Work Zone Innovations–SMART Only?

Transportation Engineering and Safety Conference (12/06/17)

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Prior Speakers

- **Work Zone Data Initiative**
- **Work Zone Queues - Impact on Safety**
- **How do we ............. ?**
  - **Collect Data**
    - Real time/Automated
    - Accurate/Reliable
    - Portable
  - **Report Out/ Inform (Public, DOT, Others)**
- **Goal**
  - Improve Safety (XX injured or killed today, up XX % over the last 5 years)
  - Improve Mobility (XX % of non-recurring delay nationwide)

*Is Smart Work zones the Answer?*
What is a Smart Work Zone?

- ... provide motorist and workers with “real time” information for improved safety and mobility through the work zone.

- **Intent of these “Dynamic Systems”**
  - Supplements existing Static Signs
  - Automatically identifies less obvious or confusing conditions/hazards
  - Provides information immediately – appropriate message
  - Impact Driver Behavior
Many Technologies

- **Traffic Responsive**
  - Dynamic Merge (Late/Early)
  - Queue Warning (Congestion/Stopped Advisory)
  - Travel Time Information
  - Ramp Metering

- **Vehicle Responsive**
  - Variable Speed Limits
  - Construction Vehicle Warning
  - Over Dimensional Warning
  - Assigned Truck Lanes
  - Intrusion Warning
  - Connected Vehicle vs. Automated vs. Autonomous
What Technology is Most Appropriate?

Well that Depends …

- Potential problem - Underlying Cause (be Pro-Active or Re-Active)
  - Safety
    - Back of Queue Crashes
    - Construction Vehicles Entering Main Line
    - Shoulder deterioration
    - Speeding (large speed deferential)
  - Mobility
    - Long Queues
    - Excessive Travel Time
- Action Required to Mitigate
- Available Practice/s to Mitigate Action (QW, DL/EM, RM, etc.)
- The Best Is NOT always the Acceptable Practice (e.g., Automated Enforcement, Ramp Metering)
Key Components of a Smart Work Zone?

- Detect (Radar, Video, etc.)
- Monitor (including built-in redundancies to eliminate system failure)
- Communicate
- Analyze (be clear on the issue you are mitigating – defines the outcome)
- Manage (database, back up, etc.)
- Inform (Driver, DOT, Others)
  - Driven by the desired action you need the driver to take
- Delivery Means
  - CMS, Static with Dynamic features, HAR, Media, 511, etc.
Many Technologies

- **Traffic Responsive**
  - Dynamic Merge (Late/Early)
  - Queue Warning (Congestion/Stopped Advisory)
  - Travel Time Information
  - **Ramp Metering (Preliminary Data)**

- **Vehicle Responsive**
  - Variable Speed Limits
  - Construction Vehicle Warning
  - Over Dimensional Warning
  - Assigned Truck Lanes (**Preliminary Data**)
  - Intrusion Warning
  - Connected Vehicle vs. Automated vs. Autonomous

*(Discuss briefly the preliminary evaluation for these 2 strategies - Report 2018)*
Temp. Ramp Metering (US 52/US 63, MN)

Notes:
1. Locations shown are approximate only and will be field adjusted to ensure maximum safety.
2. All roadside sensors (RS) will be placed outside the shoulder.
3. During meter on time, two lanes are formed.

Legend of Symbols
- Camera
- Ramp Control Signal

See Figures 2 for Ramp Control Signal Details
Data Collection (3 weeks each location)

- Volume
- Speed
- Travel Time
- Classification
- Headway
- Compliance
- Signal Timing Info

*(Fixed vs. Variable Time)*
Ramp Metering (NCHRP 03 111) – Main Line
Ramp Metering (NCHRP 03 111) – Speed Comparison

### Meter Off (Without Ramp Metering) and Option 1 (Fixed Cycle Length)

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Meter Off</th>
<th>Option 1</th>
<th>Meter Off</th>
<th>Option 1</th>
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### Meter Off (Without Ramp Metering) and Option 2 (Variable Cycle Length)

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Ramp Metering (NCHRP 03 111) – Main Line

AM Travel Time from Location 1 to Location 3

- Option 1 (Fixed Cycle Length)
- Option 2 (Variable Cycle Length)

D1: Variation Between Meter Off and Option 1
D2: Variation Between Meter Off and Option 2
## Ramp Metering (NCHRP 03 111)- Travel Time Comparison

### Meter off (Without Ramp Metering) and Option 1 (Fixed Cycle Length)

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<th>Average Travel Time/Veh. (Second)</th>
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### Meter Off (Without Ramp Metering) and Option 2 (Variable Cycle Length)

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Ramp Metering (NCHRP 03 111)- Headway

Cumulative Headway Distribution Plot – NOT Significant
Driver compliance Rates

- Fixed cycle length ramp metering—sample size: 445, 63.1 percent compliance
- Variable cycle length ramp metering—sample size: 376, 76.3 percent compliance
Ramp Metering Conclusion

- **Conclusion:**
  - Speeds of vehicles on the mainline increased in both ramp metering scenarios (Significant)
  - Travel time became shorter in both ramp metering scenarios (Significant)
  - Headways of vehicles on the mainline increased in both ramp metering scenarios (Not statistically significant)
  - Driver compliance rate > 60 % (NO enforcement)
  - Understand the traffic profile – know when to meter
    - Total Lane Volume < 14-1,600 VPH (Ramp Volume < 400-600 VPH)
    - Examine smaller data bins (<15 mins)
  - Equipment Limitations – Built-in Redundancies
Temp. Truck Lane Restrictions (I 75, MI)

- Reconstruction of 5.6 miles of Interstate-75 (Rehabilitation of three (3) bridges, and replacement of three (3) bridges)
Data Collection (Multiple locations)

- Volume
- Speed
- Classification
- Headway
- Compliance
### Truck Lane Restrictions (I 75, MI) - Compliance

<table>
<thead>
<tr>
<th>Time</th>
<th>Before</th>
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<th>% Change</th>
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<th>Statistically Significant</th>
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<th>% Change</th>
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Truck Lane Restrictions (I 75, MI) – Speed Comparison

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<tr>
<th>Time</th>
<th>Sample Size</th>
<th>Left Lane – Truck Mean Speeds</th>
<th>% Change</th>
<th>T Statistic</th>
<th>Statistically Significant</th>
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<td>After</td>
<td>Before</td>
<td>After</td>
<td></td>
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Before-After Truck Mean Speeds—Left Lane
Truck Lane Restrictions (I 75, MI)

Left Lane – Speed & Volume Graph for Trucks with Trend Line, 6.00 AM to 6.00 PM (5 min bin)
Truck Lane Restrictions (I 75, MI)

Right Lane – Speed & Volume Graph for Trucks with Trend Line, 6.00 AM to 6.00 PM (5 min bin)
Truck Lane Restrictions (I-75, MI) – Headway (Left Lane)

<table>
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<th>T-T &amp; T-C</th>
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Truck Lane Restrictions (I 75, MI)-
Conclusion

- **Conclusion:**
  - Truck volumes up significantly
  - Truck Speeds increased in Left Lane (but below WZ posted Speed Limit)
  - Headways for both cars and trucks increased significantly
  - Crash data - (being investigated)
  - Understand the traffic profile
    - Best when truck traffic is greater than 15-25 % (?) or traffic stream
  - Equipment Limitations – Built-in Redundancies
  - Need Periodic Enforcement

(Data validation ongoing for other sites)
Lessons Learned?

- Many Work zone Innovations
- Understand the Underlying Cause and Action Required to Mitigate
- Understand the Available Practice/s to Mitigate Action
  - Build your Knowledge Base (Don’t rely on the Contractor)
- Have a Clear Data Performance Plan
- Use Feedback Constructively
- Recognize that No System is Perfect – Build-in Redundancies
- The Best Is NOT always the Acceptable Practice
- Document – Share with Others
Thank You

- Looking for more sites to test
  - Ramp Metering (XX - PA, I 4 - FL)
  - Truck Lane Restrictions (2 ongoing)
- Completed or ongoing evaluation of Smart Work Zones/Technologies
  please email me

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