Bringing Order to Chaos:
The Growing Role of Proactive Traffic Management Solutions

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Order in Traffic Chaos
Characteristics of Traffic Networks

Efficient self-organization

Inefficient self-organization

Extreme demands and turbulence

Increase in loads

When it becomes too busy the production will degenerate

Prevent queue spillback

Optimal distribution of flows over network

Improve throughput at bottlenecks

Reduce inflow in (sub-) networks
Proactive Traffic Management

Deployed Technologies in the U.S.

- CCTV Cameras
- Traveler Information
  - DMS ~90% of freeways
  - Social Networking 40%
  - HAR 60%
  - Subscription 35%
  - Web 90%
  - Email 50%
  - Phone 20%
  - 511 70%
- Electronic Toll Collection
- Ramp Control
- Sensors/Loops
- Automated Enforcement
- Lane Management
- Archived Data
- Probe Vehicles
Active Traffic Management in the UK

- CCTV
- Driver Info
- VSL/Lane Control
- Gantry
- Enforcement

- E-Call
- E-Refuge
- Hard Shoulder Running
- Sensors in Lanes
- Ramp Metering

Variable Speed Limit (VSL)

- Deployed during recurring congestion, incidents, adverse weather
- Decreased headways
- Increased throughput
- More uniform speeds
- More uniform driver behavior
- Delay onset of freeway breakdown
- Decrease in primary incidents
- Decrease in incident severity
- Increased trip reliability
- Reduced noise, fuel consumption, emissions
- Supports temporary shoulder use, queue warning, and dynamic merge control
VSL Worldwide Overview

- 150 Surveys distributed: Ministries of Transportation, DOTs, TRB Committees, AASHTO STSMO, Universities, Integrators, Personal Contacts
- Survey Responses: 47
- Response rate: ~31%
- Other information assembly: Email, Skype interviews, Literature Review, Reports
- Number of countries that use VSL: 22
- Number of states in the US that use VSL: 11
- VSL used for:
  - Weather and road conditions
  - Congestion (Avoid shock-wave and smoothing flow in congestion area)
  - Work zones
- Most sensors in use:
  - Loop detectors
  - Radar
- Algorithms used for VSL:
  - Mainly simple look-up tables using thresholds (speed, flow, occupancy, weather data)
  - Complex IF-THEN algorithms such as logic-tree
  - MARZ algorithm and Modifications of MARZ algorithm in central Europe
  - Fuzzy logic to overcome sensitivity problem

VSL Worldwide

VSL in 22 countries
Planned in 4 countries
Removed in 0 countries
VSL Worldwide

Active
Planned

VSL in 11 U.S. States
Planned in 7 States
Deactivated in 2 States
VSL in 2 Canadian Provinces
Planned in 1 Province
Portland, Oregon USA - Corridor Overview

- 7.52 mile highway between Beaverton US 26 – Tigard I-5
- 55 mile per hour speed limit
- 11 sets of on and off ramps in each direction
- High commuter volumes
- Approximately 110,000 vehicles per day in 2013
- Application of basic speed rule
- Two lanes in each direction
- 300+ crashes per year
- Widening to six lanes and braiding ramps would cost nearly $1 billion

OR 217 Active Traffic Management Project

- Elements
  - Variable Advisory Speed Limit System
    - Congestion
    - Weather
  - Traveler Information System
  - Adaptive Ramp Metering
  - Queue Warning System
  - Curve Warning
- Three Main Goals
  - Improve Safety
  - Reduce Congestion
  - Utilize Existing Assets
- Other Attributes
  - Low Cost (minimal gantries)
  - Advisory Speeds Only
  - No Automated Enforcement
OR 217 ATM Components

- 7 miles (11 km)
- 28 overhead VSL signs
- 7 mainline Variable Message Signs (VMS)
- 6 arterial VMS
- 4 roadway weather sensors
- 5 radar traffic sensors
- 12 Bluetooth sensors
- 20 mainline dual loop stations (20-sec intervals)

Variable Advisory Speed Limit System on OR 217
Preview of Results

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Hypotheses vs. Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed standard deviation</td>
<td>↓ Will decrease after VSL</td>
</tr>
<tr>
<td>Relative frequency of peak hour crashes</td>
<td>↓ Will decrease after VSL</td>
</tr>
<tr>
<td>Lane flow ratio</td>
<td>↓ Will be closer to one after VSL</td>
</tr>
<tr>
<td>Travel time buffer index</td>
<td>↓ Will decrease after VSL</td>
</tr>
<tr>
<td>Flow drop around bottlenecks</td>
<td>↓ Will decrease in severity after VSL</td>
</tr>
<tr>
<td>“Wet” mean travel times</td>
<td>↑ Will increase after VSL</td>
</tr>
<tr>
<td>“Wet” travel time reliability</td>
<td>↑ Will increase after VSL</td>
</tr>
</tbody>
</table>

Summary of Results

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Hypotheses</th>
<th>Results</th>
<th>Correlation with Hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed standard deviation</td>
<td>Will decrease after VSL</td>
<td>Decreased at two stations and increased at two stations</td>
<td>000</td>
</tr>
<tr>
<td>Relative frequency of peak hour crashes</td>
<td>Will decrease after VSL</td>
<td>Decreased during the AM peak and remained unchanged during PM peak</td>
<td>0000</td>
</tr>
<tr>
<td>Lane flow ratio</td>
<td>Will be closer to one after VSL</td>
<td>Generally moved closer to one, particularly during midday and PM peak</td>
<td>0000</td>
</tr>
<tr>
<td>Travel time buffer index</td>
<td>Will decrease after VSL</td>
<td>Decreased in all but NB left lane, particularly during midday hours</td>
<td>0000</td>
</tr>
<tr>
<td>Flow drop with congested conditions</td>
<td>Will decrease in severity after VSL</td>
<td>Decreased in severity upstream of bottlenecks, increased in severity downstream</td>
<td>0000</td>
</tr>
<tr>
<td>“Wet” travel times &amp; travel time reliability</td>
<td>Will both increase after VSL</td>
<td>Travel times were generally lower, but reliability did increase</td>
<td>0000</td>
</tr>
</tbody>
</table>
Driver Speeds and VAS Displayed Speeds [March 18, 2015]

Northbound OR 217 Speed Data—Portal
First Day of Activation
Northbound OR 217 VAS Display Data—Portal

First Day of Activation

Sample VAS Display in September 2014 (Thursday)

- System calibration
  July—September
- Sign mostly off
- SLOW advisory during congestion
Sample VAS Display in February 2015 (Saturday)

Sample VAS Display in March 2015 (Wednesday)

Detected Speeds NB OR 217 March 18, 2015
Sample VAS Display in March 2015 (Wednesday)

Compliance = difference between displayed speed and actual measured traffic speed
Statistical Analysis of Compliance Parameters

Variable Advisory Speed Compliance OR 217 NB March 18, 2015

Mean 19
Median 20
Standard Deviation 19
Variance 355

47% +/- 20%
33% +/- 15%
19% +/- 10%
10% +/- 5%
8% Below VAS
88% Above VAS

0% 5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95% 100%
Cumulative Percent of Observations

-80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
Percent Above/Below VAS

-4% -3% -2% -1% 0% 1% 2% 3% 4% 5% 6% 7% 8% 9% 10% 11% 12% 13% 14% 15% 16% 17% 18% 19% 20%
Percent of Observations

10.24.17
Statistical Analysis of Compliance Parameters

Displayed VAS Speed vs. Compliance (Displayed - Actual)

Compliance per VAS speed

Pre-VSL 55 mph Speed Limit

Post-VSL Sample Day

Driver Compliance June 2014

Driver Compliance to VAS Speeds, March 2015

Driver Compliant to VAS Speeds, March 2015

Pre-VSL 55 mph Speed Limit

Post-VSL Sample Day

Driver Compliance June 2014

Driver Compliance to VAS Speeds, March 2015

Driver Compliant to VAS Speeds, March 2015
Average Selected Compliance Parameters (6 months)

Off-Peak vs. Peak Period Compliance

Off peak worse than peak hour compliance, especially at lower VAS speeds
Peak vs. Off-Peak Compliance

- Filter out periods when traffic is moving slower than VAS displays
- Comparison of compliance between right lane and left lane
- Identify days with state police enforcement presence (if available)
- Adaptive smoothing
- Before/after cluster analysis
- Connections to ongoing before/after crash analyses
- Travel time and reliability

Limitations and Future Research
Accelerating Innovation

- Accelerate deployment and innovation in partnership with stakeholders and implementers
- Mainstreaming ITS technologies that have known benefits
- Performance measurement and rigorous evaluation
- Collaboration among transportation agencies and industry
- Charismatic leadership
- Archived data
- Performance culture
- Careful before and after evaluation
- It’s the people—workforce development

Thank you for your attention!

Acknowledgments
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