 lanes	2 lanes	3 lanes	4 lanes	5 lanes	2 lanes	3 lanes	4 lanes
Alcohol																		
OtherCrashType	3	2	22	2		24	13				2	92	4	4		37	5	4
Sideswipe	1	1	12	1		14	22					23				12	2	3
Rear End	11		30	11	1	50	56		4	1	1	37	1		25	1	3	
OtherFactors																		
OtherCrashType	32	5	66	2	3	1	51	21		4		494	20	9		215	13	15
Sideswipe	10	1	12	5	1		20	16			1	176	4	1		45	2	1
Rear End	8	1	35	12	3		42	39		1	1	60			1	33	4	4
Improper Turn																		
OtherCrashType	8		67	12	1		80	76		6	6	181	1			85	1	3
Sideswipe	3		35	10	1		55	71		2	3	62	2			20	1	
Rear End	4		13	4			24	35		1	1	19	3	1		7		
Lane Change																		
OtherCrashType		1	24	17	1		50	55		5	3	1				5	3	
Sideswipe	1		71	9	1		91	127		10	2	5		1		3	1	
Rear End			15	10			37	31	1	2	2	1		1		2		1

Two vehicles

Creating Systemic Matrices

	Divided Highway				L/R Independent Alignment								Undivided Highway							
	Paved shoulder up to 4ft		Paved shoulder 5ft or more		Paved shoulder up to 4		Paved shoulder 5ft or more		Paved shoulder up to 4ft		Paved shoulder 5ft or more									
	2 lanes	3 lanes	4 lanes	5 lanes or r 2 lanes	3 lanes	4 lanes	5 lanes or r 2 lanes	4 lanes	2 lanes	3 lanes	4 lanes	2 lanes	3 lanes	4 lanes	5 lanes	2 lanes	3 lanes	4 lanes		
Speeding																				
OtherCrashType	4		49	3			63	49		3	1	5		222	9	1		35	8	4
Sideswipe			11	2			23	30		1	3	2		46	1			10	2	3
Rear End	71	5	325	76	16	1	485	482	1	26	8	41	2	580	18	15	1	337	20	13
Speeding																				
Rear-end	95	5	914	4261	10	3	791	6610	22	15	37	23	309	5	49	10	218	8	46	4
Sideswipe	2		17	105			19	197	1	1	3	1	12		1		8		1	
OtherAccType	2		25	84		1	15	186				1	31	2			5			1
OtherFactors																				
Rear-end	19	1	177	340	2		100	600	7	3	3		48	2	13	2	26	7	7	1
Sideswipe	5		60	242	1	1	34	360	2		5	1	69	2	3	1	32		9	1
OtherAccType	8		78	186			44	315			3	1	107	5	3		67	4	3	
Lane Change																				
Sideswipe			27	485	1	1	51	820	2		6	5				1	3	1	2	1
Rear-end			11	123			10	227		1	2	1			1					
OtherAccType			14	77			9	140	1											

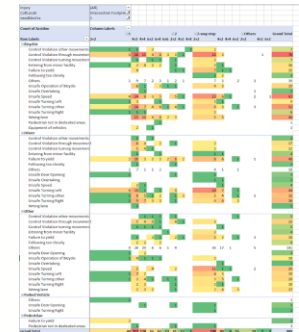
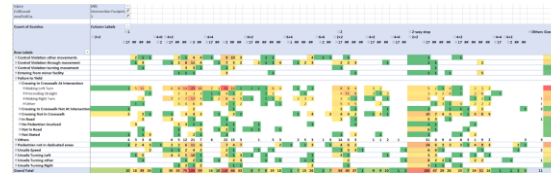
Different Matrices Reveal Different Insights

VEHICLE

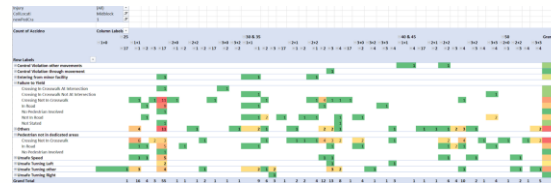
PEDESTRIAN

BICYCLE

INTERSECTION



SEGMENT



Bicycle-involved matrix for intersection crashes in California (2010-2011)

CALIFORNIA		INFRASTRUCTURE																				Grand Total								
Collision	Timed Signals										4 way Stop signs				2 way Stop signs				No controls		Others		Grand Total							
	2+2	3+2	3+3	4+2	4+3	4+4	5+2	5+4	6+2	6+3	6+4	6+5	6+6	8+2	8+3	8+4	2+2	4+2	2+2	3+2	4+2	4+4		5+2	6+2	6+3	8+2	4+1		
B																														
Alcohol		1			2					2									5		3		1		1					
Control Violation	1		1		12			9	1	1	4	2	3					4	1	5										
Failure to yield	1				12			4		1		3			4			4	1	14		6				1				
Improper Turn				1	5		1				3					1		9		5										
Other Improper Driving	5		1		29	1		16		12	1	11	3	1	1	1	1	13	4	33	1	3	12	1	2					
Other than driving							1			1								3		2										
Pedestrian Violation					1			1													2									
Speeding		1			4					2	1	1		1				2		4										
Others					3		1				1				1			1		5		1								
Other																														
Control Violation		1			1			1			1							1												
Failure to yield					2	1														1		1					1			
Improper Turn		1			1								1					3		1			2							
Other Improper Driving					1			2			2		1								1									
Other than driving																		4		1										
Speeding					1			2		1		1								1				1						
Others		1			5	1		2	1	1		1	1					3		8		1								
V																														
Alcohol					1			1													1									
Control Violation					2						2		1					2		1		1	1							
Failure to yield		3		1	10			3	1	1	3		5					21	2	33			2							
Following too closely					1																									
Improper Turn		1		3	9			9		1		4				1	1	2		4			1							
Other Improper Driving		1			5			2		1	3	1		4					1	1		1			1					
Pedestrian Violation										1																				
Speeding													1						1											
Others												1											1							
Grand Total		17	6	1	107	3	58	3	5	33	5	35	4	8	1	1	6	3	2	78	9	122	1	8	27	1	4	1	3	552

Pedestrian-involved matrix for intersection crashes in California (2010-2011)

CALIFORNIA		INFRAST																											
		Timed Signals																											
		2+2		3+2		3+3		4+0		4+2		4+3		4+4		5+2		5+4		6+2		6+3		6+4		6+6		8+4	
Collision		<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000		
Alcohol																													
Control Violation																													
Failure to yield		6	2	2	1	28		2	16	3	2	7		1	1	1	2		1	2	5	3							
Improper Turn						3			1																				
Other Improper Driving						2			2																				
Other than driving									1																				
Pedestrian Violation		1				17	2	1	4	2	1		1		1	6	1	3	6	1	3							1	
Speeding						2									1														
Others		1				3			3							3					1							2	
Grand Total		8	2	2	1	56	2	3	28	5	3	9	1	20	2	7	19	6	7	2	3								

4 way Sto 2 way Stop signs														Yield signs		No controls		Grand Total											
2+2		2+2		3+2		4+1		4+2		5+0		5+2		5+4		6+2		6+3		8+2		2+2		2+1		2+2			
<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000	<= 50000	> 50000		
																													3
																													15
																													158
																													10
																													10
																													2
																													96
																													13
																													19
																													326

Left portion of the non-PDO auto-only matrix for intersection crashes in California (2010-2011)

CALIFORNIA		INFRASTR																												
		Timed Signals																												
		2+0		2+1		2+2		3+0		3+2		3+3		4+1		4+2		4+3		4+4		5+2		5+3		5+4				
		<= 50000		<= 50000		<= 50000		<= 50000		<= 50000		> 50000		> 50000		> 50000		> 50000		> 50000		> 50000		> 50000		> 50000				
Collision	> 400	> 400	<= 400	> 400	> 400	<= 400	> 400	> 400	> 400	> 400	<= 400	> 400	> 400	> 400	<= 400	> 400	> 400	> 400	> 400	<= 400	> 400	> 400	<= 400	> 400	> 400	<= 400	> 400	> 400		
A																														
Alcohol				4				1																						
Control Violation				2	8			1	1					1																
Failure to yield				1	15			3						2	49	1	1			4										
Improper Turn								1																						
Other Improper Driving					5			1																						
Other than driving					1																									
Speeding																														
Others					1																									
B																														
Alcohol																														
Control Violation				1		2				2																				
Failure to yield					1					1																				
Improper Turn				1																										
Other Improper Driving				1																										
Other than driving						4				2																				
Speeding																														
Others					1					1																				
C																														
Alcohol					4																									
Control Violation																														
Failure to yield																														
Following too closely																														
Improper Turn					2																									
Other Improper Driving																														
Other than driving																														
Speeding					2	5	27		1	2	10			2	3	4	104		9	1	3	4			67	9	4	1		
Others																														
D																														
Alcohol					1	7			1	1				1	1	6	23			1	1									
Control Violation					7	8	15	71		2	36	5	17	7	15	272			7	4	24	4	5	126	20	1	9	2	4	
Failure to yield					1	2	4	23			4									6		9	1	3	61	3		4	2	1
Following too closely																														
Improper Turn																														
Other Improper Driving					1																									
Other than driving																														
Speeding																														
Others																														
E																														
Alcohol																														
Control Violation																														
Failure to yield																														
Improper Turn																														
Other Improper Driving																														
Other than driving																														
Speeding																														
Others																														
F																														
Alcohol																														
Control Violation																														
Failure to yield																														
Following too closely																														
Improper Turn																														
Other Improper Driving																														
Other than driving																														
Speeding																														
Others																														
Other																														
Grand Total		12	18	36	232	1	13	77	8	21	14	47	846	2	32	8	59	10	20	441	46	2	29	4	3	6	1	3	50	13

Right portion of the non-PDO auto-only matrix for intersection crashes in California (2010-2011)

=4+2		=4+3		=4+4		=5+2		=5+4		=6+2		=7+2		=8+2		Yield signs		No controls		=3+2		=4+1		=4+2		=6+2		Others	Grand Tot							
≤ 50000		≤ 50000		≤ 50000		≤ 50000		≤ 50000		≤ 50000		≤ 50000		≤ 50000		≤ 50000		≤ 50000		≤ 50000		≤ 50000		≤ 50000		≤ 50000										
<= 400	> 400 (blank)	<= 400	> 400	<= 400	> 400	<= 400	> 400	<= 400	> 400	<= 400	> 400	<= 400	> 400	<= 400	> 400	<= 400	> 400	<= 400	> 400	<= 400	> 400	<= 400	> 400	<= 400	> 400	<= 400	> 400									
2	6																											32								
2	4																											76								
10	23		1				1			4	1	3			2	1					1				1	1	2	257								
	5														1													32								
	2																											31								
																												6								
1	1		1				1			1		1									1							22								
	1																											19								
1	4		1								1																	18								
1	3											3			1					1								40								
7	19		1																		1							76								
2	6										1									1					1	1		72								
2	6		1	1							1									1								65								
2	2		1																									1								
	4																											20								
4											1																	63								
	1																											10								
3	8		1								1										1							28								
8	8		1									3		2							1							90								
2	2																											14								
4	9		1								1	1		1											1			103								
1																												6								
25	52		4				1		2			2	3	5		5					2				2		1	649								
	1																											20								
13	17						1				1				3						1							3								
21	56		1	1	2				1	2			5	4							1							200								
137	378		1	6	24	5	2	5	7		6		6	48	6	26	1	1	1	1	24				6	1	3	1197								
																													2							
6	26		1								1										1							135								
	14		1																									96								
	2																											13								
3	9		2	1																								70								
1	12																											133								
2	6		1																									74								
	2		1																									8								
4	6																											11								
																												68								
	1																											11								
6	5		2																									8								
	1																											80								
																												3								
																												6								
1	1																											20								
	1																											6								
																												19								
1	3																											1								
																												27								
3	2		1																									6								
																												3								
4	12																											34								
																												3								
275	726	2	15	43	6	3	6	17	1	9	5	14	82	7	47	1	1	1	1	34	2	4	6	3	1	38	2	5	1	1	6	3	2	2	25	5867

Considerations for Screening

Trade-offs when setting safety screening priorities:

Inclusive approach	Restrictive approach
Capturing all potential systemic safety challenges	Higher cost-effectiveness
Lower cost-effectiveness	Potentially missing valuable safety-improving opportunities

Summary

- Data-driven methodology to identify recurring safety concerns within a road network, by identifying the crash profiles that are associated with certain roadway features
- Flexible enough to allow agencies with varying degrees of data availability to implement it—regardless of the level of performance their data management systems
- Provide aggregate information on the crashes that occurred to identify systemic hotspots, which then allows to target blanket improvements across an entire facility type.
- Support transition from existing practices in road safety to approaches such as safe systems



Comments

Discussion

Questions