BIKE DETECTION DIFFERENTIATION USING INDUCTIVE LOOPS

PRESENTED BY:

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APPLICATIONS SALES & TECHNICAL SERVICES MANAGER
DISTRICT 6 ITE LAS VEGAS, NEVADA JULY 22, 2015
WHAT TO EXPECT

• Discussion on increasing Safety for Bicyclists
• Loop detection technology used for bicyclists
• Discussion of inductive loop detection as a system
• Loop installation and new loop wire technology
• First Bicycle invented in 1817
• 1896 first automobile accident was with a bicycle
• Pedalcyclists considered “second class citizens”
• 2007 study suggest 700 bicyclists die annually, with over 44,000 bike/car accidents occurring each year.

### Pedalcyclists Killed, by Related Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number</th>
<th>Percent*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure to yield right of way</td>
<td>117</td>
<td>18.6</td>
</tr>
<tr>
<td>Under the influence of alcohol, drugs or medication</td>
<td>67</td>
<td>10.6</td>
</tr>
<tr>
<td>Failure to obey (e.g., signs, control devices, officers)</td>
<td>60</td>
<td>9.5</td>
</tr>
<tr>
<td>Walking, playing, working, etc., in roadway</td>
<td>51</td>
<td>8.1</td>
</tr>
<tr>
<td>Improper crossing of roadway or intersection</td>
<td>44</td>
<td>7.0</td>
</tr>
<tr>
<td>Operating without required equipment</td>
<td>38</td>
<td>6.0</td>
</tr>
<tr>
<td>Not visible</td>
<td>34</td>
<td>5.4</td>
</tr>
<tr>
<td>Daring into road</td>
<td>32</td>
<td>5.1</td>
</tr>
<tr>
<td>Riding on wrong side of road</td>
<td>25</td>
<td>4.0</td>
</tr>
<tr>
<td>Making improper turn</td>
<td>19</td>
<td>3.0</td>
</tr>
<tr>
<td>Improper lane changing</td>
<td>18</td>
<td>2.9</td>
</tr>
<tr>
<td>Failure to keep in proper lane or running off road</td>
<td>17</td>
<td>2.7</td>
</tr>
<tr>
<td>Inattentive (talking, eating, etc.)</td>
<td>11</td>
<td>1.7</td>
</tr>
<tr>
<td>Improper entry to or exit from traffic way</td>
<td>4</td>
<td>0.6</td>
</tr>
<tr>
<td>Failing to have lights on when required</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Portable electronic devices</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Other factors</td>
<td>25</td>
<td>4.0</td>
</tr>
<tr>
<td>None reported</td>
<td>239</td>
<td>37.9</td>
</tr>
<tr>
<td>Unknown</td>
<td>19</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Total Pedalcyclists</strong></td>
<td>630</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Note: The sum of the numbers and percentages is greater than total pedalcyclists killed as more than one factor may be present for the same pedalcyclist.

**Pedalcyclists** – Designates bicycles only, not other forms of cycles – scooters, motorcycles, or mopeds.

43.8%

WHERE ARE THE RIDERS?

GROWTH ACROSS THE COUNTRY

Average 46% increase since 2005 (to 2013)

BICYCLE COMMUTING GROWTH BY STATE

NATIONALLY, since 2005, states have seen, on average, a 46% increase in the share of people commuting by bike. But an average is just that – there are many states that have seen tremendous increases in cycling, including some that might not be expected. This map shows the growth in bicycle commuting for all 50 states from 2005 to 2013.
INCREASED NUMBER OF RIDERS

WHY ARE WE SEEING MORE RIDERS

- **Economy**
  - Excessive Fuel Prices
- **Health**
  - Obesity and Aging
- **Environment**
  - Green Awareness
“It’s clear that if we build it, they will come,” said Shahum. “No other mode of transportation is growing as fast or has a higher return on investment in terms of improving our city for everyone. It’s time for the City to truly invest in our bicycle network, and ensure that our City’s streets are welcoming and comfortable for the growing number of people riding.”

The old expression, "if you build it, they will come," could not be more true than it is on the streets of New York City. Since 2006, the City of New York has laid down more than 250 miles of bikes lanes (just over four percent of the city's 6,000 miles of streets) and New Yorkers are flocking to use the lanes as fast as they're opened. There was a 13 percent increase in daily commuter bicycling between 2009 and 2010 alone. Our city has seen double-digit growth in bike ridership for four straight years - effectively doubling the number of regular cyclists on our streets, according to the DOT's.

https://transalt.org/
“BUILD IT THEY WILL COME”

PROTECTED ROUTES

As a study from Portland State University’s National Institute of Transportation and Communities notes; **about three-quarters of new users riding on protected routes tended to come from other routes (presumably because the physical separation makes these safer and more comfortable than the alternatives)** and about one-quarter of the new users tend to be using a bicycle when they wouldn't have done so before.

http://www.peopleforbikes.org/blog/entry/everywhere-they-appear-protected-bike-lanes-seem-to-attract-riders
WHERE DO PEOPLE LIKE TO RIDE?

14 out of 25 are cities in the western US

<table>
<thead>
<tr>
<th>Rank</th>
<th>City</th>
<th>Bikeability Score</th>
<th>Population Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Boulder, CO</td>
<td>862</td>
<td>~300</td>
</tr>
<tr>
<td>19</td>
<td>Los Angeles</td>
<td>54</td>
<td>2</td>
</tr>
<tr>
<td>18</td>
<td>Ft. Collins</td>
<td>762</td>
<td>163</td>
</tr>
<tr>
<td>20</td>
<td>Houston</td>
<td>49</td>
<td>4</td>
</tr>
<tr>
<td>25</td>
<td>San Francisco</td>
<td>70</td>
<td>14</td>
</tr>
<tr>
<td>10</td>
<td>Philadelphia</td>
<td>558</td>
<td>145</td>
</tr>
<tr>
<td>21</td>
<td>San Diego</td>
<td>48</td>
<td>8</td>
</tr>
<tr>
<td>22</td>
<td>Austin</td>
<td>45</td>
<td>13</td>
</tr>
<tr>
<td>17</td>
<td>Miami</td>
<td>647</td>
<td>384</td>
</tr>
<tr>
<td>18</td>
<td>Oakland</td>
<td>57</td>
<td>46</td>
</tr>
<tr>
<td>13</td>
<td>Seattle</td>
<td>64</td>
<td>22</td>
</tr>
<tr>
<td>112</td>
<td>Washington, D.C.</td>
<td>675</td>
<td>825</td>
</tr>
<tr>
<td>8</td>
<td>Portland</td>
<td>70</td>
<td>29</td>
</tr>
<tr>
<td>14</td>
<td>Tucson</td>
<td>64</td>
<td>33</td>
</tr>
<tr>
<td>147</td>
<td>Miami</td>
<td>647</td>
<td>384</td>
</tr>
<tr>
<td>18</td>
<td>Oakland</td>
<td>57</td>
<td>46</td>
</tr>
<tr>
<td>10</td>
<td>Minneapolis</td>
<td>629</td>
<td>38</td>
</tr>
<tr>
<td>123</td>
<td>Pittsburgh</td>
<td>539</td>
<td>431</td>
</tr>
<tr>
<td>184</td>
<td>Oakland</td>
<td>537</td>
<td>434</td>
</tr>
<tr>
<td>19</td>
<td>Long Beach</td>
<td>547</td>
<td>82</td>
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<tr>
<td>5</td>
<td>Tempe</td>
<td>75</td>
<td>145</td>
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<tr>
<td>6</td>
<td>Eugene</td>
<td>75</td>
<td>150</td>
</tr>
<tr>
<td>3</td>
<td>Ft. Collins</td>
<td>78</td>
<td>163</td>
</tr>
<tr>
<td>23</td>
<td>Pittsburgh</td>
<td>396</td>
<td>629</td>
</tr>
<tr>
<td>1</td>
<td>Boulder, CO</td>
<td>86</td>
<td>300</td>
</tr>
<tr>
<td>25</td>
<td>Tyler, TX</td>
<td>38</td>
<td>301</td>
</tr>
</tbody>
</table>

Bikeability scores are from WalkScore.com on 12/31/12. As of that date, these are the only 25 cities.
WHAT IS EXPECTED

WHERE IS BICYCLE SAFETY GOING?

• Continued focus on safety for bicyclists
  – Requires education and public awareness programs
  – Change behavior of bicyclist to obey traffic laws

• Bicyclists now considered in designs of intersection and timing, as part of mainstream traffic.

• New controller software with bike timing as additional parameter, just like vehicle and pedestrian timing.

• MUTCD changes to reflect changing environment
  – Signal heads and signage
ASPECTS OF BIKE SAFETY

WHY DON’T BICYCLIST OBEY SIGNALS?

– Manual Bike detection
  • Push Buttons are inconvenient
– Designated timing in Controllers
  • Bike discrimination for separate timing only in new controller software
– Automatic bike detection
  • Loops, Video, Microwave, etc. are not prevalent
NEW REGULATIONS

AB1581

TOPD 09-06 / California AB1581

The Traffic Operations Policy Directive (TOPD) 09-06 was issued August 27, 2009, since Assembly Bill 1581 became law (California Vehicle Code 21450.5) on January 1, 2008. This TOPD states that "All new limit line detector installations and modifications to the existing limit line detection on a public or private road or driveway intersecting a public road shall either provide limit line bicycle/motorcycle detection in which a Reference Bicycle-Rider is detected or be placed on permanent recall or fixed time operation." If more than 50 percent of the limit line detectors need to be replaced at a signalized intersection, then the entire intersection should be upgraded so that every lane has a limit line bicycle/motorcycle detection zone. Whether using detection, recall or fixed timing, the minimum bicycle timing must be according to Table 4D-109(CA) "Signal Operations Minimum Bicycle Timing" in the attached TOPD 09-06 (See Attachment 1). Limit line bicycle/motorcycle detection zones, as defined by the TOPD 09-06 and this memorandum, are not applicable to freeway ramp meter signals.

IMPLEMENTATION OPTIONS: Currently, there are three types of technology approved for use for bicycle detection in Caltrans "Bicycle/Motorcycle Detection Installation Notes." (See Attachment 2):

- In-pavement detection (Type D inductive loop)
- Video detection
- Bicycle Push button
WHY BIKE TIMING?

(WITH ANY TECHNOLOGY)

- More efficient intersection timing
- Bike Riders need their own timing
- Timing ensures enough time to get through intersection but not too much time

Intersection Width

- Focus on Pedalcyclists to begin to obey the laws
- Safer operations at intersection
BIKE TIMING

CALTRANS RECOMMENDS THE FOLLOWING FOR BIKE TIMING

**Guidance:**

Where a Limit Line Detection Zone that detects the Reference Bicycle-Rider has been provided, minimum bicycle timing should be provided as follows:

For all phases, the sum of the minimum green, plus the yellow change interval, plus any red clearance interval should be sufficient to allow a bicyclist riding a bicycle 6 ft long to clear the last conflicting lane. It is a speed of 14.7 ft/sec plus an additional effective start-up time of 6 seconds, according to the formula:

\[
G_{\text{min}} + Y + R_{\text{clear}} \geq 6 \text{ sec} + \frac{W + 6 \text{ ft}}{14.7 \text{ ft/sec}}
\]

- \(G_{\text{min}}\) = Length of minimum green interval (sec)
- \(Y\) = Length of yellow interval (sec)
- \(R_{\text{clear}}\) = Length of red clearance interval (sec)
- \(W\) = Distance from limit line to far side of last conflicting lane (ft)
INDUCTIVE LOOP SYSTEM
TWO PARTS NOT JUST ONE

The First $\frac{1}{2}$ of the system
REQUIREMENTS

WHAT IS NEEDED FOR BIKE DETECTION

• Differentiation between Bikes and other vehicles.
  – Differentiates against Motorcycles / Scooters / Mopeds and all other vehicles

• Provide bike timing for older controllers
  – “Minimum Bike” and “bike extension” timing
  – Provide calls for vehicles on separate channel outputs

• Counts bicycles
SPECIFICS

BASIC FUNCTIONALITY

• 2 channel detector with four outputs
• Bike detection comes out on separate channels
• Bike Timing relies on field green inputs into the detector
• Bicycle differentiation **requires** a specific loop design.
FOR TS2 AND 332 CABINETS

HOW DOES THE DETECTOR KNOW ABOUT THE GREEN INDICATION.

- In some cabinets it is already wired into the detector rack. TS1
- In other cabinets a PGI is installed
- Capable of inputs into two cards
- Outputs from two cards
LOOP CONFIGURATION

WHY IS NEW DESIGN NEEDED?

Loop design for bike detection is a rectangle or parallelogram at 45° of direction of travel.

- 45° is required for discrimination and enhances signature
- Additional loop is not required for presence and vehicle detection if needed.
THE DETECTION
BICYCLE THROUGH MIDDLE OF LOOPS

Bicycle through center of 2 turn Round Loop

Bicycle through center of 1 turn Round Loop

Bicycle through center of 4 turn 45 degree Loop
Loop Configuration for Differentiation

- Loop is placed across a whole lane or it can be placed on the lane line (ex. Between left turn & adjacent thru lane)
  - Set up configurations in the detector for both designs
- Loop is installed 45° to the direction of travel
- Loop leading edge to trailing edge is approximately 42” (3 ½ feet, or 1.06 meters)
THE DETECTION

PATENTED TECHNOLOGY

12FT WIDE, 4 TURN, 45 DEGREE LOOP W/ 50FT OF FEEDER CABLE (TYPICAL THRU LANE INSTALLATION)

• MULTIPLE ALGORITHMS
  • Signature analysis
  • Amplitude analysis
  • Signature rejection
THE DETECTION

WON’T DETECT ANY OTHER VEHICLE

12ft wide, 4 turn, 45 degree Loop 50ft of Feeder Cable

7/20/2015

Author: Matt Zinn
THE DETECTION

DIFFERENTIATION OF ALL KINDS

12FT WIDE, 4 TURN, 45 DEGREE LOOP 50FT OF FEEDER CABLE

7/20/2015
Author: Matt Zinn
THE DETECTION

DOES IT WORK WITH A CAR ON THE LOOP?

Scale = 1:24
Loops, car, bicycle

Crosswalk

Bicycle
WHAT ABOUT COMPOSITE BIKES?

- Less than 1:5000 bikes are expected to be totally carbon fiber.
- We detect rims only
- Fix using a 24 AWG wire around rim.

THE DETECTION

USE WITH EXISTING LOOPS

Will it pick up the bike in the presence loop too?
Another example of the Presence detection capabilities
THE DETECTION

DOES IT ALL!

Will it pick up the car in the Bicycle loop too?
THE LOOPS

THE SECOND ½ OF THE SYSTEM

• Loop Myths
  – Loops only detect ferrous metals.
    • Wrong, they detect all metal that is conductive (copper, aluminum, titanium, etc.)
  – Loop wire has to be big (#12 - #16 AWG)
    • Wrong, today’s technology in wire manufacturing allows for smaller gauge wire.
  – Loops fail.
    • Roads fail, back hoes happen, installations are done incorrectly, but loops rarely fail on their own, if done correctly.

7/20/2015
Author: Matt Zinn
• Detection is ONLY as good as the detector.
  – Doesn’t matter what the technology is
  – All detection methods have some issues
  – Correct installation is important
  – Correct maintenance is key
• When installed correctly, loops have the least amount of maintenance needs.
Study done by FHWA suggests that preform or Prefabricated loops out perform contractor wound loops

<table>
<thead>
<tr>
<th>State</th>
<th>Percent installed by</th>
<th>Contractor</th>
<th>Major failures</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alaska</td>
<td>10</td>
<td>90</td>
<td>No loop failures reported</td>
<td>Preformed loops used exclusively</td>
</tr>
<tr>
<td>California</td>
<td>5</td>
<td>95</td>
<td>Improper sealing and foreign material in saw slot</td>
<td>Preformed loops used in poor pavement and dirt detours</td>
</tr>
<tr>
<td>Idaho</td>
<td>10</td>
<td>90</td>
<td>Improper sealing</td>
<td>No failure for loops made of #20002 cable</td>
</tr>
<tr>
<td>Montana</td>
<td>10</td>
<td>90</td>
<td>Improper sealing</td>
<td></td>
</tr>
<tr>
<td>Nevada</td>
<td>5</td>
<td>95</td>
<td>Improper sealing and pavement deterioration</td>
<td></td>
</tr>
<tr>
<td>Oregon</td>
<td>10</td>
<td>90</td>
<td>Improper sealing</td>
<td></td>
</tr>
<tr>
<td>Utah</td>
<td>70</td>
<td>30</td>
<td>Improper sealing and pavement deterioration</td>
<td>Some preformed loops used with no failures reported</td>
</tr>
<tr>
<td>Washington</td>
<td>10</td>
<td>90</td>
<td>Improper sealing and foreign material in saw slot</td>
<td>Need better inspection to improve loop performance</td>
</tr>
</tbody>
</table>

http://www.fhwa.dot.gov/publications/research/operations/its/06139/chapt5b.cfm
PREFABRICATED LOOPS – MATERIAL

XLPE (CROSS-LINKED POLYETHYLENE)

- Water Resistance
- Abrasion Resistance
- Low Temp. Flexibility
- Electrical Properties
- Oil Resistance
- Heat Resistance

Graph showing comparison of PVC, NYLON, and XLPE for various properties.
PREFABRICATED LOOPS

THE SECOND ½ OF THE SYSTEM

- Built to last
- Easy to install
- Ready made for any installation
- New technology materials
- Saves money in the long run
  - *No maintenance!*
  - Less need to repair
WHY PREFABRICATED LOOPS?

- Noise to signal ratio
  - Movement of wires needs to be extremely low
  - Movement causes “noise” which could hide the small bike signal.
- Vibration and stretching against each wire
PREFABRICATED LOOPS - BENEFITS

THE SECOND ½ OF THE SYSTEM

- Wires never move in reference to the other wires in the sheath.
- Quality is insured and warranted with Prefabricated loops.
  - Meg’d to 999 Megaohms prior to leaving the factory
  - Normal standards of 20 Megs would fail.
  - Salt bath for three days before testing
- Ready made for any installation
- Material Costs are offset by performance, maintenance, and lower installation costs
• It’s not Rocket Surgery
  – Install the loop (Prefabricated loops are required)
  – Configure the detection settings
  – Walk away
THANK YOU!

THIS HAS BEEN A PLEASURE!

Thank you for your attention
Any Questions?
For more information contact:

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Flying Bicycle