BIKE DETECTION

DIFFERENTIATION USING INDUCTIVE LOOPS

PRESENTED BY:

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DISTRICT 6 ITE LAS VEGAS, NEVADA JULY 22, 2015

WHAT TO EXPECT

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

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BIKES AND TRAFFIC

HISTORY

- First Bicycle invented in 1817 [1]
- 1896 first automobile accident was with a bicycle [3]
- Pedalcyclists considered “second class citizens” [2]
- 2007 study suggest 700 bicyclists die annually, with over 44,000 bike/car accidents occurring each year. [4]

1. A Quick History of Bicycles. http://www.pedalinghistory.com/PHhistory.html.
2. My Central Jersey Track News Forum - Cyclist Buffer Laws Topic. My Central Jersey Traffic News Forum
3. Track Safety Facts 1996: Pedalcyclists. National Highway Traffic Safety Association (NHTSA), U.S. Dept. of Transportation, 1996.
4. Traffic Safety Facts 2007: Bicyclists and Other Cyclists. National Highway Traffic Safety Association

SERIOUS PROBLEM

NHTSA STUDY

Pedalcyclists Killed, by Related Factors	Number	Percent*
Failure to yield right of way	117	18.6
Under the influence of alcohol ,drugs or medication	67	10.6
Failure to obey(e.g., signs, control devices, officers)	60	9.5
Walking, playing, working ,etc., in roadway	51	8.1
Improper crossing of roadway or intersection	44	7.0
Operating without required equipment	38	6.0
Not visible	34	5.4
Darting into road	32	5.1
Riding on wrong side of road	25	4.0
Making improper turn	19	3.0
Improper lane changing	18	2.9
Failure to keep in proper lane or running off road	17	2.7
Inattentive (talking, eating, etc.)	11	1.7
Improper entry to or exit from traffic way	4	0.6
Failing to have lights on when required	2	0.3
Portable electronic devices	2	0.3
Other factors	25	4.0
None reported	239	37.9
Unknown	19	3.0
Total Pedalcyclists	**630**	**130.7***

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

43.8%

http://www-nrd.nhtsa.dot.gov/Pubs/811402EE.pdf , *"Traffic Safety Facts 2009"* (table 105) Pg. 140.

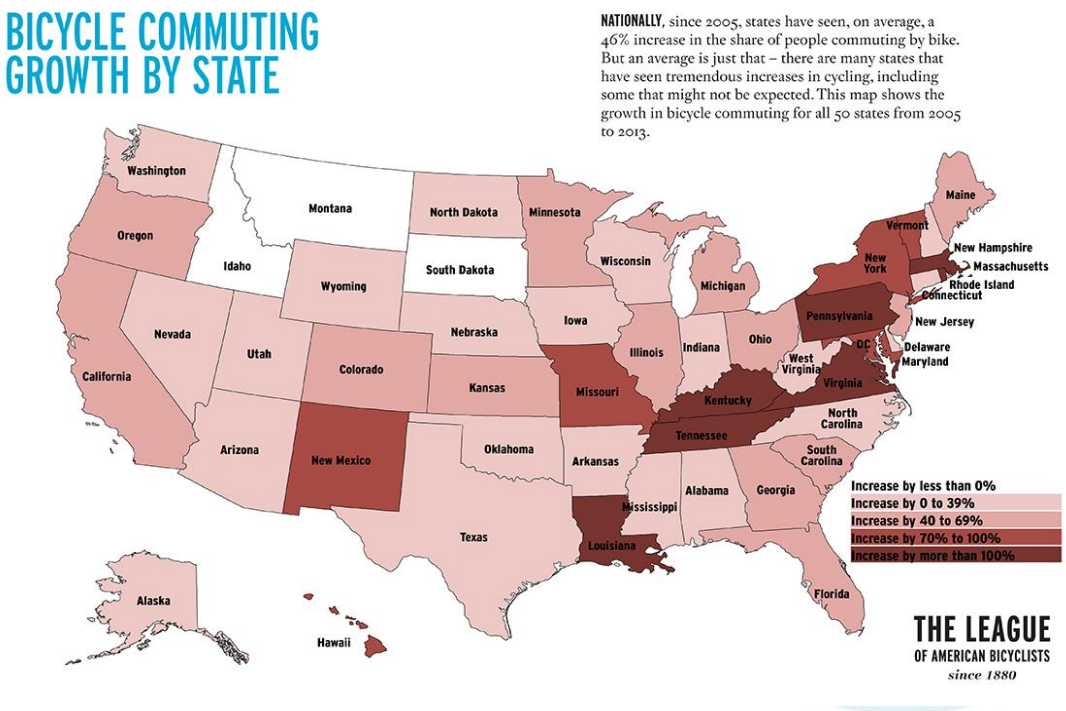
*Note: The sum of the numbers and percentages is greater than total pedalcyclists killed as more than one factor may be present for the same pedalcyclist.

WHERE ARE THE RIDERS?

GROWTH ACROSS THE COUNTRY

Average 46%increase since 2005 (to 2013)

< 0 %
0 – 39%
40 – 60 %
70 – 100 %
Above 100 %



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INCREASED NUMBER OF RIDERS

WHY ARE WE SEEING MORE RIDERS

- Economy
  - Excessive Fuel Prices
- Health
  - Obesity and Aging
- Environment
  - Green Awareness

"What fits your busy schedule better, exercising one hour a day or being dead 24 hours a day?"

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“BUILD IT THEY WILL COME”

REASON FOR INCREASE

“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.”

https://www.sfbike.org/news/city-city-bicycle-count-report-shows-a-dramatic-96-increase-in-ridership/

“BUILD IT THEY WILL COME”

REASON FOR INCREASE

Transportation Alternatives

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/

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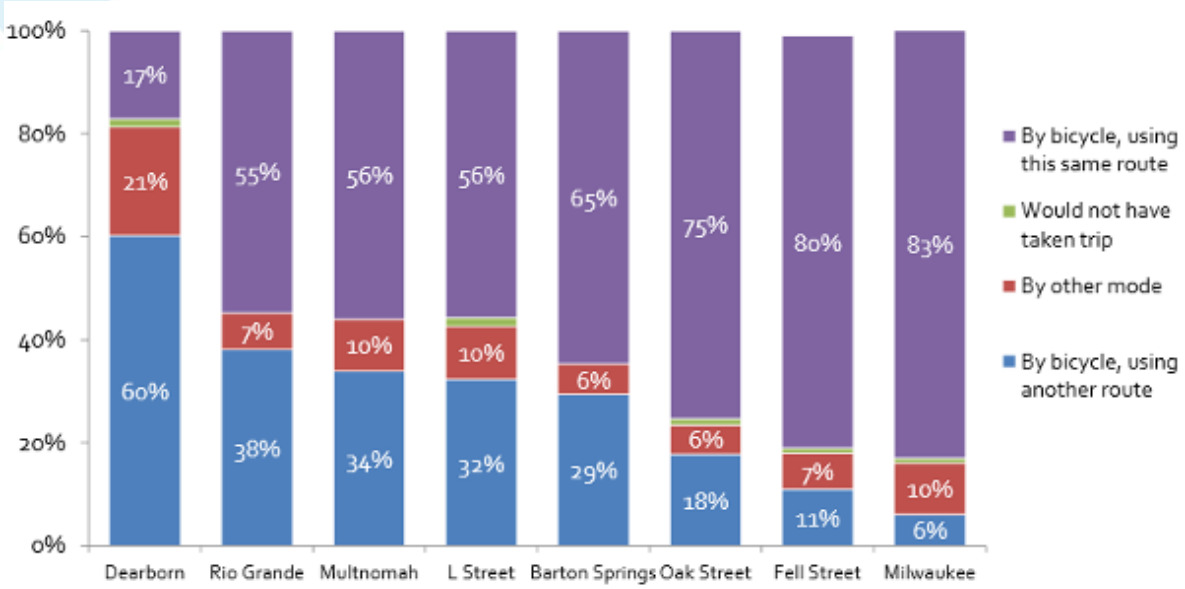
“BUILD IT THEY WILL COME”

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

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SAFEST CITIES

WHERE DO PEOPLE LIKE TO RIDE?

14 out of 25 are cities in the western US

Rank	City	Bikeability Score	Population Rank
15	Boulder, CO	86	~300
19	Los Angeles	54	2
16	Chicago	78	163
20	Houston	49	4
10	Philadelphia	75	145
21	San Diego	48	8
22	Austin	45	13
7	San Francisco	70	14
9	Boston	68	21
13	Seattle	64	22
12	Washington, D.C.	67	25
8	Portland	70	29
14	Tucson	64	33
17	Miami	64	34
18	Oakland	57	46
12	Minneapolis	67	48
23	Pittsburgh	39	61
24	Cincinnati	37	64
11	Madison	67	82
5	Tempe	75	145
6	Eugene	75	150
3	Ft. Collins	78	163
4	Ann Arbor	76	229
1	Boulder, CO	86	300
25	Tyler, TX	38	301

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

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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 Bill1581 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.

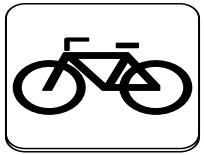
IMPLEMENTATION OPTIONS: Currently, there are three types of technology approved for use for bicycle detection in Caltrans "Bicycle/Motorcycle Detection Installation Notes." (See Attachment 2):

- **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 at a speed of 14.7 ft/sec plus an additional effective start-up time of 6 seconds, according the formula $G_{min} + Y + R_{clear} \geq 6\ sec + (W+6\ ft)/14.7\ ft/sec$*, where*

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

G_{min} *= Length of minimum green interval (sec)*

Y *= Length of yellow interval (sec)*

R_{clear} *= Length of red clearance interval (sec)*

W *= Distance from limit line to far side of last conflicting lane (ft)*

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INDUCTIVE LOOP SYSTEM

TWO PARTS NOT JUST ONE

The First ½ of the system

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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

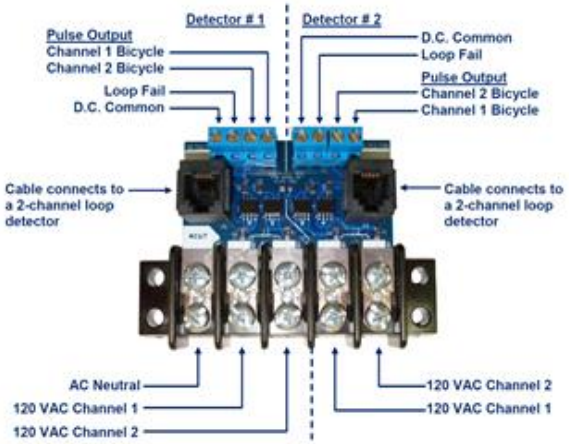
- 2 channel detector with four outputs
- Bike detection comes out on separate channels
- Bike Timing relies on field green inputs into the detector
- Bicycle differentiation ***requires*** a specific loop design.

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

Phase Green Interface Module PGI



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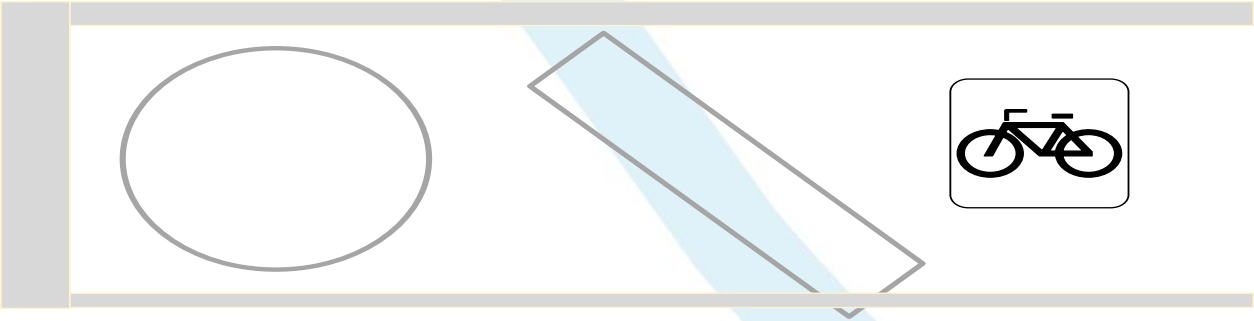
LOOP CONFIGURATION

WHY IS NEW DESIGN NEEDED?

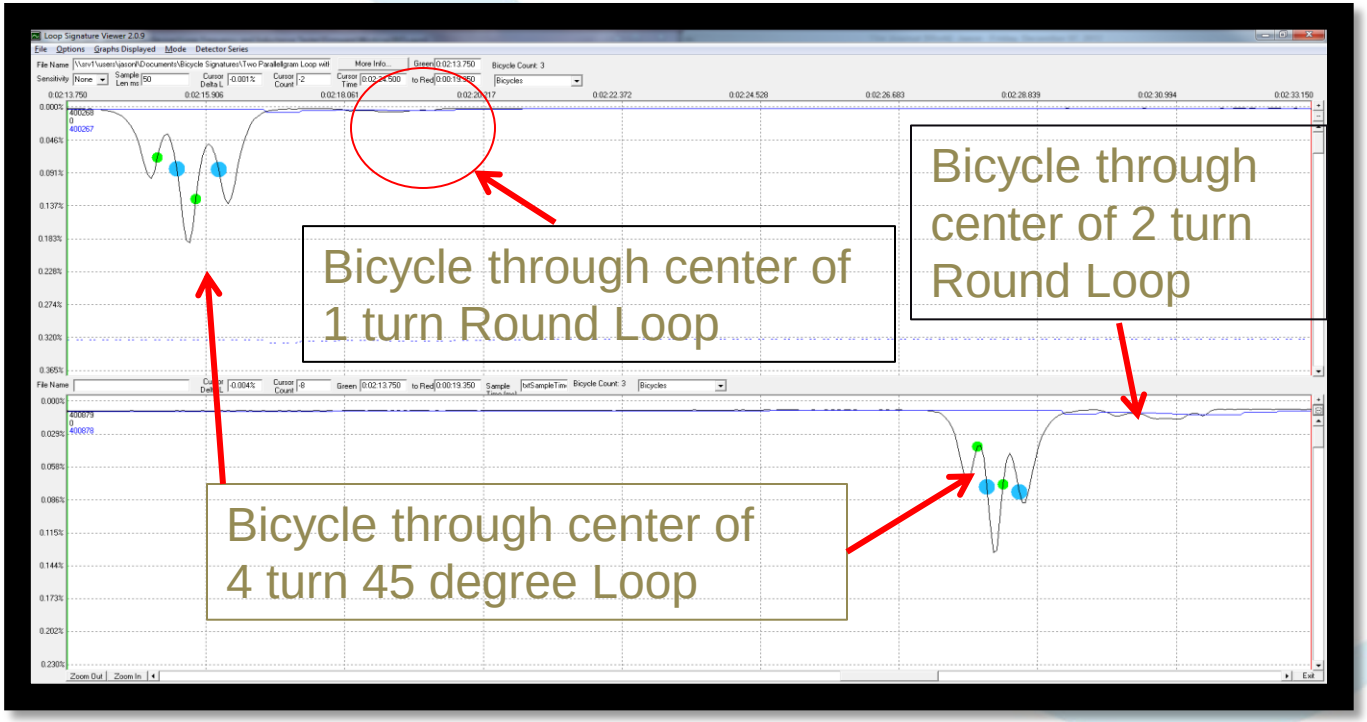
Loop design for bike detection is a rectangle or parallelogram at 45° of direction of travel.



- 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



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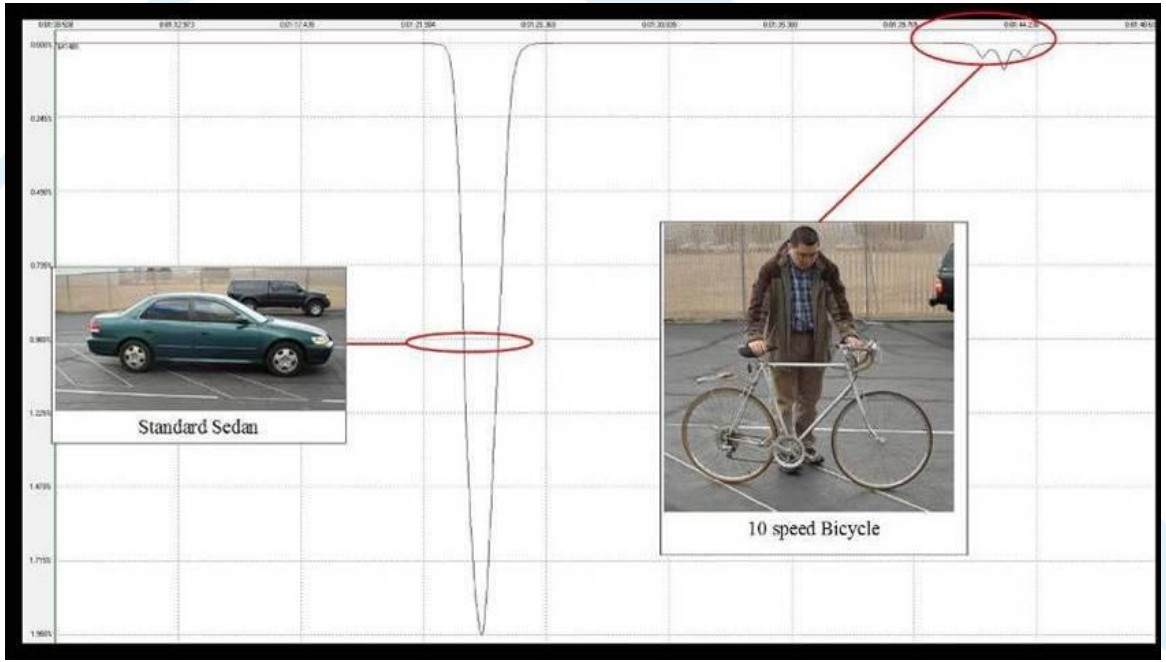
LOOP CONFIGURATION

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

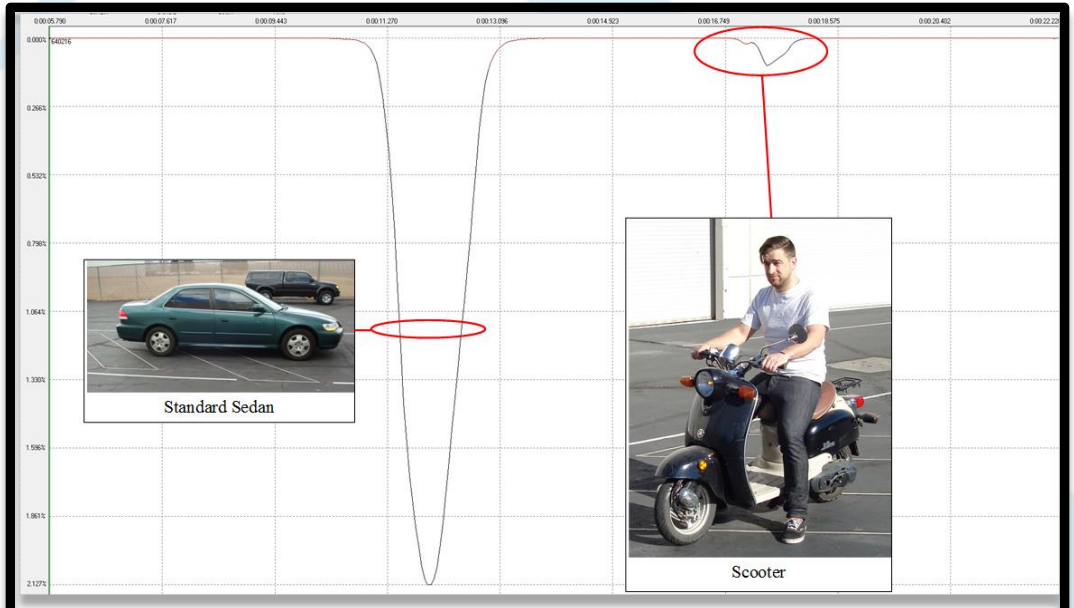


12FT WIDE, 4 TURN, 45 DEGREE LOOP W/ 50FT OF FEEDER CABLE
(TYPICAL THRU LANE INSTALLATION)

- 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

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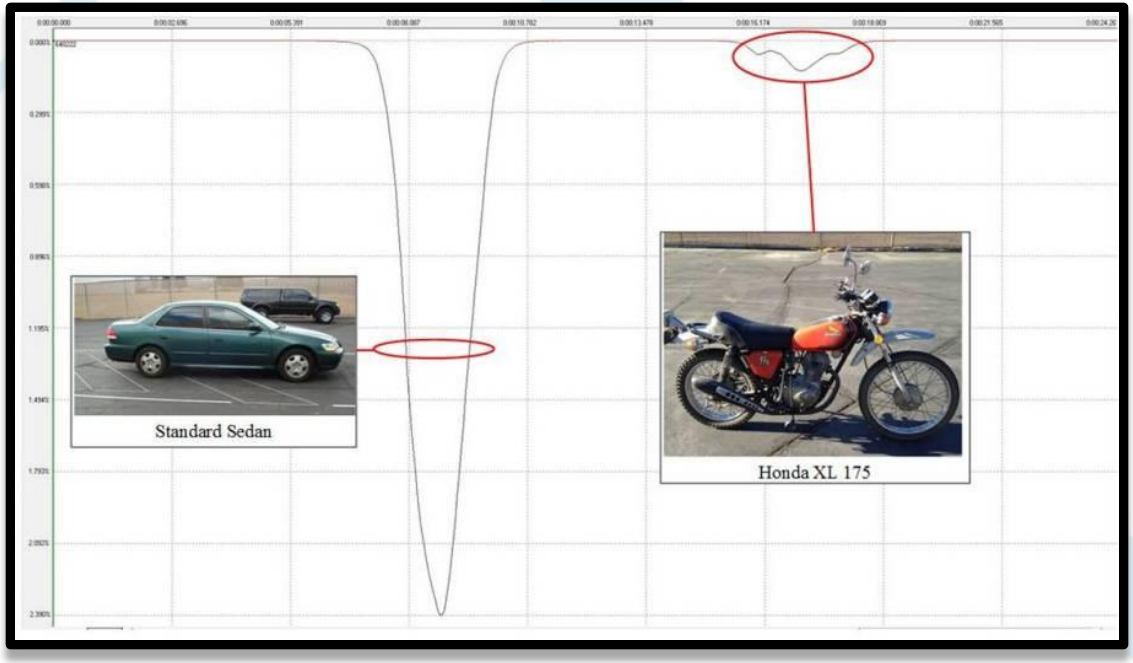
THE DETECTION

DIFFERENTIATION OF ALL KINDS



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

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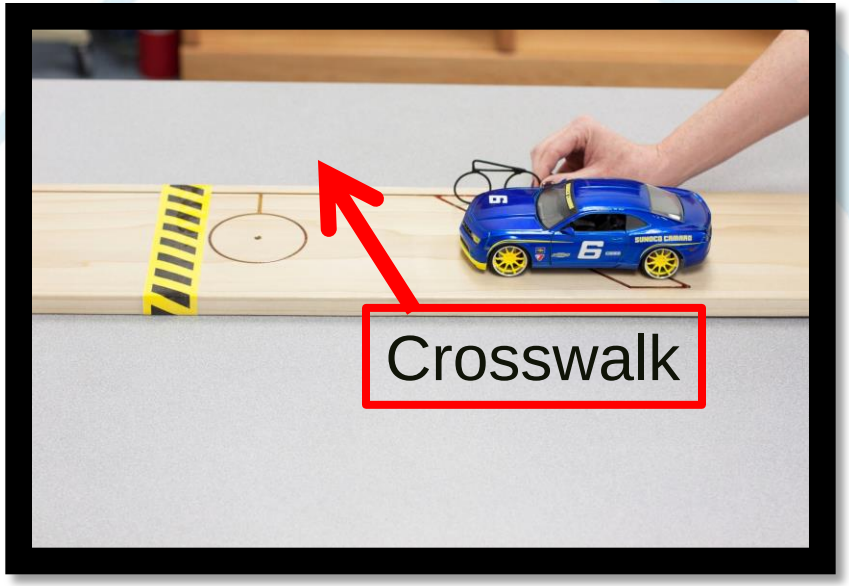
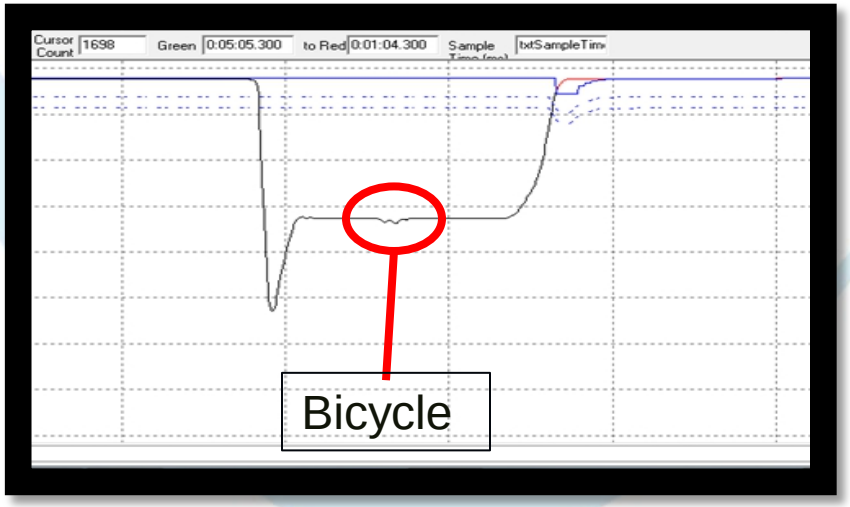
THE DETECTION

DOES IT WORK WITH A CAR ON THE LOOP?

Scale= 1:24
Loops, car, bicycle





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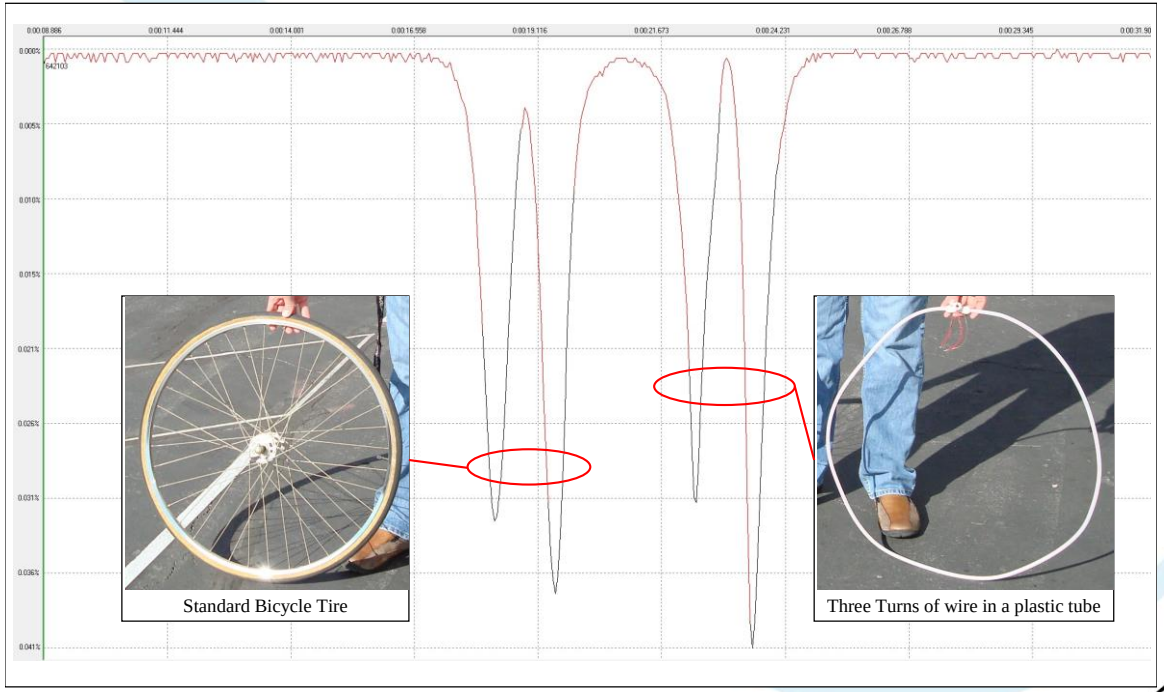
THE DETECTION

WHAT ABOUT COMPOSITE BIKES?

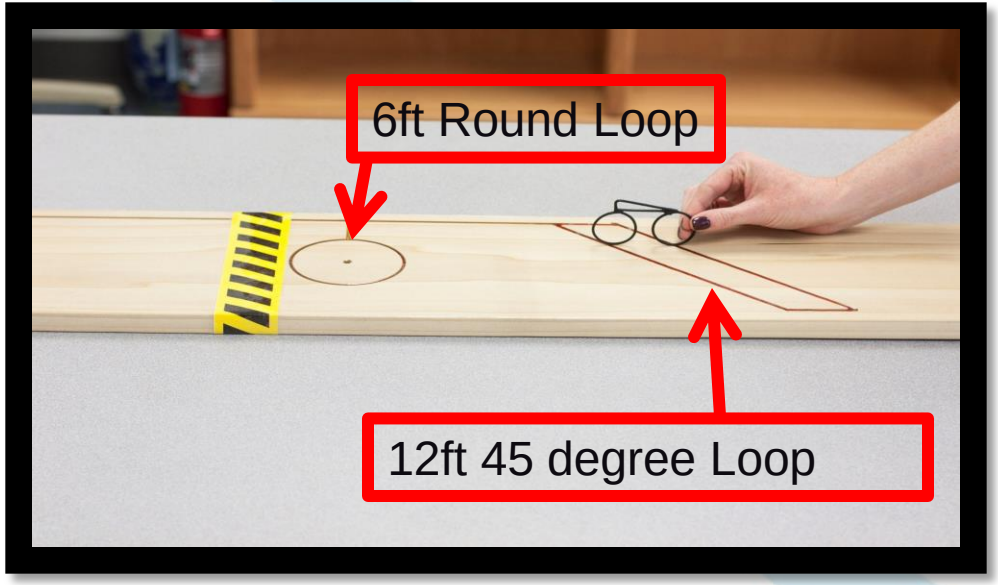
- Less than 1:5000 bikes are expected to be totally carbon fiber.
- We detect rims only
- Fix using a 24 AWG wire around rim.



http://www.livestrong.com/article/482575-how-much-lighter-is-a-carbon-bicycle-frame-than-an-aluminum-one/

THE DETECTION

USE WITH EXISTING LOOPS



Will it pick up the bike in the presence loop too?

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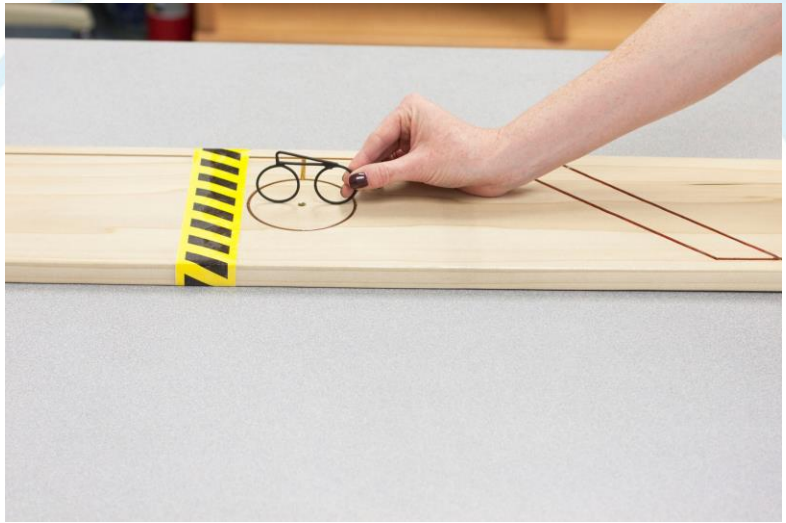
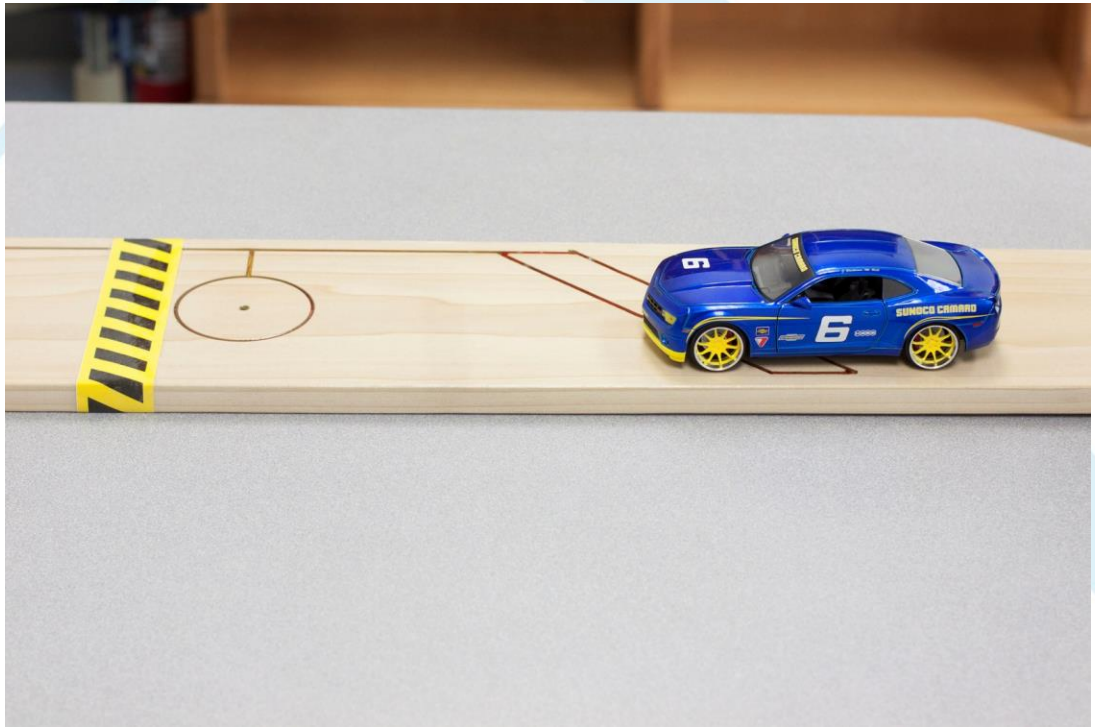
THE DETECTION



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.

THE LOOPS

THE SECOND ½ OF THE SYSTEM

- 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.

THE LOOPS

WHY PREFABRICATED LOOPS

Study done by FHWA suggests that preform or Prefabricated loops out perform contractor wound loops

Table 5-4. Summary of inductive-loop detector failures.				
	Percent installed by			
State	State	Contractor	Major failures	Remarks
Alaska	10	90	No loop failures reported	Preformed loops used exclusively
California	5	95	Improper sealing and foreign material in saw slot	Preformed loops used in poor pavement and dirt detours
Idaho	10	90	Improper sealing	No failure for loops made of #20002 cable
Montana	10	90	Improper sealing	–
Nevada	5	95	Improper sealing and pavement deterioration	–
Oregon	10	90	Improper sealing	–
Utah	70	30	Improper sealing and pavement deterioration	Some preformed loops used with no failures reported
Washington	10	90	Improper sealing and foreign material in saw slot	Need better inspection to improve loop performance

http://www.fhwa.dot.gov/publications/research/operations/its/06139/chapt5b.cfm

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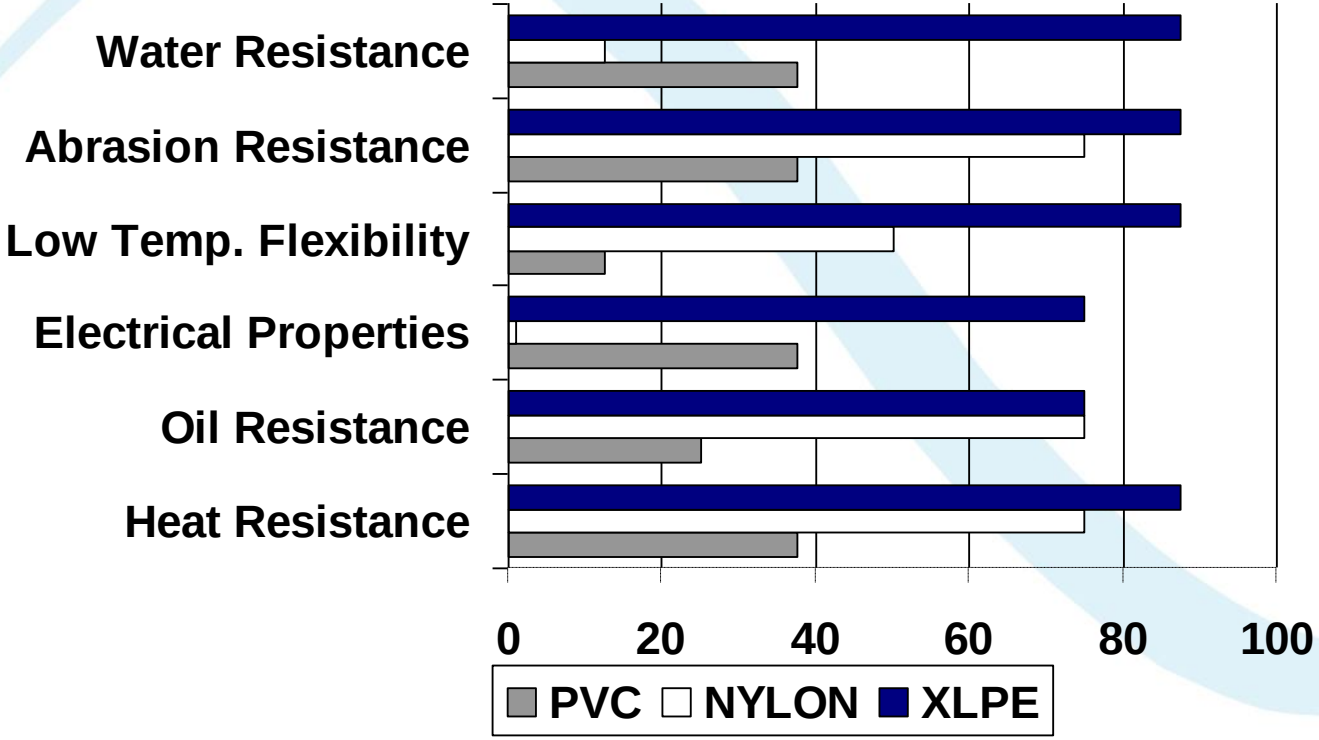
PREFABRICATED LOOPS – MATERIAL

XLPE (CROSS-LINKED POLYETHYLENE)



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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
  - ***<u>No maintenance!</u>***
  - Less need to repair

PREFABRICATED LOOPS

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

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IS IT COMPLICATED?

DOESN'T HAVE TO BE!

- 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?

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