Signalization and Safety

A Study of the Safety Effects of Signalizing Intersections on Colorado State Highways

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A Study of the Safety Effects of Signalizing Intersections on Colorado State Highways

Presentation by Richard G. Sarchet, P.E.

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Signalization and Safety

A Study of the Safety Effects of Signalizing Intersections on Colorado State Highways

- Why do we Install Traffic Signals?
  - Because They Reduce Delay?
  - Because The Location Meets Warrants?
  - Because They Improve Safety?

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- Why do we Install Traffic Signals?
  - Because They Reduce Delay?
    - Replacing a 2-way stop with a Signal generally reduces delay on the *minor* road.
    - Replacing a 2-way stop with a Signal almost always *increases* total delay.
      - At certain side road volumes 2-way stop fails. Signal causes less delay than all-way stop.
      - Delay at Signals is distributed more equitably than at 2-way stops.
    - *Delay at a Roundabout is usually less than at a Signal*.

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- Why do we Install Traffic Signals?
  - Because They Reduce Delay?...Sometimes

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- Why do we Install Traffic Signals?
  - Because They Reduce Delay?
  - Because The Location Meets Warrants?
  - Because They Improve Safety?

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- Why do we Install Traffic Signals?
  - Because The Location Meets Warrants?
    - Every New Signal Studied was “Warranted”
    - Engineers, Politicians, Press and Public Fret Over Planned Signals that are “Warranted but Unfunded”
      - MUTCD Says:
        - “The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic signal”
        - and “A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.”

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- Why do we Install Traffic Signals?
  - Because The Location Meets Warrants?...Maybe

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- Why do we Install Traffic Signals?
  - Because They Reduce Delay?
  - Because The Location Meets Warrants?
  - Because They Improve Safety?

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- Why do we Install Traffic Signals?
  - Because They Improve Safety?
    - ITE *Traffic Engineering Handbook* says, “Traffic Engineers know that a traffic signal is not a panacea and can actually contribute to collisions, congestion, delay, and speeding.”
    - Thomas and Smith of Iowa State University found rear end and “left turn” accidents increase with new signals, but overall crashes decrease slightly. (2001)
    - Voss of Kansas DOT found that new signals should be assigned an ARF of 45%. (1997)

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- Why do we Install Traffic Signals?
  - Because They Improve Safety?

Do Traffic Signals Improve Safety?

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Do Traffic Signals Improve Safety?

- Study Locations on Colorado Highways
  - Intersections that became signalized
  - Where data is available
- Compare 3 years Before and 3 years After
  - Consider traffic volume growth

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Site Selection

- Used Video Log to Identify Locations
  - Found 112 Locations w/ Signals in 2002, Not in 1992
  - Which to Use for Sample?

STUDIED SIGNAL LOCATIONS

Site #	Highway	MP	Video Log	Description
1	2B	11.10	1998	Hwy 2 (Hansen BV) at 64th Ave in Commerce City
2	2B	12.37	1998	Hwy 2 (Hansen BV) at 72nd Ave (and Railroad Crossing) in Commerce City
3	2C	15.61	1996	Hwy 2 at 96th Ave in Adams County
4	2C	16.96	1994	Hwy 2 at Hwy 44 (104th Ave) in Adams County
5	2D	0.58	1997	Hwy 2 (Sable Road) at Hwy 22 (124th Ave) in Brighton
6	6E	166.00	1995	Hwy 6 at I-70 Business Spur in Eagle County near Edwards
7	7A	0.34	1997	Hwy 7 (South Saint Vrain Ave) at Manford Dr. in Estes Park
8	7B	46.27	1998	Hwy 7 (Broadway) at Old Stage Road/Lee Hill Road in Boulder
9	7B	46.77	1998	Hwy 7 (Broadway) at Violet Avenue in Boulder
10	7B	48.64	1998	Hwy 7 (Broadway) at Cedar Avenue in Boulder
11	7B	48.97	1998	Hwy 7 (Broadway) at Portland Place/Bluff Street in Boulder
12	7B	50.53	1996	Hwy 7 (Canyon Boulevard) at 26th Avenue
13	7C	54.92	1998	Hwy 7 (Arapahoe Avenue) at Cherrywale Road in Bouler
14	7D	62.13	1998	Hwy 7 (Baseline Road) at Carr Avenue in Lafayette
15	7D	62.38	1998	Hwy 7 (Baseline Road) at 111th Street/Christopher Street in Lafayette
16	7D	63.22	1998	Hwy 7 (Baseline Road) at 119th Street in Lafayette
17	7D	77.59	1998	Hwy 7 (Bridge Street) at 8th Avenue in Brighton
18	9C	87.17	1998	Hwy 9 (Main Street) at ? near Breckenridge
19	9C	87.80	1998	Hwy 9 (Main Street) at Valley Brook Road/Bikeway near Breckenridge

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Analysis

- Data from CDOT Accident History Database

								SEVERITY					# of VEHICLES							
site #	notes	Highway	section	from milepoint	to milepoint	from date	to date	Property Damage Only	Injury Crash	Fatal Crash	Injured	Killed	1 car	2 cars	3+ cars	On Road	Off Road	Overturn	School Age Pedstrian	Other Pedestrian
1	Before Signalization - Urban	2	B	11.08	11.12	1/1/1994	12/31/1996	8	7	0	11	0	2	11	2	13	2	0	0	0
1	After Signalization - Urban	2	B	11.08	11.12	1/1/1999	12/31/2001	10	3	0	7	0	2	11	0	11	2	0	0	0
1	Change (After-Before)	2	B	11.08	11.12			2	-4	0	-4	0	0	0	-2	-2	0	0	0	0
2	Before Signalization - Urban	2	B	12.35	12.39	1/1/1992	12/31/1994	18	12	0	14	0	7	22	1	26	4	0	0	2
2	After Signalization - Urban	2	B	12.35	12.39	1/1/1997	12/31/1999	18	9	0	11	0	4	22	0	24	3	0	0	1
2	Change (After-Before)	2	B	12.35	12.39			0	-3	0	-3	0	-3	0	-1	-2	-1	0	0	-1
3	Before Signalization - Urban	2	C	15.59	15.63	1/1/1992	12/31/1994	8	9	1	11	1	2	15	1	16	2	0	0	0
3	After Signalization - Urban	2	C	15.59	15.63	1/1/1997	12/31/1999	2	5	0	10	0	0	7	0	7	0	0	0	0
3	Change (After-Before)	2	C	15.59	15.63			-6	-4	-1	-1	-1	-2	-8	-1	-9	-2	0	0	0
4	Before Signalization - Urban	2	C	16.94	16.98	1/1/1990	12/31/1992	7	7	0	15	0	0	13	1	14	0	0	0	0
4	After Signalization - Urban	2	C	16.94	16.98	1/1/1995	12/31/1997	3	2	0	6	0	1	4	0	4	1	0	0	0
4	Change (After-Before)	2	C	16.94	16.98			-4	-5	0	-9	0	1	-9	-1	-10	1	0	0	0
5	Before Signalization - Urban	2	D	0.56	0.6	1/1/1994	12/31/1996	0	0	0	0	0	0	0	0	0	0	0	0	0
5	After Signalization - Urban	2	D	0.56	0.6	1/1/1999	12/31/2001	0	1	0	1	0	1	0	0	0	1	1	0	0
5	Change (After-Before)	2	D	0.56	0.6			0	1	0	1	0	1	0	0	0	1	1	0	0
6	Before Signalization - Rural	6	E	165.98	166.02	1/1/1992	12/31/1994	10	8	0	14	0	1	16	1	17	1	0	0	0
6	After Signalization - Rural	6	E	165.98	166.02	1/1/1996	12/31/1998	23	15	0	22	0	0	33	5	38	0	0	0	0
6	Change (After-Before)	6	E	165.98	166.02			13	7	0	8	0	-1	17	4	21	-1	0	0	0

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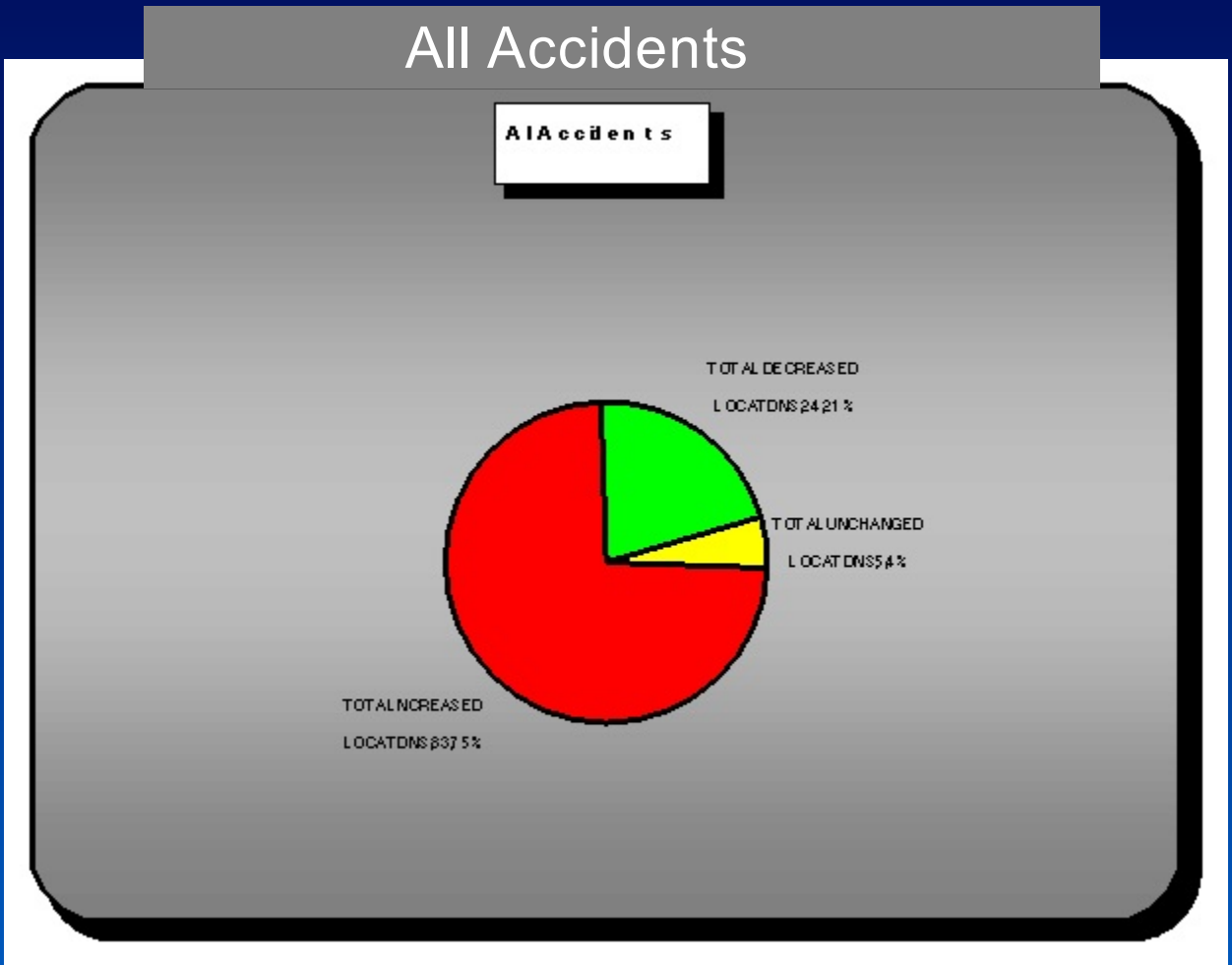

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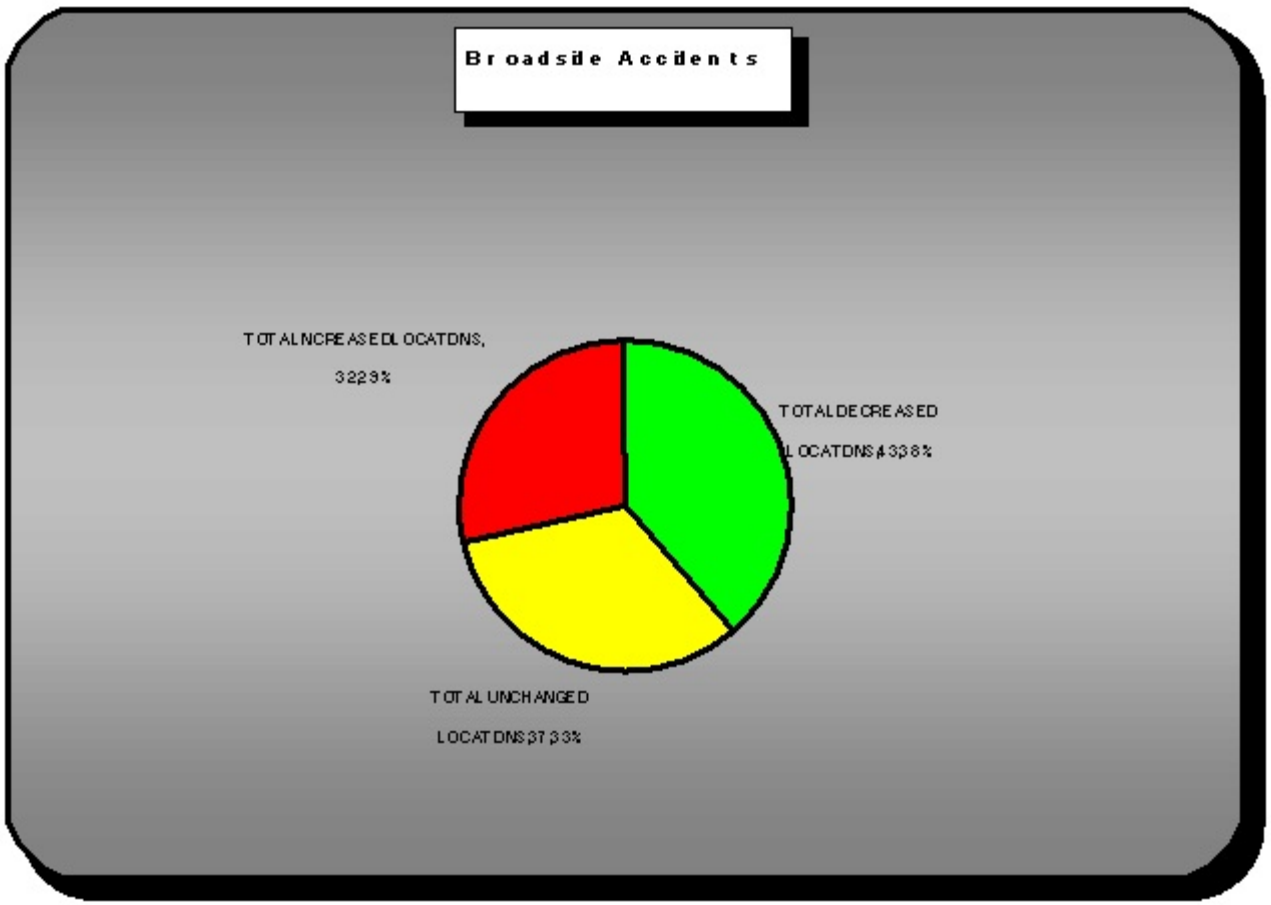
Broadside Accidents



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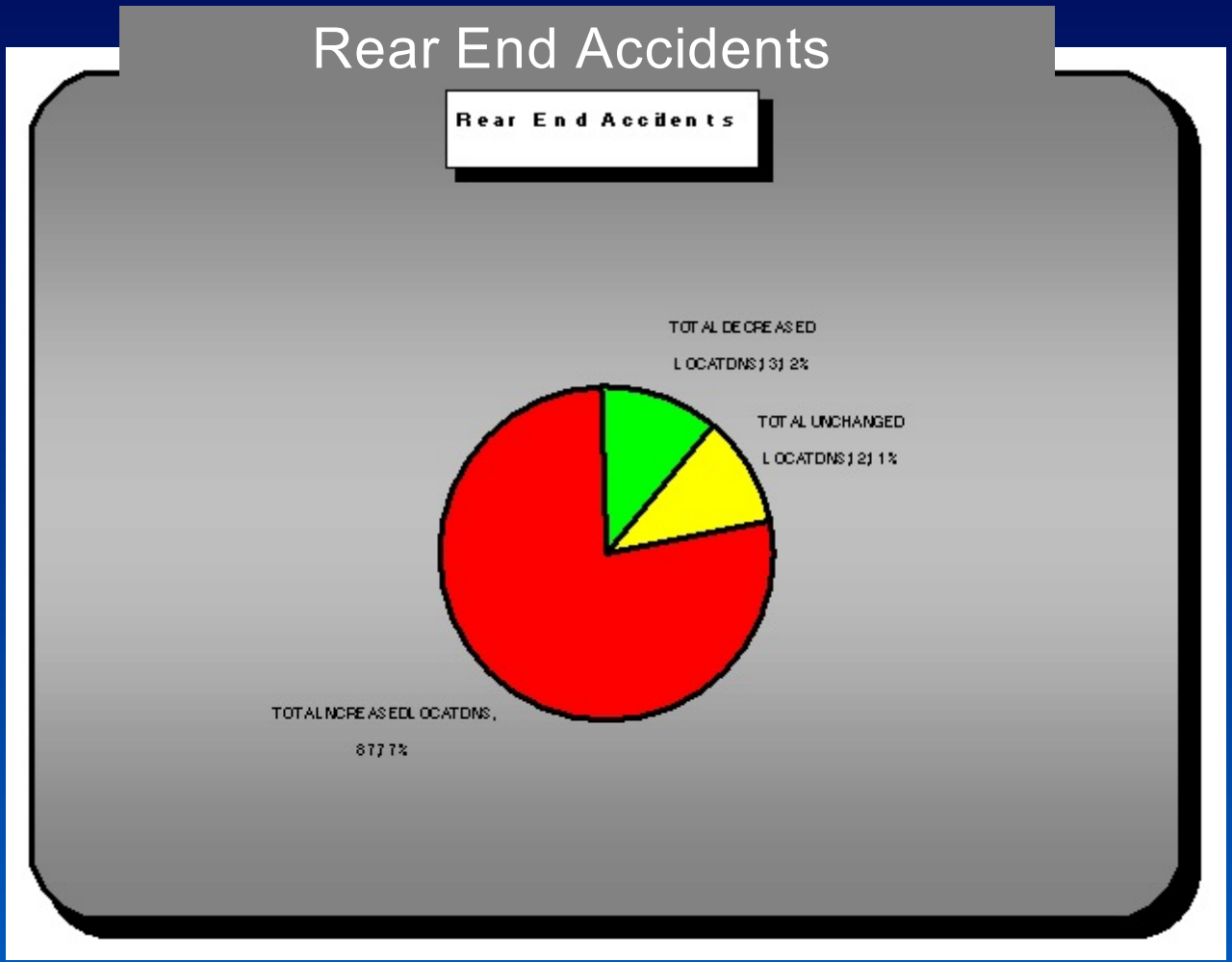

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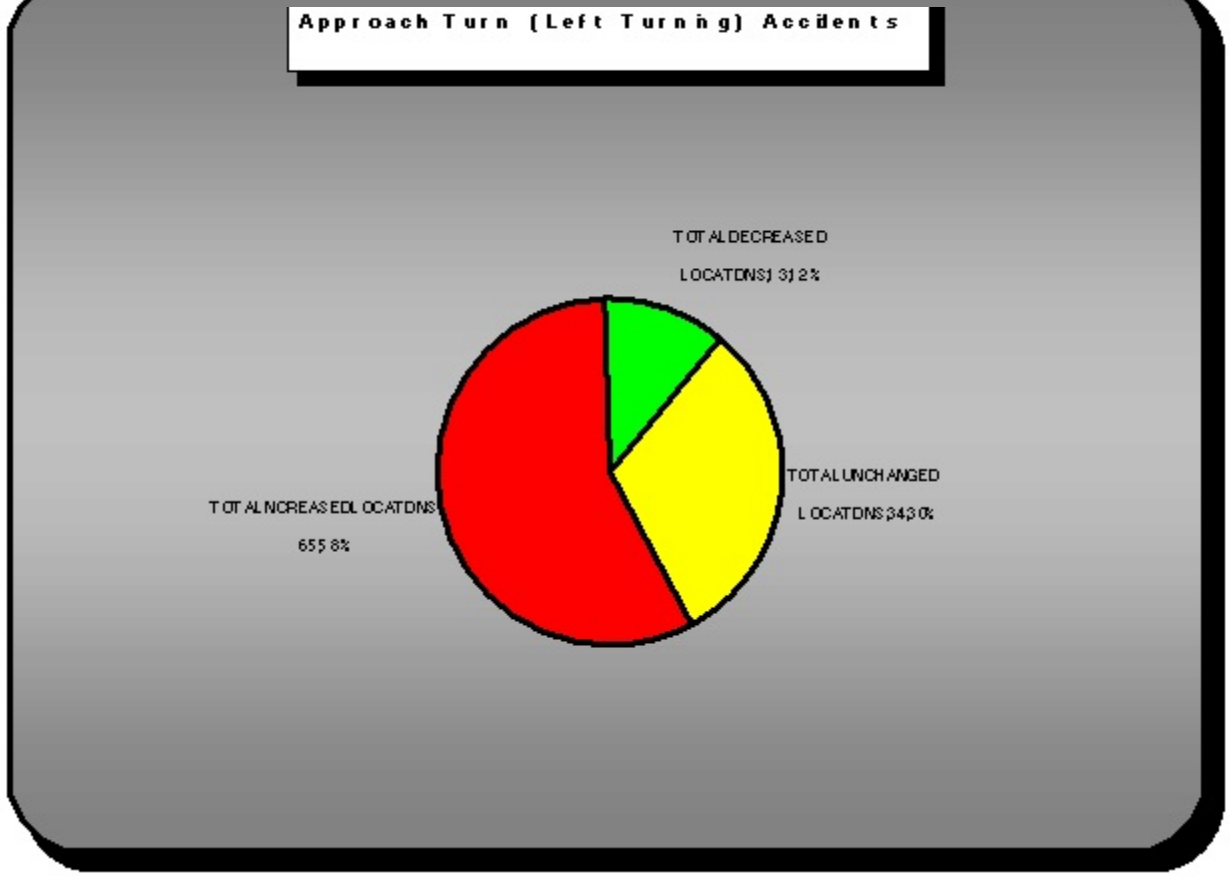
Approach Turn (Left Turn) Accidents



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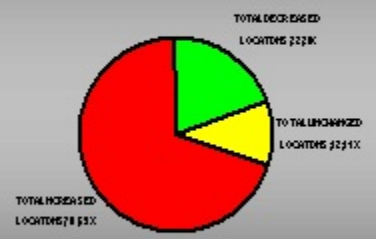
Property Damage Accidents



Injury Accidents

Fatal Accidents

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Analysis

- These Decreased in the After Period
  - Fatal Crashes
  - Persons Killed
  - School Aged Pedestrian Struck
  - Broadside
  - Overtaking Turn
  - Bicycle Struck
  - Dark, Not Lighted
  - Motor Home (At Fault)
  - Motorcycle (At Fault)
  - Driver Emotionally Upset
  - Driver Evading Law Enforcement
  - Driver Physically Disabled
  - Driver Under Influence of Alcohol and Drugs

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A Study of the Safety Effects of Signalizing Intersections on Colorado State Highways

Analysis

- These Were Unchanged in the After Period
  - Bicycle (At Fault)
  - Driver Under Influence of Illegal Drugs
- All Others Were Increased (49 Attributes)

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A Study of the Safety Effects of Signalizing Intersections on Colorado State Highways

Analysis

- 95% Confidence Intervals Were Constructed
  - These DECREASED by an Amount Significantly Different Than Zero
    - Broadside
    - Overtaking Turn

Signalization and Safety

A Study of the Safety Effects of Signalizing Intersections on Colorado State Highways

Analysis

- 95% Confidence Intervals Were Constructed
  - 31 Attributes Were INCREASED by an Amount Significantly Different Than Zero.
  - 9 Attributes INCREASED Significantly *More Than 50%*
    - Property Damage Only Crashes
    - Crashes Involving 3 or More Vehicles
    - Crashes on the Roadway
    - Rear Ends
    - Approach Turns
    - Dark, Lighted
    - Pickup Truck or Utility Van (At Fault)
    - Driver Inexperienced

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    - Crashes on the Roadway
    - Rear Ends
    - Approach Turns
    - Dark, Lighted
    - Pickup Truck or Utility Van (At Fault)
    - Driver Inexperienced
    - Total Number of Crashes

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A Study of the Safety Effects of Signalizing Intersections on Colorado State Highways

Analysis

- Traffic Volume (AADT) Increased by 19.30% (Average) from Before to After
- 95% Confidence Intervals Compared to 19.30% (Rather Than Zero)
  - Attributes Significantly Reduced Relative to Change in Highway Traffic Volume
    - Collisions Involving a School Aged Pedestrian
    - Broadside Collisions
    - Overtaking Turn Collisions
    - Motor Home as the At-Fault Vehicle

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Analysis

- Traffic Volume (AADT) Increased by 19.30% (Average) from Before to After
- 95% Confidence Intervals Compared to 19.30% (Rather Than Zero)
  - Severity Measures Increased Significantly Beyond Change in Highway Traffic Volume
    - Property Damage Only Collisions
    - Injury Collisions
    - Total Persons Injured

Signalization and Safety

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Analysis

- Traffic Volume (AADT) Increased by 19.30% (Average) from Before to After
- 95% Confidence Intervals Compared to 19.30% (Rather Than Zero)
  - Collisions Under The Following Conditions Increased Significantly Beyond Change in Highway Traffic Volume
    - Daylight
    - Dawn or Dusk
    - Darkness, at Illuminated Locations
    - Good Weather
    - Rain
    - Snow, Sleet or Hail
    - Dry Road
    - Wet Road

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Analysis

- Traffic Volume (AADT) Increased by 19.30% (Average) from Before to After
- 95% Confidence Intervals Compared to 19.30% (Rather Than Zero)
  - Collisions Where Drivers of the Following Vehicle Types Were At Fault Increased Significantly Beyond Change in Highway Traffic Volume
    - Passenger Cars and Vans
    - Pickups and Utility Vehicles
    - Heavy Trucks and Busses
    - Unknown (Hit and Run) Vehicles

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- Traffic Volume (AADT) Increased by 19.30% (Average) from Before to After
- 95% Confidence Intervals Compared to 19.30% (Rather Than Zero)
  - Collisions Involving The Following Apparent Human Factors Increased Significantly Beyond Change in Highway Traffic Volume
    - No Apparent Contributing Human Factor
    - Driver Inexperience
    - Driver Preoccupied

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Analysis

- Traffic Volume (AADT) Increased by 19.30% (Average) from Before to After
- 95% Confidence Intervals Compared to 19.30% (Rather Than Zero)
  - Collisions Types Increased Significantly Beyond Change in Highway Traffic Volume
    - Rear End
    - Approach Turn (Left Turning)

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Conclusions

- Safety Was Generally Not Improved
  - Accidents Increased at 75% of Locations
  - Accidents Increased by 74.6% while AADT Increased 19.3%
  - 26 Attributes Were Increased Significantly More Than AADT
  - Only 4 Attributes Were Decreased Significantly Relative to AADT
- Increases Followed Signalization
  - Signalization Isn't Necessarily Cause of Each Increase
    - Lacking other arguments, signalization is the most likely culprit.

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Conclusions

- The Bad News is Good News
  - Rear Ends Increased at 77% of Locations
  - Rear Ends Increased by 165%
  - Increase in Rear Ends = 64% of Increase in Total Accidents
  - Approach Turns Increased at 58% of Locations
  - Approach Turns Increased by 150%
  - Increase in Approach Turns = 34% of Total Increase
- How is That Good?
  - Rear End Countermeasures (Dilemma Prevention, Signal Progression) Approach 50% Reduction
  - Fully Protected Lefts Reduce Approach Turn by 90%+
  - Roundabouts Don’t Have Approach Turn and Reduce Rear End

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Conclusions

- MUTCD says, “A traffic signal should not be installed unless an engineering study indicates that installing a traffic signal will improve the overall safety and/or operation of the intersection.”
- Traffic Engineers should strive to improve safety AND operation (though many of the studied signals apparently improved neither).
- By thoughtfully considering *HCM*, available counter-measures for the (now expected) safety impacts and appropriate alternatives, we should be able to improve both.

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