Systemic Approach to Rural Highway Safety

Victor Lund, PE, Traffic Engineer
St. Louis County, Minnesota

September 8, 2016
University of Minnesota Roadway Safety Institute
Fall 2016 Seminar Series

LOCAL

One killed in rollover crash in Itasca County; pedestrian killed in Brooklyn Park ID'd

MARCH 19, 2016 — 12:19AM

A 56-year-old man from Bovey, Minn., was killed late Thursday when he was ejected in a single-vehicle rollover crash in Itasca County, the State Patrol said.

What was the likely question asked of the highway agency?

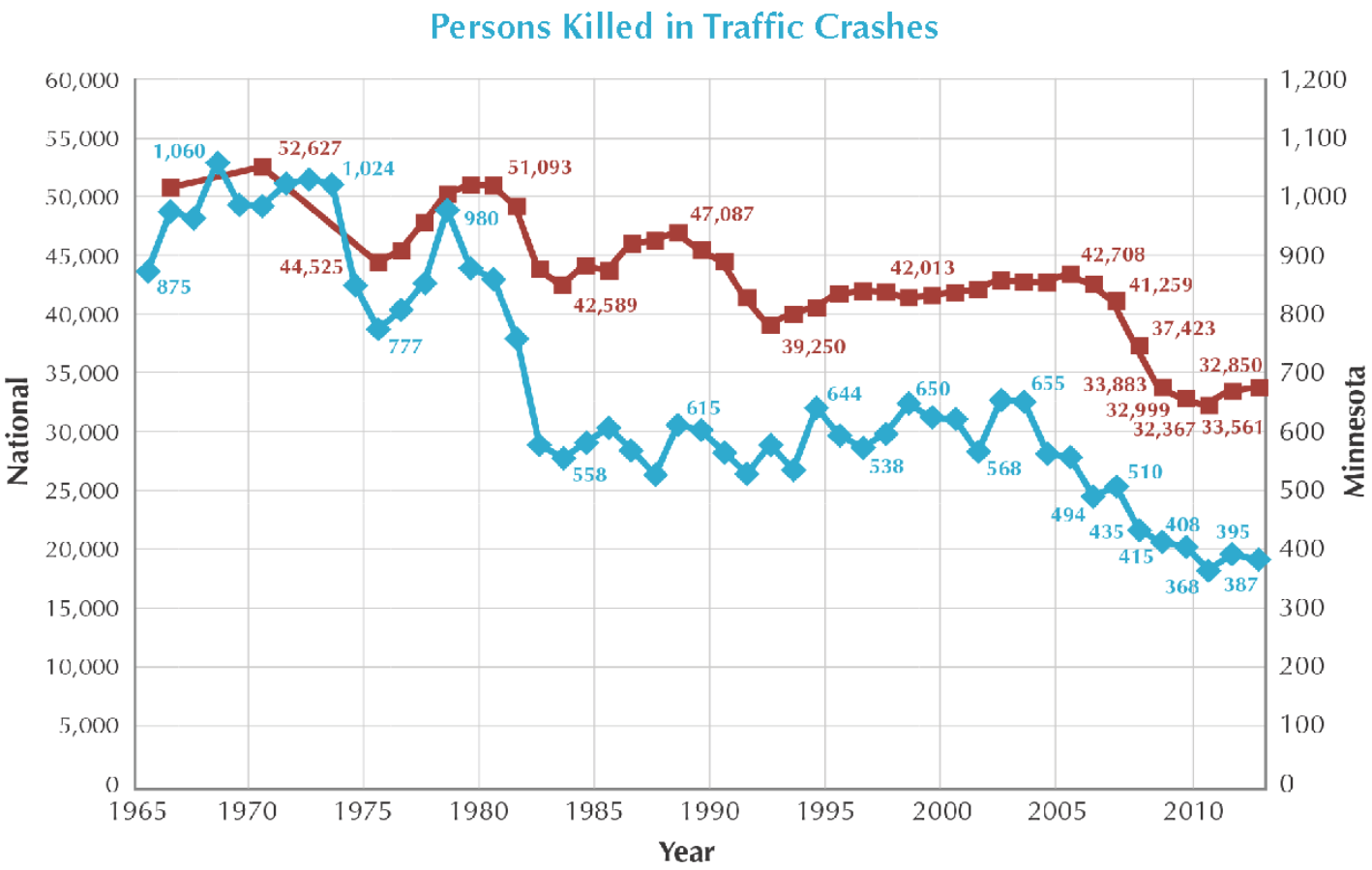
What question should be asked and to whom?

Source: Star Tribune, March 19, 2016

The Focus is Safety

- The traveling public is the "customer" of the highway agency…the safety of the customer is the priority.
- Improving highway safety requires a "data-driven" approach.
- The goal is "Toward Zero Deaths" not "Toward Zero Crashes".
- Real results are leveraged by a multi-disciplinary approach involving the "4Es".

National and State Crash Data



National Highway Traffic Safety Administration (NHTSA)

Note: 2013 fatalities from FARS statistical projections

Image Source: Minnesota Traffic Safety Fundamentals Handbook

National Fatality Clock
2015 Fatalities – 35,092

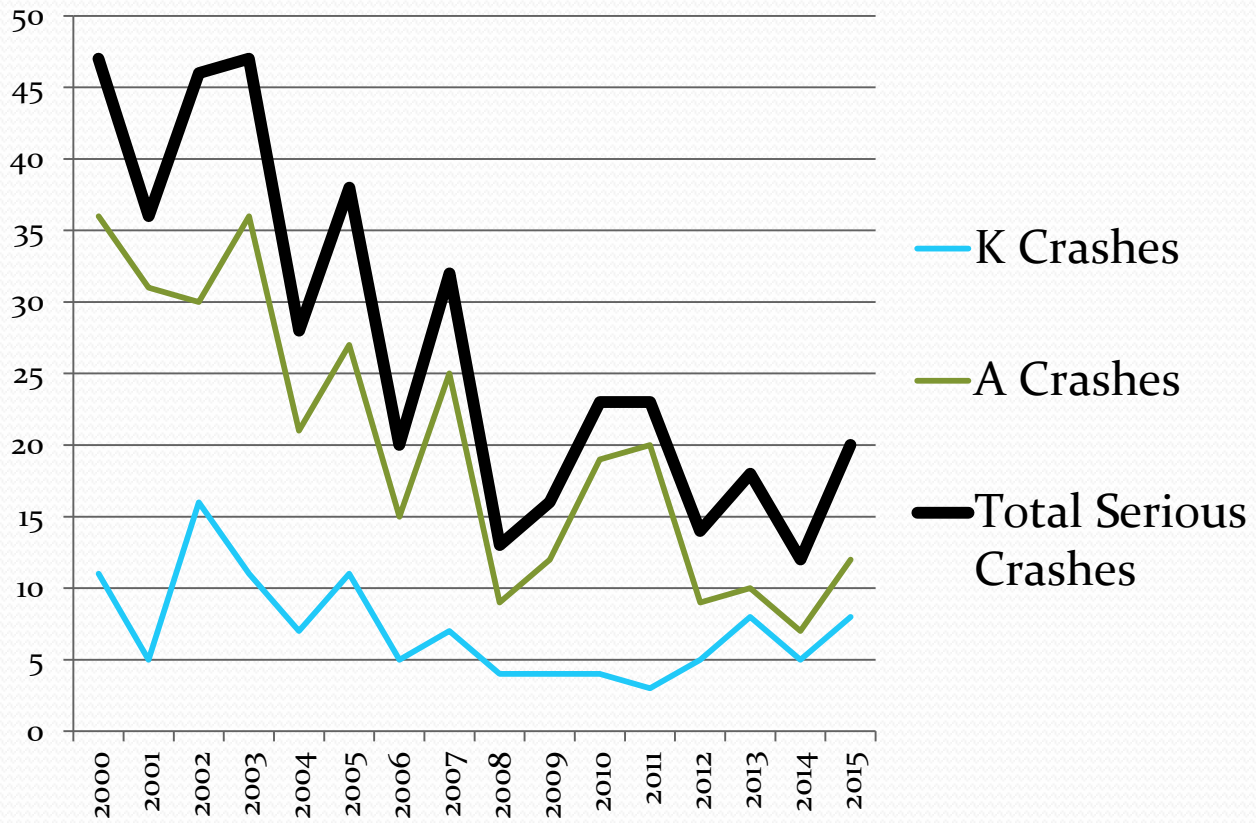
- 4 fatalities per hour
- 96 fatalities per day
- 675 fatalities per week
- 2,924 fatalities per month

Data Source: 2015 Motor Vehicle Crashes, NHTSA

St. Louis County Crash Data

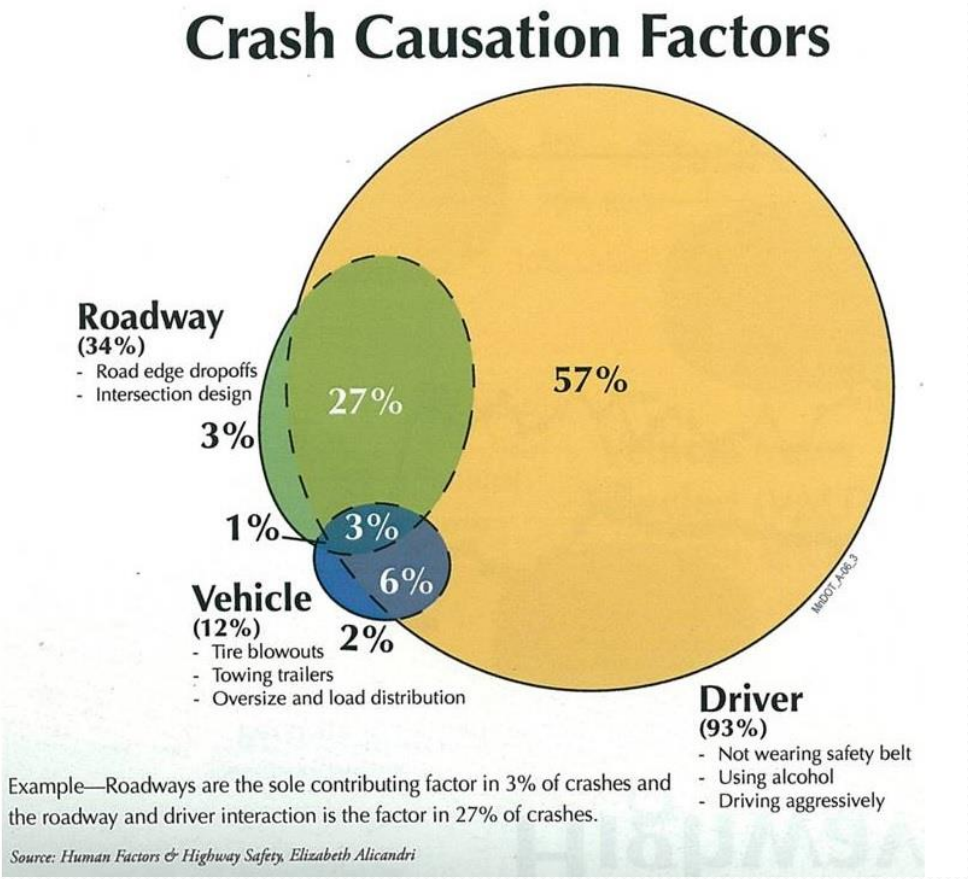
County Highway Fatal and Serious Injury Crashes

2000 to 2014



Data Source: MN CMAT

What are the Major Contributing Factors?



- Driver behavior contributes to 93% of crashes.
- Roadway features contributes to 34% of crashes.
- Vehicle equipment failures contribute to 12% of crashes.

Image Source: Minnesota Traffic Safety Fundamentals Handbook

Traditional Approach to Traffic Safety

- Public perception
  - Highway agencies wait until enough people are seriously injured or killed to identify the problem locations and select future safety countermeasures (if the agency ever does anything)
- Agency perception
  - Find locations with a high number of crashes and implement moderate to high cost safety countermeasures that are justified by a benefit-cost approach.

Consequences of "Traditional Approach" Only

- Public relations/political
  - "How many people have to die before you do something?"
- "Distracted engineering"
  - Public or political pressure may not allow the focus to be on the real problem.
- Drain on resources
  - Always reacting to crash events which limits resources to address traffic safety comprehensively.
- No system-wide accomplishments
  - No significant reduction in system wide serious crashes.

Consequences of "Traditional Approach" Only

- Where do you invest safety projects?
- The reality…
  - Most serious crashes occur in the rural highway system.
  - However, serious crashes are rare and widely dispersed.
- Think about this…
  - In greater Minnesota, 50 percent of severe road departure crashes occur on curves but 75 percent of curves have had no crashes in a previous 5-year period.
- How do you prioritize locations with a low density of serious crashes?

Crash Density by Jurisdictional Class

Roadway Jurisdiction	Miles	Total Crashes*	Fatal Crashes*	Total Crash Density**	Fatal Crash Density**
Interstate	916	11,491	25	12.5	0.027
Trunk Highway	10,930	18,747	158	1.7	0.014
CSAH/County Roads	44,958	19,054	141	0.4	0.003
City Streets	22,373	23,682	29	1.1	0.001
Township & Other	63,799	1,798	22	0.03	<0.001

**2015 Crash Data*

***crashes/mile/year*

Data Source: 2015 Minnesota Motor Vehicle Crash Facts

How do we measure success?

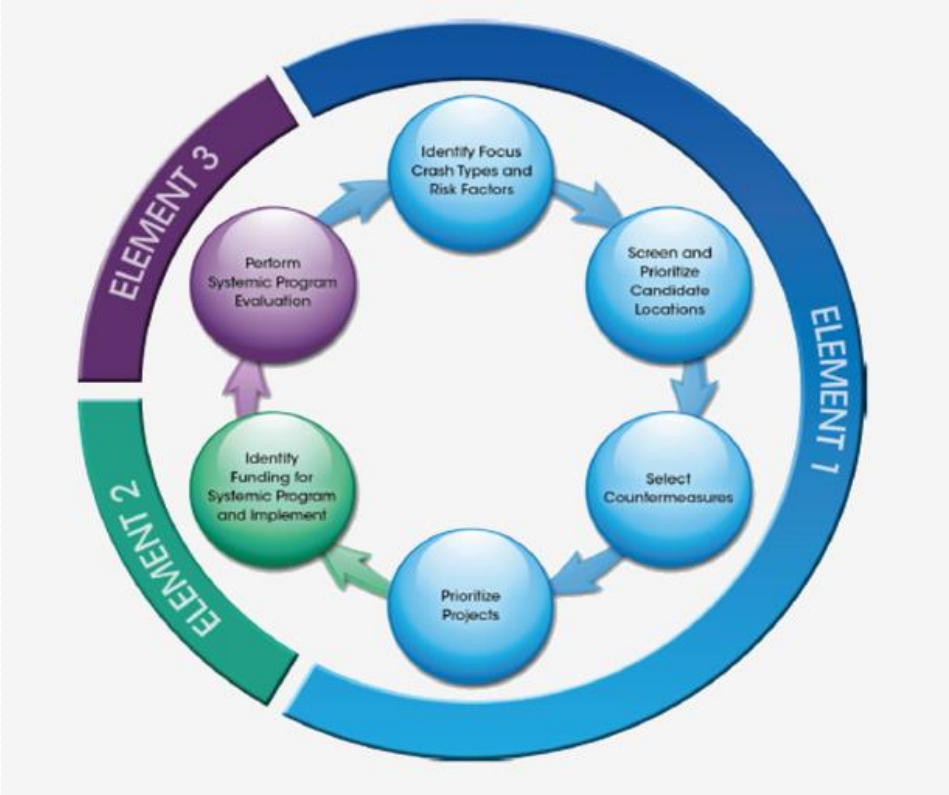
- The primary safety performance measure has been total number of crashes. But is this the right performance measure?
- Property damage crashes and low severity crashes can be scary and frustrating, but I still get to come home to my family at night.
- Serious crashes have significant costs personally and economically.
- If safety is defined by reduction (elimination) in injuries and fatal crashes, then high severity crashes should be the “yard stick”.

Serious Crashes are Different

- The most common type of crashes in Minnesota are Rear-End (31%) and Right-Angle (27%). These crashes occur primarily on signalized corridors in the urban areas. This led to a bias to invest in safety projects at these locations.
- The problem is only 10% of fatal crashes occur at these locations, meaning there was little effect on reducing fatalities.
- Fatal crashes are overrepresented in rural areas. The most common types include Run-Off-The-Road, Right-Angle and Head-On. **These three crash types alone account for 67% of the serious crashes in St. Louis County.**

Source: Minnesota Traffic Safety Fundamentals Handbook

How the Systemic Approach Works

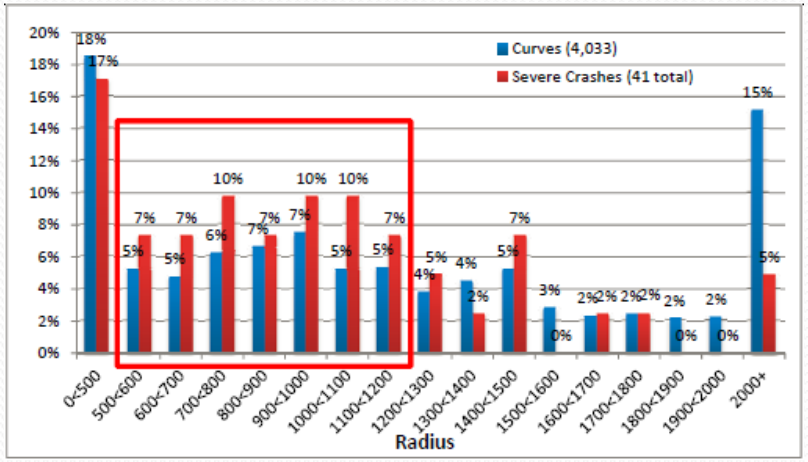


- Three basic elements:
- Element 1
  - Selecting locations and countermeasures
- Element 2
  - Achieving the correct balance between systemic and traditional safety investments
- Element 3
  - Evaluating the effectiveness of the systemic approach

Source: The Systemic Approach to Safety, FHWA

What is the Systemic Approach?

- What it is not…
  - Road safety audits
  - Worst first
  - Specific site safety improvement (e.g. turn lane) based upon an engineering study
- What it is…
  - Result of a planning process
  - Safety improvements based upon risk factors
  - Proactive deployment of low cost safety strategies over entire at-risk system

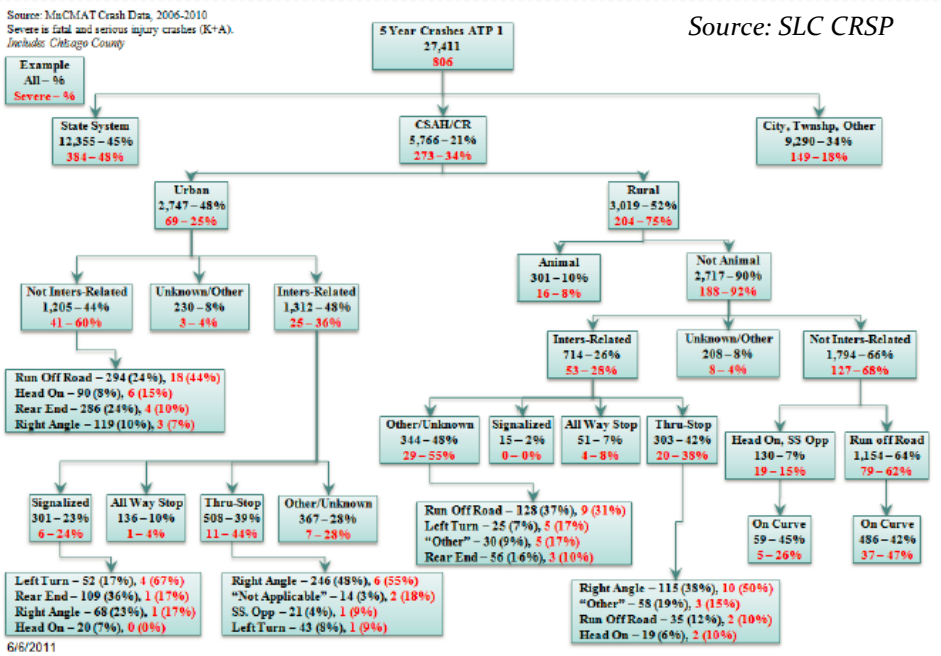


Source: SLC CRSP

Source: SLC CRSP

What is the Systemic Approach?

- Approach
  - Traditional: Crashes = Risk, No Crashes = No Risk
  - Systemic: No Crashes ≠ No Risk
- Recognized that ~50% of serious crashes occur on the local road system (county roads)
- Focus
  - Segments
  - Intersections
  - Curves



Source: SLC CRSP

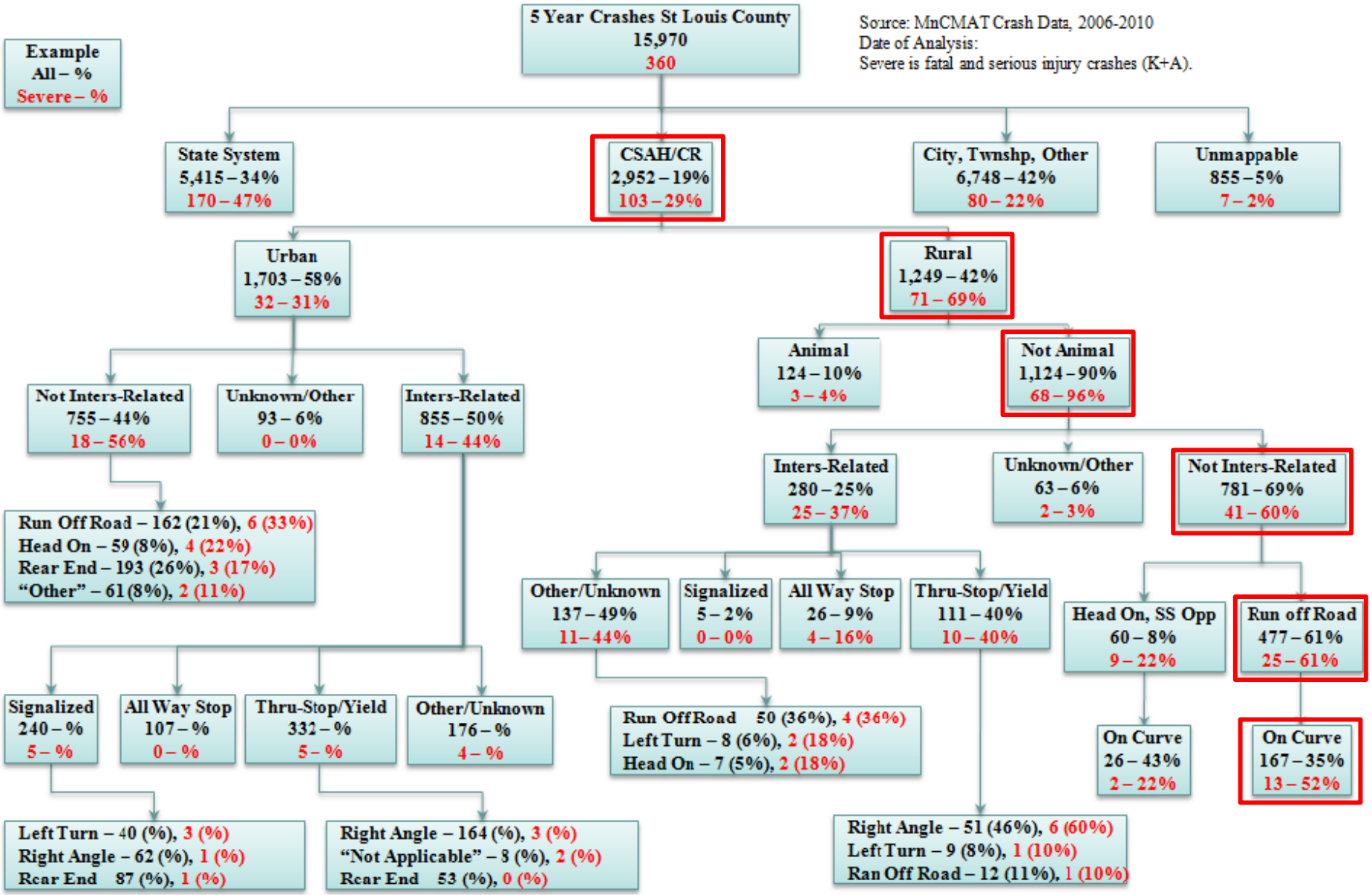


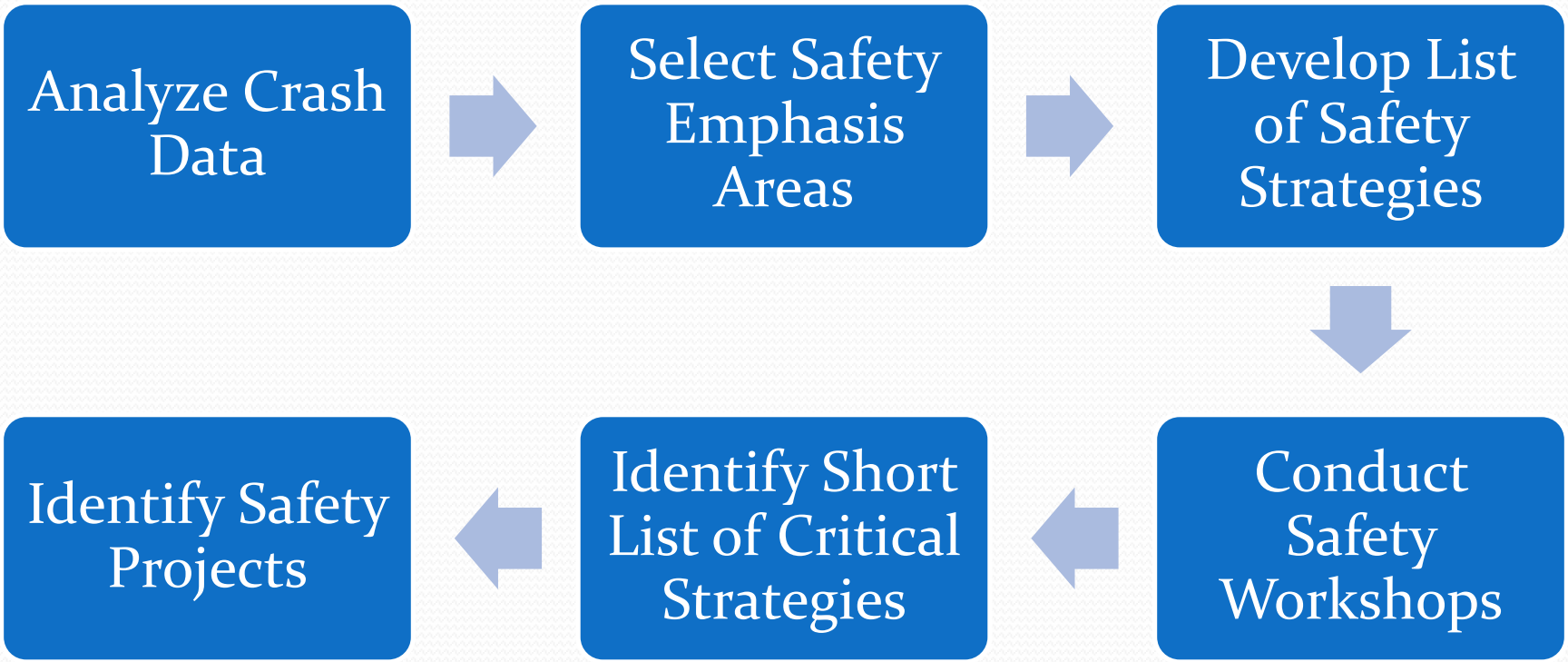
Image Source: St. Louis County Road Safety Plan

A Change in Direction

- Minnesota developed county road safety plans for all 87 counties based upon the systemic approach
- Safety plan ranks locations based upon risk factors
- Recommends safety projects for each at-risk location

- Reactive to proactive
- Localized to systemic
- Events based to risk based

The Minnesota Experience



Source: County Road Safety Plans, MnDOT State Aid

Example Risk Factors

- Intersections
  - Skew
  - On/Near Curve
  - Development
  - Near RR Crossing
  - Distance to Previous STOP Sign
  - Volume Ratio
  - Total Crashes

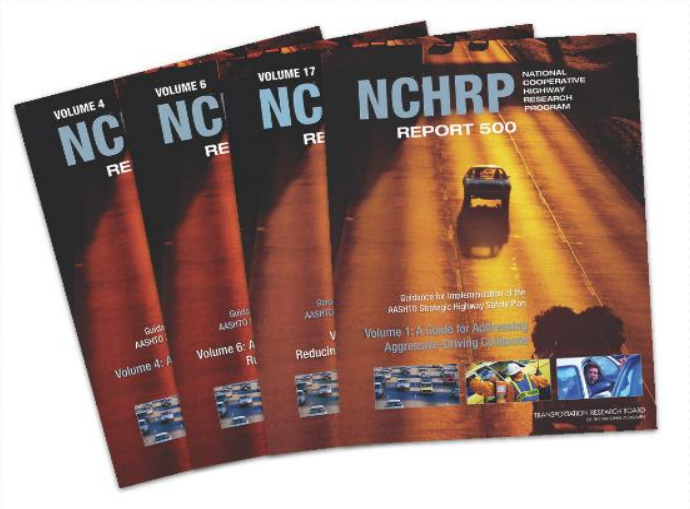
Source: County Road Safety Plans, MnDOT State Aid

Rank	Int #	Sys	#	Intersection Description	Skew	On/Near Curve	Development	RR Xing	Previous STOP (>5mi)	Total Crashes	Ratio (Min/Maj)	Priority	Crash Cost
1	21.14	CSAH	21	CSAH 21 AND MNTH-135	★	★	★		★	★	★	★★★★★★	$1,235,000
2	77.01	CSAH	77	CSAH 77 AND MNTH-169	★	★	★		★	★	★	★★★★★★	$ 539,000
3	52.10	CSAH	52	CSAH 52 AND USTH-53	★	★	★		★	★		★★★★★	$2,959,000
4	23.11	CSAH	23	CSAH 23 AND CSAH-24	★	★			★	★	★	★★★★★	$ 412,000
5	7.09	CSAH	7	CSAH 7 AND CSAH-47 (West)	★	★		★		★	★	★★★★★	$ 227,000
6	25.15	CSAH	25	CSAH 25 AND CSAH-125	★	★			★	★	★	★★★★★	$ 136,000
7	99.05	CSAH	99	CSAH 99 AND CSAH-100	★	★			★	★	★	★★★★★	$ 12,000
8	7.01	CSAH	7	CSAH 7 AND USTH-53 SB	★	★	★			★		★★★★	$1,156,000
9	47.08	CSAH	47	CSAH 47 AND USTH-53	★	★	★			★		★★★★	$ 927,000
10	26.04	CSAH	26	CSAH 26 AND MNTH-135	★	★			★	★		★★★★	$ 590,000
11	26.01	CSAH	26	CSAH 26 AND MNTH-169	★	★	★			★		★★★★	$ 527,000
12	16.20	CSAH	16	CSAH 16 AND USTH-53 (North Intersection)	★		★		★	★		★★★★	$ 445,000
13	22.14	CSAH	22	CSAH 22 AND USTH-53	★		★		★	★		★★★★	$ 436,000
14	3.01	CSAH	3	CSAH 3 AND CSAH-13	★	★				★	★	★★★★	$ 399,000
15	21.01	CSAH	21	CSAH 21 AND MNTH-169	★	★			★	★		★★★★	$ 323,000
16	68.01	CSAH	68	CSAH 68 AND USTH-53A	★	★	★			★		★★★★	$ 148,000
17	16.21	CSAH	16	CSAH 16 AND USTH-53 (South Intersection)	★		★		★	★		★★★★	$ 136,000
18	84.02	CSAH	84	CSAH 84 AND MNTH-73		★			★	★	★	★★★★	$ 103,000
19	46.07	CSAH	46	CSAH 46 AND USTH-2	★	★	★			★		★★★★	$ 84,000
20	115.01	CSAH	115	CSAH 115 AND USTH-53	★		★		★	★		★★★★	$ 36,000
21	223.04	CNTY	223	CNTY 223 AND USTH-2	★		★	★		★		★★★★	$ 24,000
22	16.12	CSAH	16	CSAH 16 AND CSAH-25	★	★			★		★	★★★★	$ -
23	24.11	CSAH	24	CSAH 24 AND CR-422 (Int #2)	★	★			★		★	★★★★	$ -
24	96.01	CSAH	96	CSAH 96 AND CSAH-132	★	★	★				★	★★★★	$ -
25	8.11	CSAH	8	CSAH 8 AND USTH-53	★	★				★		★★★	$1,142,000
26	98.04	CSAH	98	CSAH 98 AND USTH-2	★	★				★		★★★	$ 987,000
27	404.01	CNTY	404	CNTY 404 AND MNTH-1	★	★				★		★★★	$ 960,000
28	88.01	CSAH	88	CSAH 88 AND MNTH-1		★			★	★		★★★	$ 915,000
29	24.17	CSAH	24	CSAH 24 AND CR-422 (Int #5)	★	★				★		★★★	$ 824,000
30	50.02	CSAH	50	CSAH 50 AND MNTH-61	★			★		★		★★★	$ 663,000

Source: St. Louis County Road Safety Plan

Effectiveness of Safety Strategies

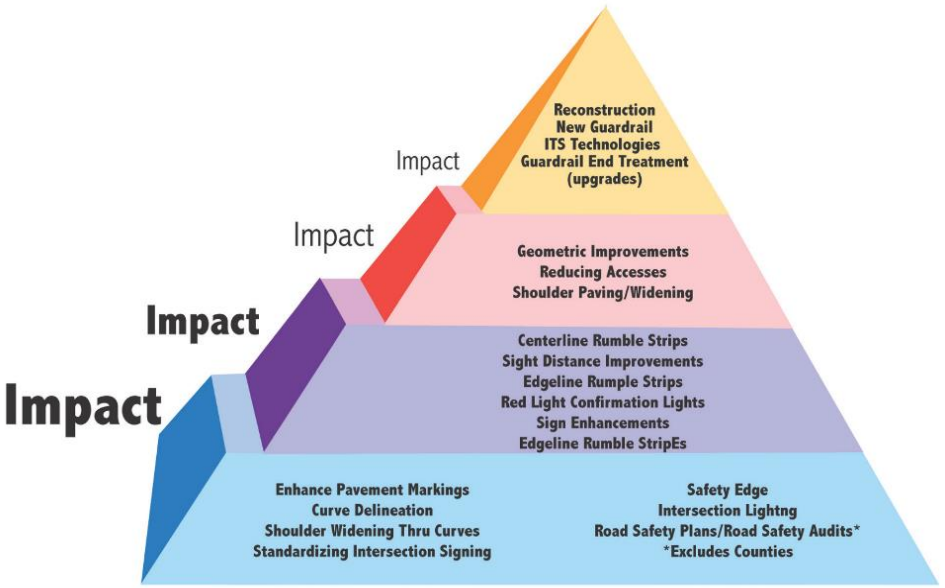
- Decisions to implement a strategy should always consider effectiveness
- National Cooperative Highway Research Program (NCHRP) produces reports documenting effectiveness of various traffic safety strategies



Proven	*Tried*	*Experimental*
• Supported by rigorous academic studies	• Some evaluations • Conflicting experience and results	• New idea • Limited to no formal evaluation completed • Limited deployments
↓	↓	↓
High confidence in effecting a change	May effect a change	Unknown if it will effect a change

Effectiveness of Safety Strategies

	Proven	Tried	Experimental
Education	• Graduated Drivers Licensing • Safety Belt Enforcement Campaigns • DWI Checkpoints		
Enforcement	• Street Lights at Rural Intersections • Access Management • Roadside Safety Initiatives		
Engineering	• Pave/Widen Shoulders • Roundabouts • Exclusive Left Turn Signal Phasing • Shoulder Rumble Strips • Improved Roadway Alignment • Cable Median Barrier • Removing Unwarranted Traffic Signals • Removing Trees in Hazardous Locations • Pedestrian Crosswalks, Sidewalks, and Refuge Islands • Left Turn Lanes on Urban Arterial	• Rumble Strips (on the approach to intersections) • Neighborhood Traffic Control (Traffic Calming) • Overhead Red/Yellow Flashers • Increased Levels of Intersection Traffic Control • Indirect Left Turn Treatments • Restricting Turning Maneuvers • Pedestrian Signals • Improve Traffic Control Devices on Minor Intersection Approaches	• Turn and Bypass Lanes at Rural Intersections • Dynamic Warning Devices at Horizontal Curves • Static/Dynamic Gap Assistance Devices • Delineating Trees in Hazardous Locations • Marked Pedestrian Crosswalks at Unsignal-ized Intersections
Engineering			



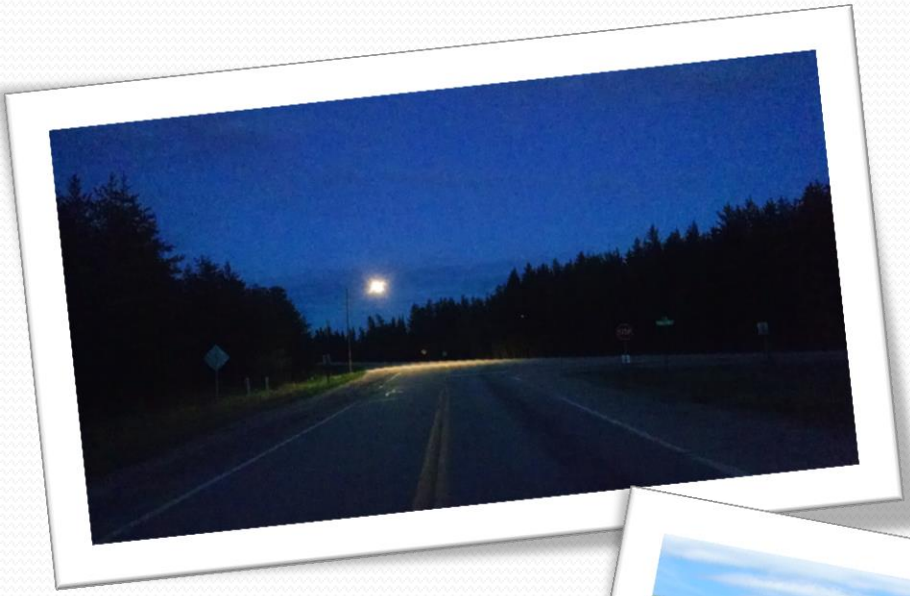
FHWA, Noteworthy Practices: Addressing Safety on Locally Owned and Maintained Roads, A Domestic Scan, August 2010

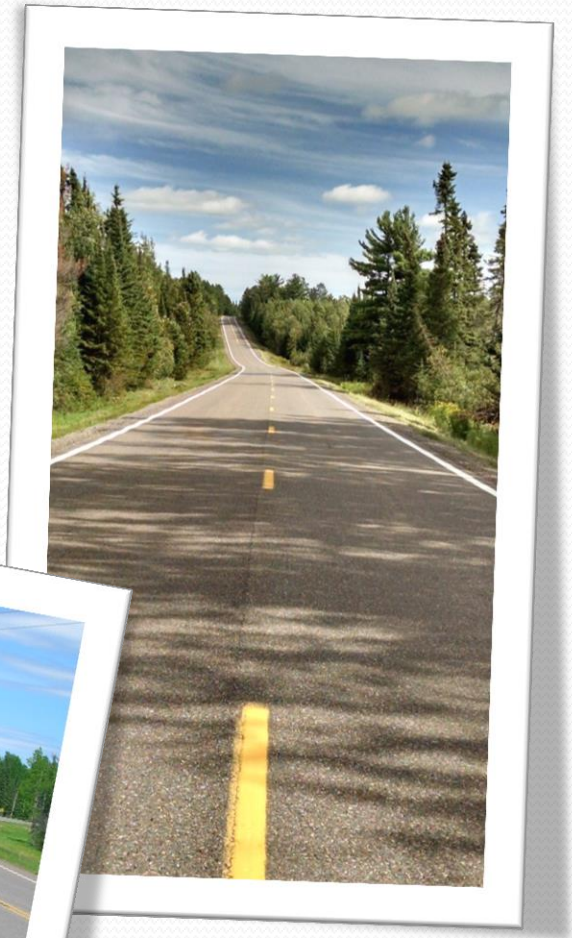
Image Source: Minnesota Traffic Safety Fundamentals Handbook

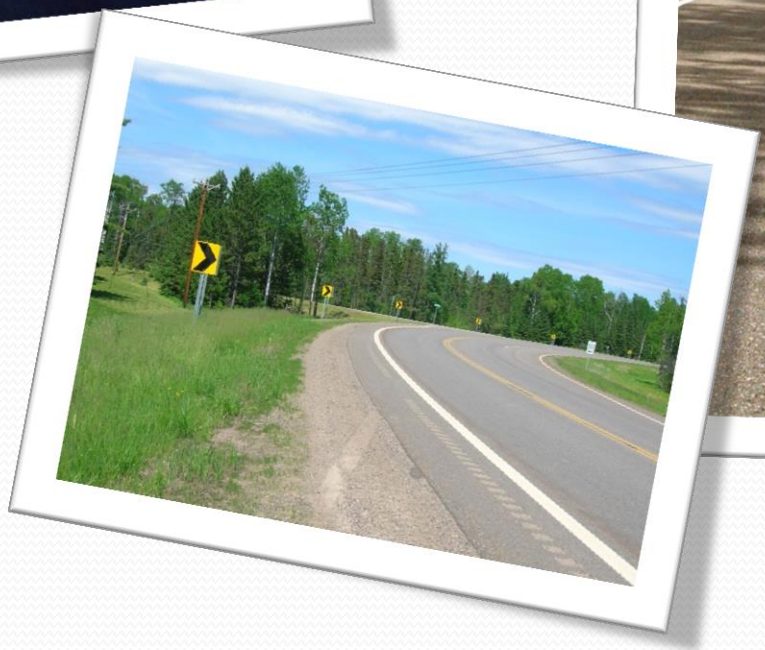
St. Louis County Highway Safety Projects

Funded HSIP Projects			
Year	**Project**	**Award (Federal $)**	**Total Project Budget**
2015	Horizontal Curve Warning	$210,600	$234,000
2015	Edgeline Rumble Strips	$94,500	$105,000
2015	Rural Intersection Lighting	$117,000	$130,000
2015	Rural Intersection Pavement Markings	$104,400	$116,000
2015	Mainline Dynamic Warning Systems	$121,500	$135,000
2015	6” Epoxy Edgeline	$123,300	$137,000
2015	6” Paint Edgeline	$52,200	$58,000
2016	6” Epoxy WR (District 1 Counties)	$859,500	$955,000
2016	6” Epoxy WR (CRSP)	$37,800	$42,000
	Total Funded HSIP Projects	**$1,720,800**	**$1,912,000**
	Grand Total	**$4,082,300**	**$4,535,889**

St. Louis County Highway Safety Projects







CSAH 23 AND CSAH-24

Agency: St Louis County

Intersection Data

Configuration: T
Configuration (2): Undivided
True Mile: 35.91
Urban/Rural: Rural
County: St. Louis
ATP: 1
Entering ADT: 885
Traffic Control Device: Thru STOP
Street Lights: No
Flashers: No
Major ADT: 615
Minor ADT: 540

Crash Data

2006-2010 MnCMAT Crash Data

	Total	Angle	K+A
Crashes	1	0	1
Rate (per MVM)		0.0	0.6

Ranking Criteria

	Value	Critical	Risk Ranking
Skew	Yes	Yes	★
On/near curve	Yes	Yes	★
Development	-	Yes	
Near RR Crossing	-	Yes	
Distance from previous STOP	Yes	Yes	★
Volume Ratio	0.88	0.6 - 1	★
Total Crashes	1	>0	★
			★★★★★

Short List of Strategies Considered

Description	Unit Cost		Units	Cost	Notes -
Roundabout	$1,000,000	per intersection	0	$0.00	
Directional Median	$150,000	per intersection	0	$0.00	
Mainline Dynamic Warning Sign	$30,000	per intersection	0	$0.00	
Installing Street Lights	$6,000	per intersection	1	$6,000.00	
Upgrade Stop Sign	$350	per sign	1	$350.00	
Upgrade Junction Sign	$350	per sign	1	$350.00	
Upgrade Stop Ahead Sign	$450	per sign	1	$450.00	
Upgrade Stop Ahead Marking	$450	per marking	1	$450.00	
Upgrade Stop Bar	$250	per marking	1	$250.00	
Review Signs and CST	$2,450	per intersection	0	$0.00	
				$7,850.00	

Signs and Markings and Street Light project costs vary by the number of minor legs associated with the intersection.

Implementation Cost

Federal Funds	$7,065
Local Match (10% of Total project cost)	$785
Total Project Cost	$7,850

Rank: 4
Intersection ID: 23.11
Date: 5/16/2012

Source: St. Louis County Road Safety Plan

Doctors have been doing this for a long time…

- Think about how doctors provide care to their patients…
- Inquire about your
  - Family health history
  - Personal health history
  - Diet/behavior
- Use this information to assess your risk to develop certain diseases
- Proactively work to treat these risk factors before major issues develop later in life

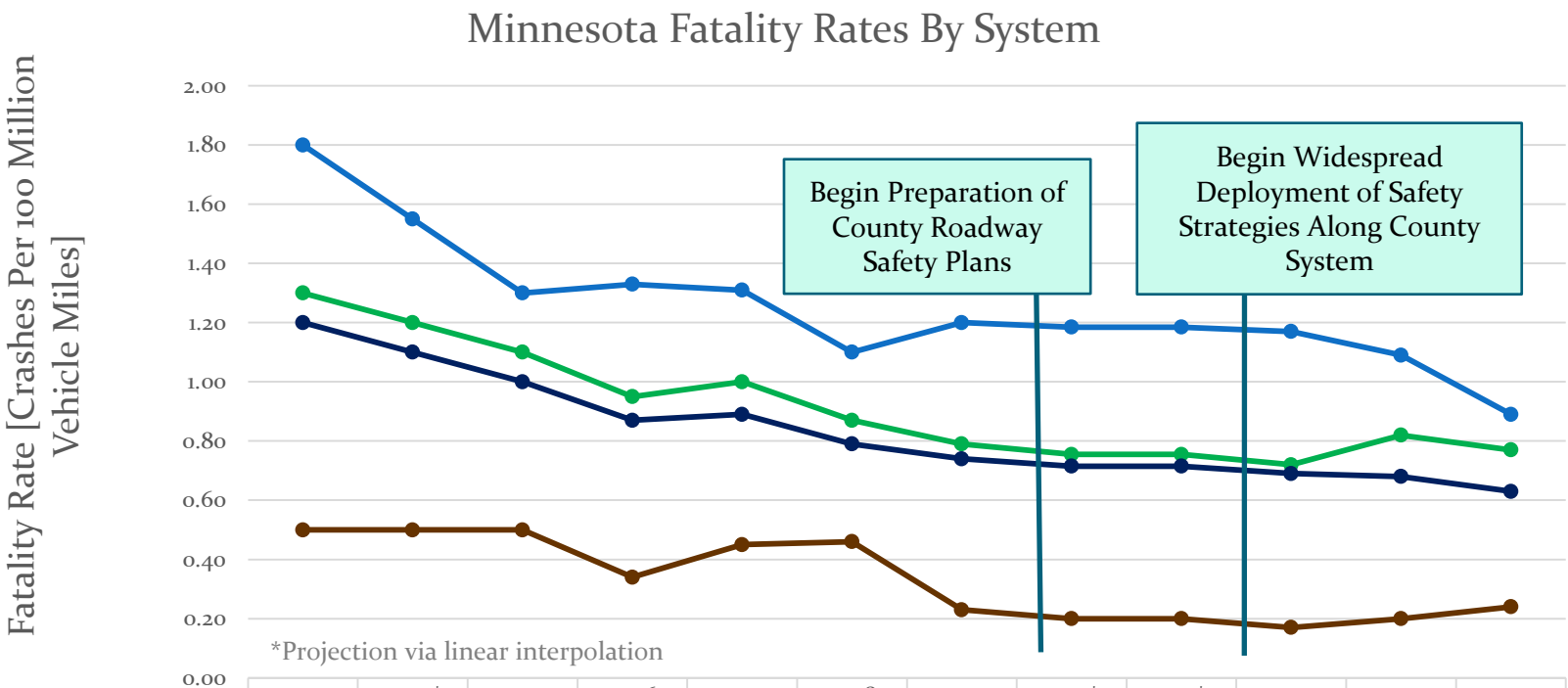
What Are the Concerns of Implementing the Systemic Approach?

County Engineer Survey Feedback

- *Most projects recommended in the safety plan are not a high priority for me.*
- *There are other safety projects we would like to do, but they are not identified in the safety plan so there are no safety funds available.*
- *I don't necessarily agree with many of the proposed projects. If they are not popular politically and are not high priority projects, then we will not pursue them.*
- *This will reduce my autonomy as the county engineer.*
- *I would like the safety plan to include a strategy that would upgrade highways to minimum geometric standards.*

- Agency's priority versus safety plan priority
- Limits engineering judgment
- Lack of political support

Tangible Results



	2003	2004*	2005	2006	2007	2008	2009	2010*	2011*	2012	2013	2014
County	1.80	1.55	1.30	1.33	1.31	1.10	1.20	1.19	1.19	1.17	1.09	0.89
Trunk Highway	1.30	1.20	1.10	0.95	1.00	0.87	0.79	0.76	0.76	0.72	0.82	0.77
State Total	1.20	1.10	1.00	0.87	0.89	0.79	0.74	0.72	0.72	0.69	0.68	0.63
Interstate	0.50	0.50	0.50	0.34	0.45	0.46	0.23	0.20	0.20	0.17	0.20	0.24

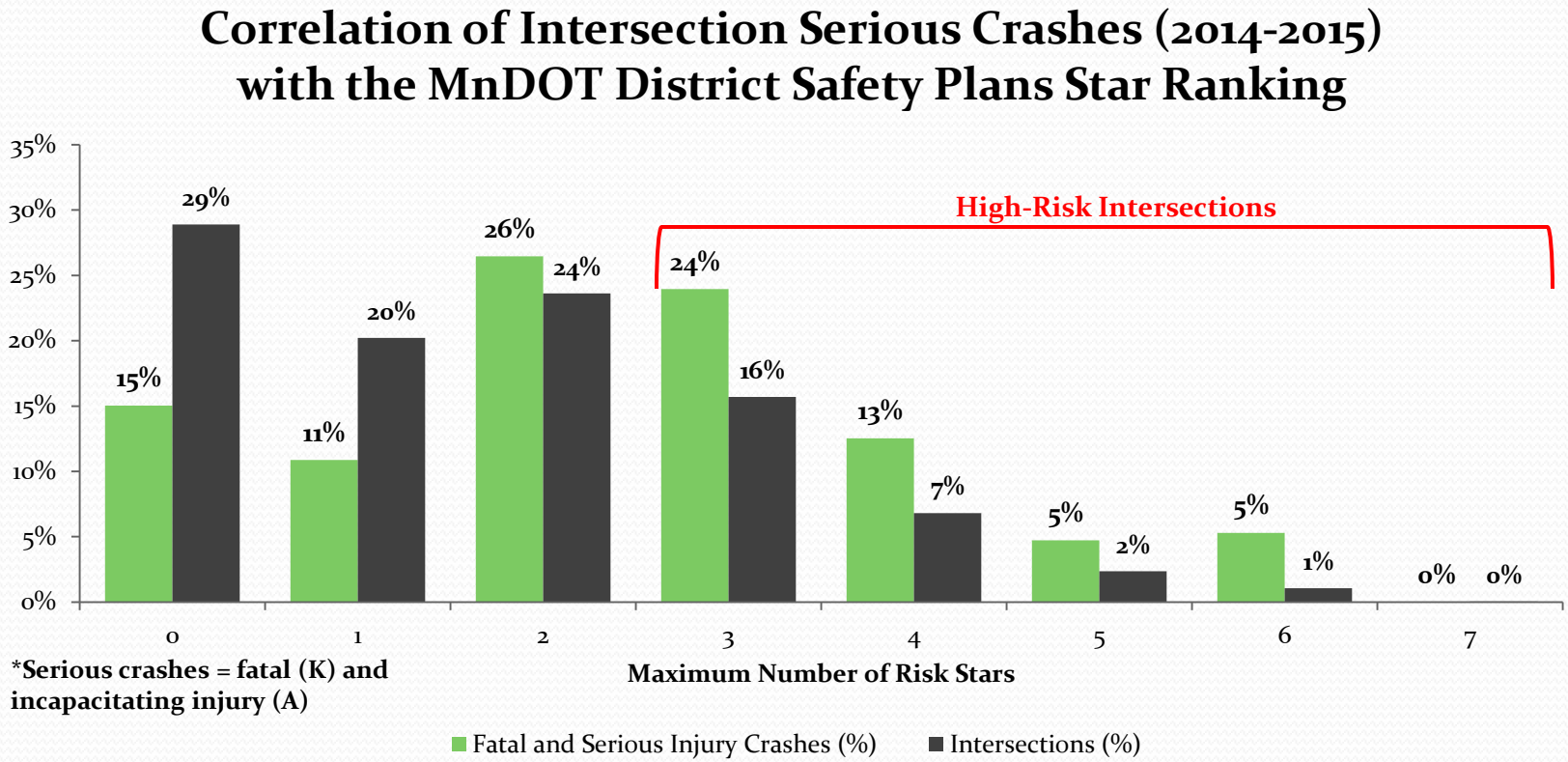
25% reduction in fatality rate from 2011 to 2014 on the County System.

Source: Howard Preston, CH2M, Author of MN CRSP

Validation…

- MnDOT recently completed an update to its District Safety Plans that utilized the systemic approach with 2009-2013 crash data
- A validation exercise was completed using 2014-2015 crash data to determine if the safety plans accurately predicted where most of the serious crashes would actually occur
- What they did…correlated those intersections identified as high-risk with their actual serious crash history

Validation…



The high-risk intersections generated by the safety plan (26% of all intersections analyzed) accounted for 47% of the serious crashes that occurred during the years of 2014 and 2015. An investment in just the high-risk intersections (a minority of the system) could potentially affect nearly 50% of the serious crashes.

Source: Derek Leuer, MnDOT OTST

FHWA Every Day Counts

- The Every Day Counts (EDC) initiative is a collaboration between FHWA and AASHTO to identify innovations and proven business processes to speed up the delivery of highway projects and address challenges with limited budgets.
- Data-Driven Safety Analysis (DDSA) is one of the innovation modules included in the latest round of EDC.
- Systemic safety is one of the two focus strategies in DDSA.

Benefits of the Systemic Approach

- Identifies a "problem" based on system-wide analysis of data (e.g. rural lane departure crashes)
- Looks for roadway characteristics that are frequently present in serious crashes (i.e. risk factors)
- Focuses on one or more low cost countermeasures that can be deployed across the system
- Identifies and prioritizes locations across the network for implementation

Source: The Systemic Approach to Safety, FHWA

"As a result of these strategic safety planning efforts and the hard work of safety professionals in both state and local highway agencies, hundreds of highly effective safety projects have been implemented, and the results are impressive – Minnesota met the initial goal of achieving under 500 fatalities by 2008, and by 2011 the number fell to fewer than 400 fatalities. However one fact remains constant – highway traffic fatalities are still the leading cause of death for Minnesotans under 35 years of age. This suggests there is still much work to do in order to move Minnesota Toward Zero Deaths."

- Minnesota Traffic Safety Fundamentals Handbook

Conclusions

- Applying the systemic approach can build trust with your public officials and the public
- Sets you up to take advantage of the Highway Safety Improvement Program (HSIP)…it produces results.
- Focuses your safety strategies on those locations that are high-risk
- Results from Minnesota suggest the safety plans are realizing a significant benefit in safety and predicting where serious crashes will occur

Resources

- Minnesota County Road Safety Plans; MnDOT; http://www.dot.state.mn.us/stateaid/county-roadway-safety-plans.html
- A Systemic Approach to Safety – Using Risk to Drive Action; FHWA; http://safety.fhwa.dot.gov/systemic/
- Proven Safety Countermeasures; FHWA; http://safety.fhwa.dot.gov/provencountermeasures/

Contact Information

Victor Lund, PE
St. Louis County Traffic Engineer
4787 Midway Road
Duluth, MN 55811
218-625-3873
lundv@stlouiscountymn.gov