Signalization and Safety

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

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

Presentation by Richard G. Sarchet, P.E.
of the Colorado Department of Transportation
at the TRB National Roundabout Conference
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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?
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?
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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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 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)
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?

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<tr>
<th>Site #</th>
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</table>
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### Analysis

- **Data from CDOT Accident History Database**

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<th>Site #</th>
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All Accidents

- Total Increased Locations: 83.75%
- Total Decreased Locations: 4.21%
- Total Unchanged Locations: 5.5%
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Broadside Accidents

- Total increased locations: 32% of total
- Total decreased locations: 52% of total
- Total unchanged locations: 16% of total

Diagram showing the distribution of broadside accidents.
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Rear End Accidents

- Total Decreased Locations: 33.2%
- Total Increased Locations: 67.7%
- Total Unchanged Locations: 9.1%
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Approach Turn (Left Turn) Accidents

- Decreased Locations: 31.2%
- Increased Locations: 65.5%
- Unchanged Locations: 3.3%
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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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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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Analysis

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

- 95% Confidence Intervals Were Constructed
  - 31 Attributes Were INCREASED by an Amount Significantly Different Than Zero.
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    - 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
    - Total Number of Crashes
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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)
  - 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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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)
  - Severity Measures Increased Significantly Beyond Change in Highway Traffic Volume
    - Property Damage Only Collisions
    - Injury Collisions
    - Total Persons Injured
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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)
  ▶ 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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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)
  - 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
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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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)
  - 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.
Signalization and Safety

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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
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 countermeasures for the (now expected) safety impacts and appropriate alternatives, we should be able to improve both.
Signalization and Safety

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Thank You!