Bellevue's Vision Zero Initiative: From Video Analytics to Corrective Measures

WA State Pedestrian Safety Advisory Council
July 27, 2016

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Bellevue's Vision Zero Initiative: Why?

Hit-and-run driver nearly kills woman on bike in Bellevue

BY KOMO NEWS | WEDNESDAY, MARCH 23RD 2016

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Car strikes, kills toddler in stroller in Bellevue

Originally published September 29, 2015 at 11:03 am | *Updated September 30, 2015 at 10:27 am*

77-year-old pedestrian killed by teen driver in Bellevue

BY TIM HAECK, KIRO Radio Reporter | December 1, 2014 @ 10:17 am

Bellevue's Vision Zero Initiative: Dialogue with the Public

Amy Carlson, Vice President and Area Office Manager, CH2M HILL

Making Vision Zero a reality entails more than just engineering, education, and enforcement.

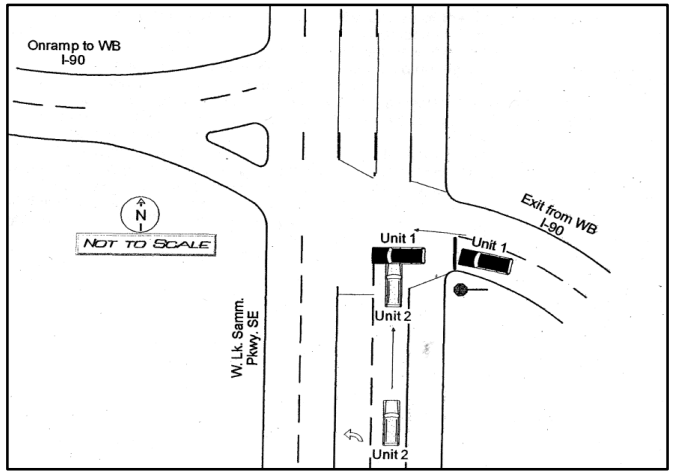
It's a collaborative effort involving Bellevue residents and businesses.

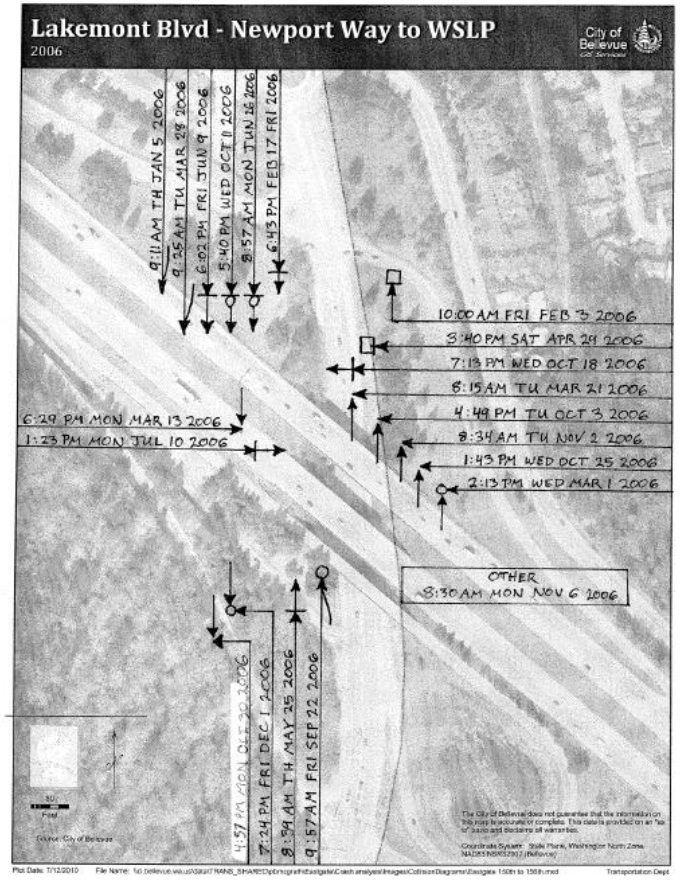
Vision Zero: Reframing Traffic Deaths & Injuries as Preventable

Reactive: Reacting to a problem after it arises.

Proactive: Preventing problems before they arise.

Crash-Based Approach: Lakemont Interchange Case Study





From 2005 through 2010 there were 60 collisions recorded by the Bellevue Police Department and the WSP at this location.

In 2013, WSDOT built a new roundabout at the intersection of the WB I-90 on- and off-ramps and WLSP SE/180 Ave SE.

Crash-Based Approach: Short-Comings

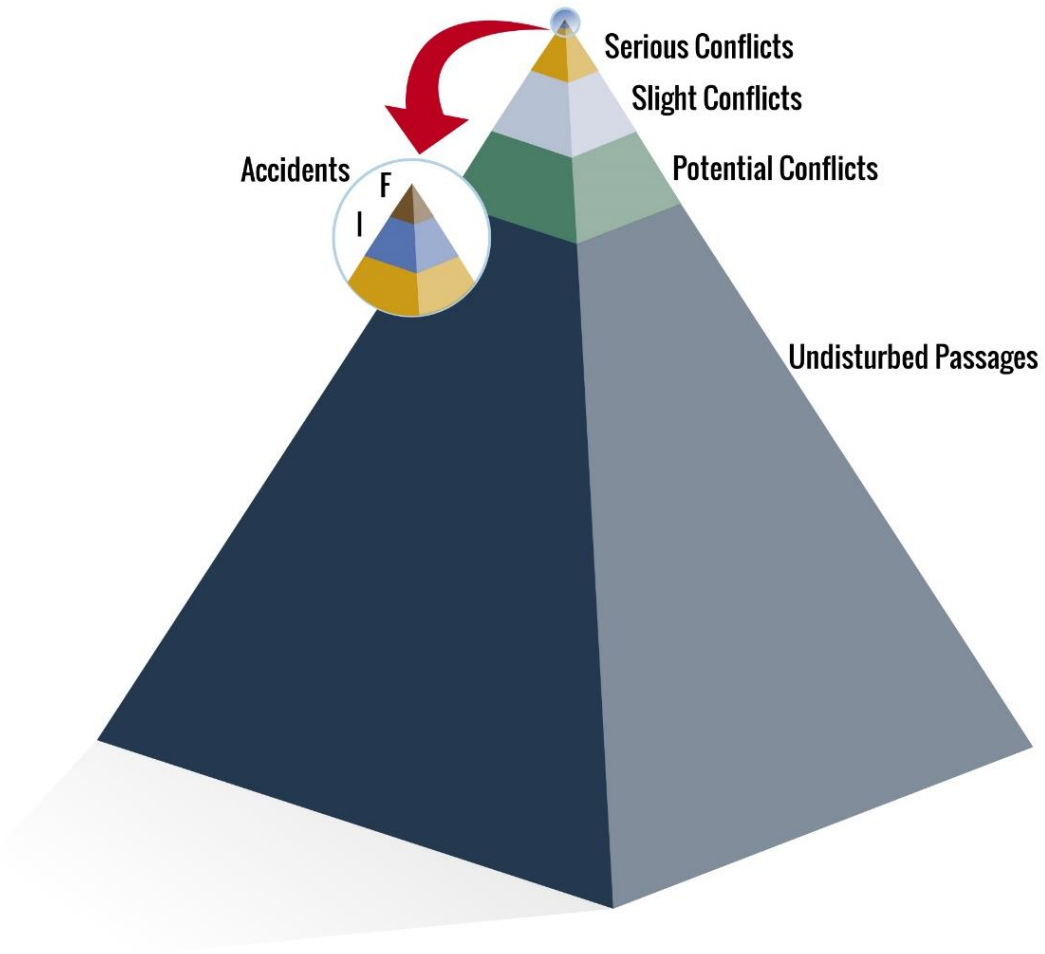
1. **Crashes are rare events and are therefore associated with the random variation inherent in small numbers.**

2. **Not all crashes are reported and the level of reporting is unevenly distributed with regard to the type of road users involved, location, severity of injuries, etc.**

3. **The behavioral or situational aspects of the events are not covered by police crash data.**

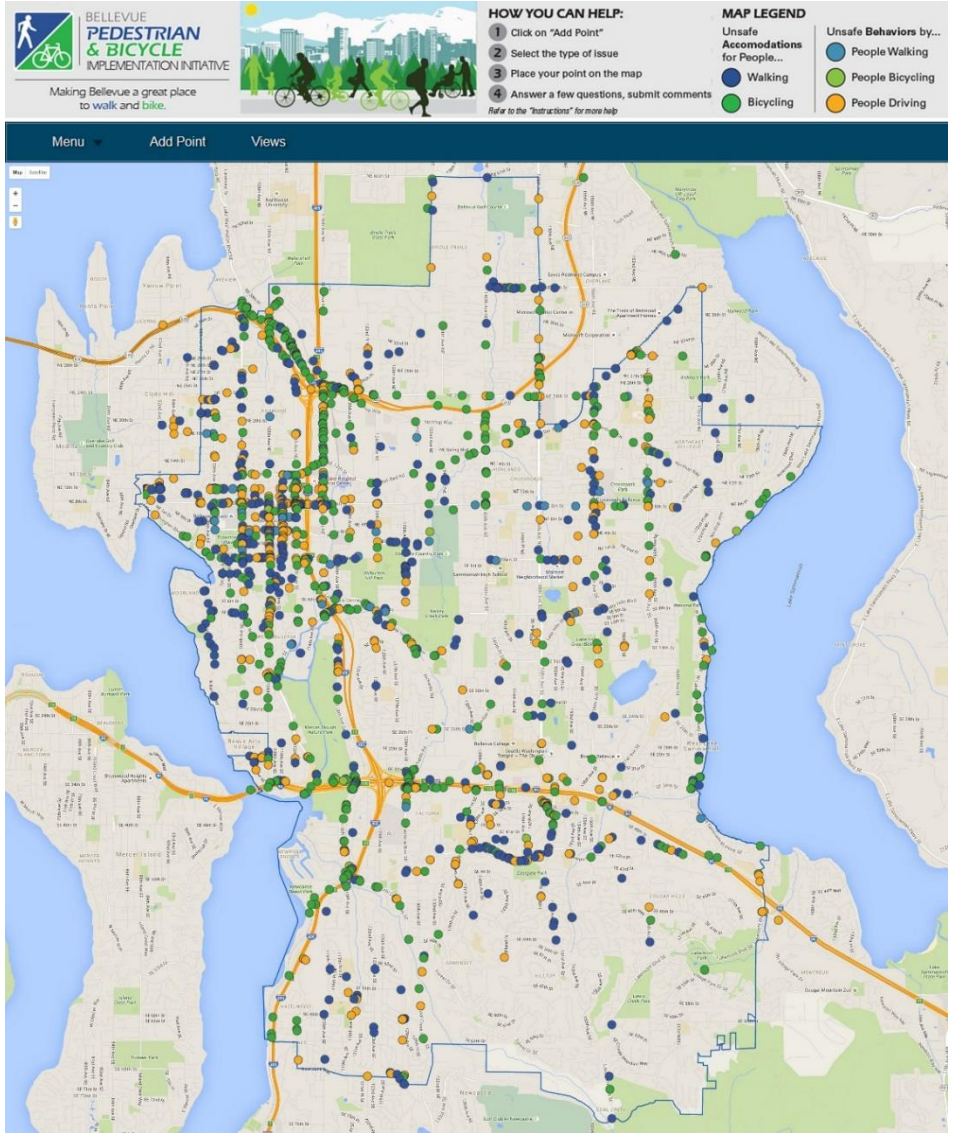
4. **Many years of crash data is typically required to develop an understanding of the situation.**

Conflict-Based Approach: Don’t Wait For Crashes to Happen



Hyden’s Safety Pyramid (adapted from Hyden, 1987)

Conflict-Based Approach: Public Involvement Strategy

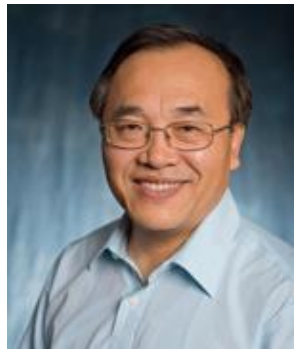


	Total Points Placed	
Ped Facilities	514	32%
Bike Facilities	573	35%
Ped Behaviors	57	4%
Bike Behaviors	22	1%
Car Behaviors	452	28%
Total	1618	

Technology Development Partnership

Microsoft

Dr. Victor Bahl
Director Mobility & Networking Research



Dr. Yinhai Wang
Director PacTrans and STAR Lab

Franz Loewenherz
Senior Transportation Planner

Exploring potential to leverage a city's existing traffic camera system to simultaneously:

- **monitor counts and travel speed of all road user groups (vehicle, pedestrian, and bicycle);**
- **document the directional volume of all road user groups as they move through an intersection; and,**
- **assess unsafe "near-miss" trajectories and interactions between all road user groups.**

Partnership Approach

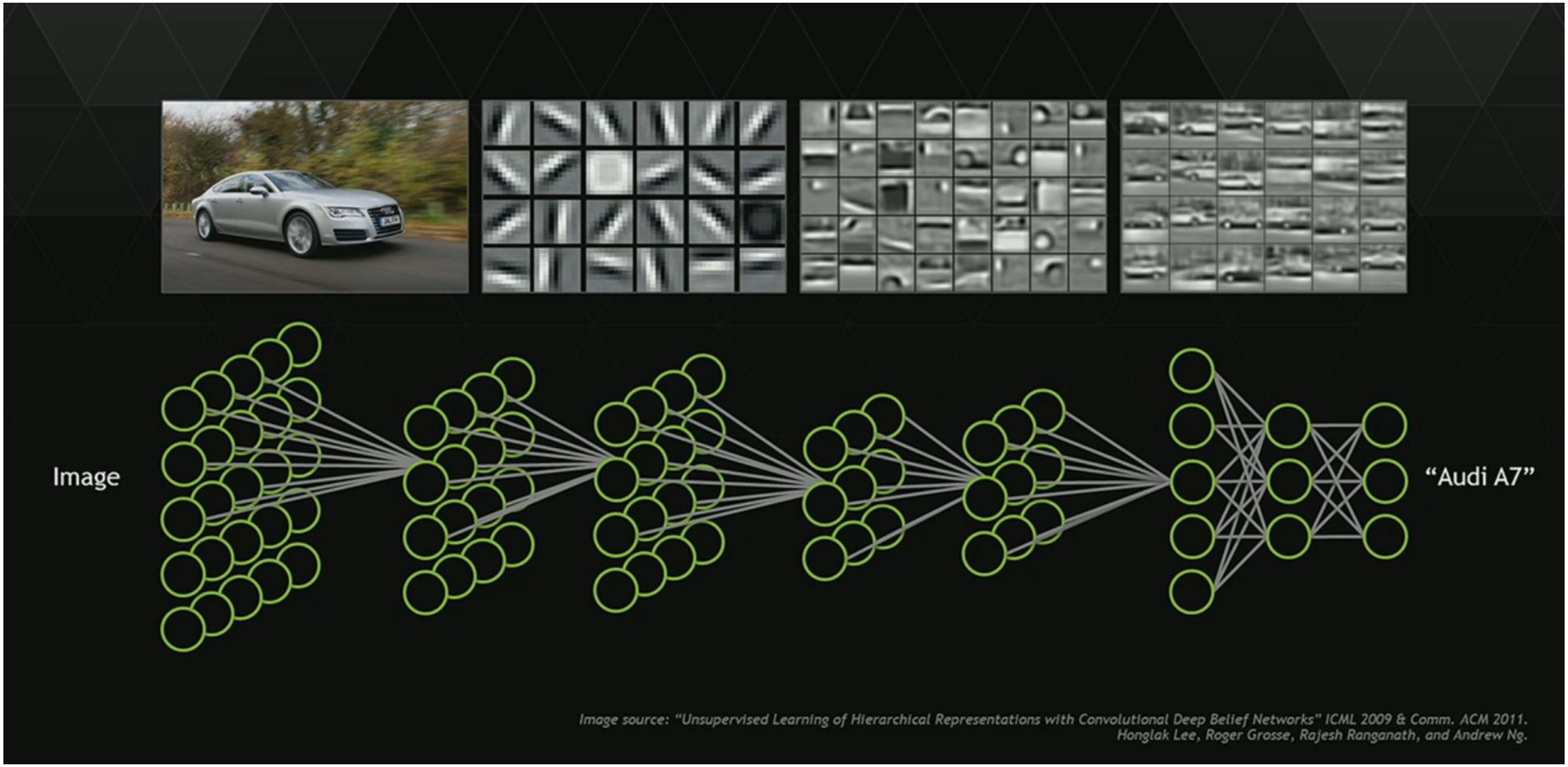
Milestone 1: Demonstrate the capability of vision technologies by detecting relevant events in the sample traffic videos (e.g., detecting cars, pedestrians, and bikes and tracking their movements).

Milestone 2: Demonstrate an end-to-end system that will, continuously in real-time, detect and store the events, and present aggregated information.

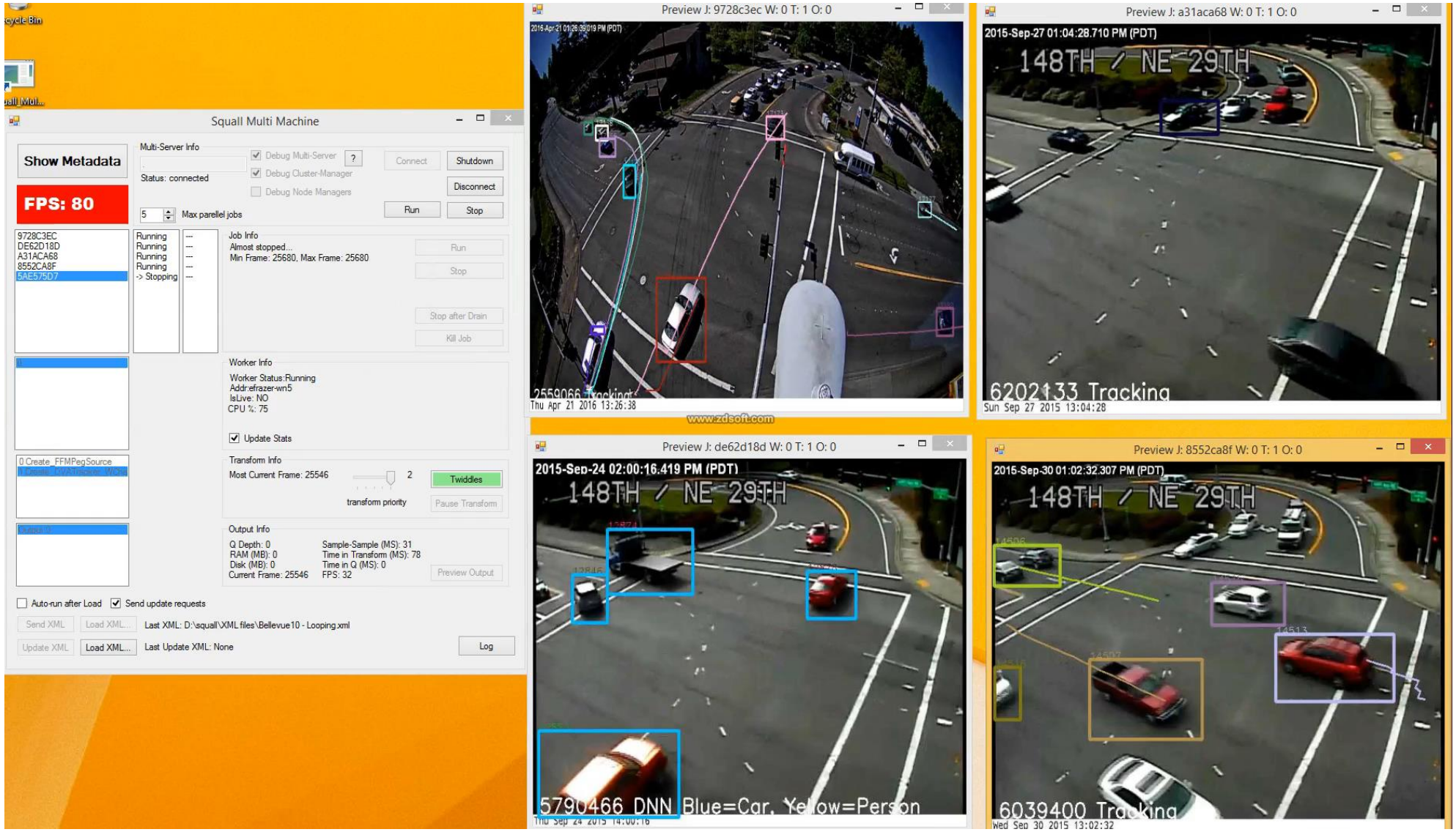
Milestone 3: Pilot deployment of end-to-end system (running on servers provided by Microsoft) in the City of Bellevue traffic control center. The system will run off of a live feed.

Milestone 4: Support additional scenarios (e.g., near-collisions of cars with pedestrians and bikes or patterns of bikers crossing a busy intersection).

How A Deep Neural Network Sees



Demo of System



Object Classification Accuracy

We recognized it as…

When it really is…

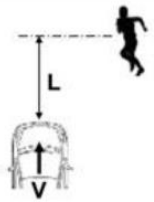
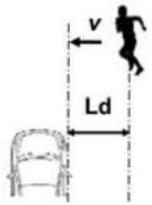
Classified-as → / Truth ↓	*Vehicles*	*Bikes*	*Peds*	*None*
Vehicles	**0.95**	0.01	0.02	0.02
Bikes	0.08	**0.66**	0.16	0.08
Peds	0.15	0.15	**0.65**	0.05
None	0.09	0.03	0.11	**0.75**

0.67

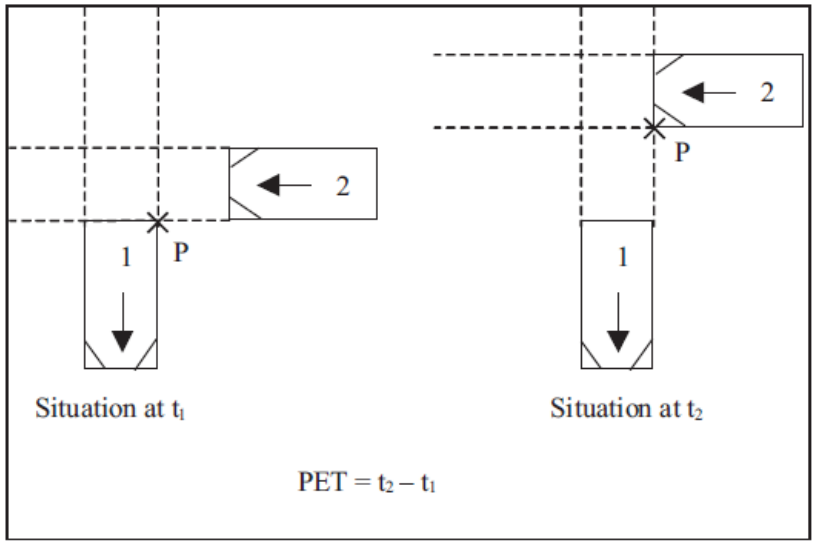
0.73

0.81

Literature Review: Classifying Near-Miss Events

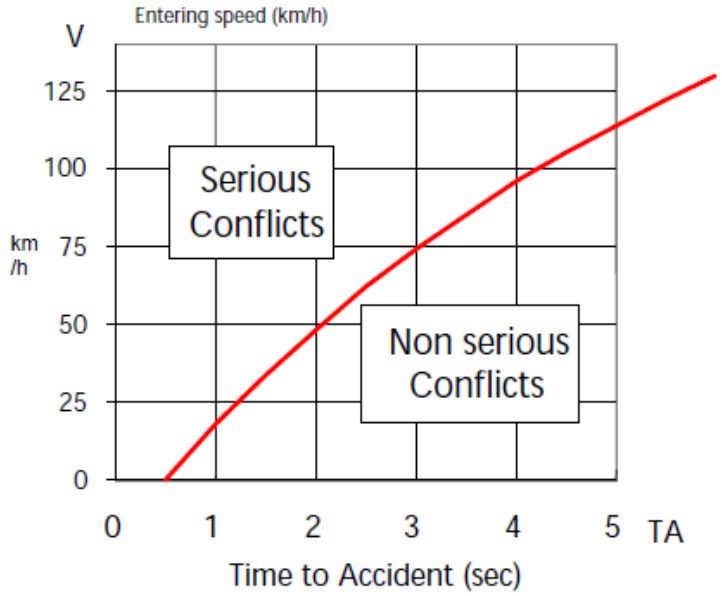
Focused object	Vehicle	Pedestrian
Time	Vehicle time to collision (Vehicle TTC)	Pedestrian time to vehicle (Pedestrian TTV)
Definition	 Vehicle TTC = $\frac{L}{V}$	 Pedestrian TTV = $\frac{Ld}{v}$
Study	Previous study (Matsui et al. 2011b)	Present study

Time to Collision (Matsui et al., 2013)



Post Encroachment Time (Van der Horst et. al., 2014)

The border between Serious and Non-serious Conflict



Definition of a Serious Conflict

TA = Time to Accident

The time that is remaining from when the evasive action is taken until the collision would have occurred *if* the road users had continued with unchanged speeds and directions.

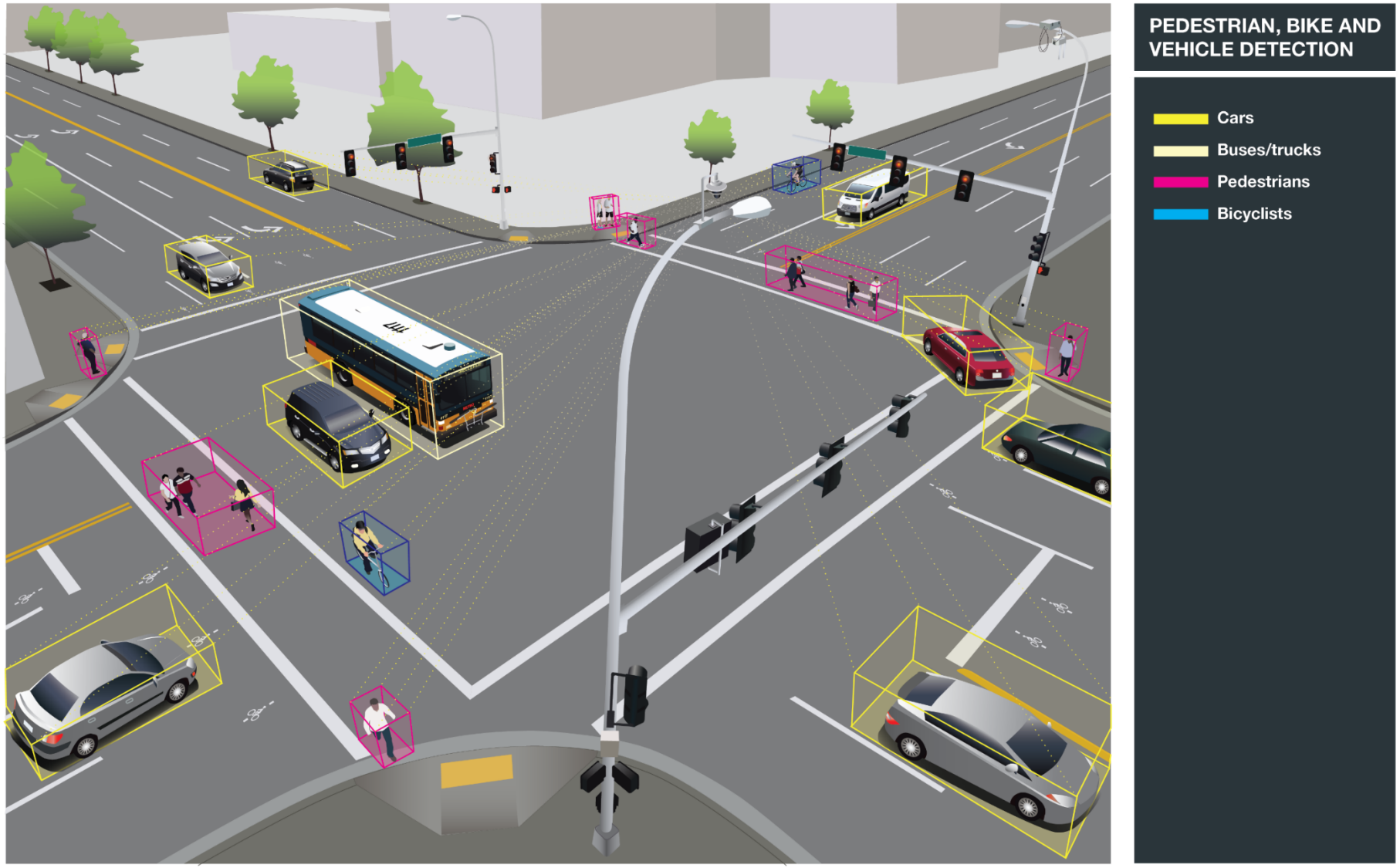
The TA value can be calculated based on the estimates of distances **d** and speed **v**.

d = Distance to the potential point of collision

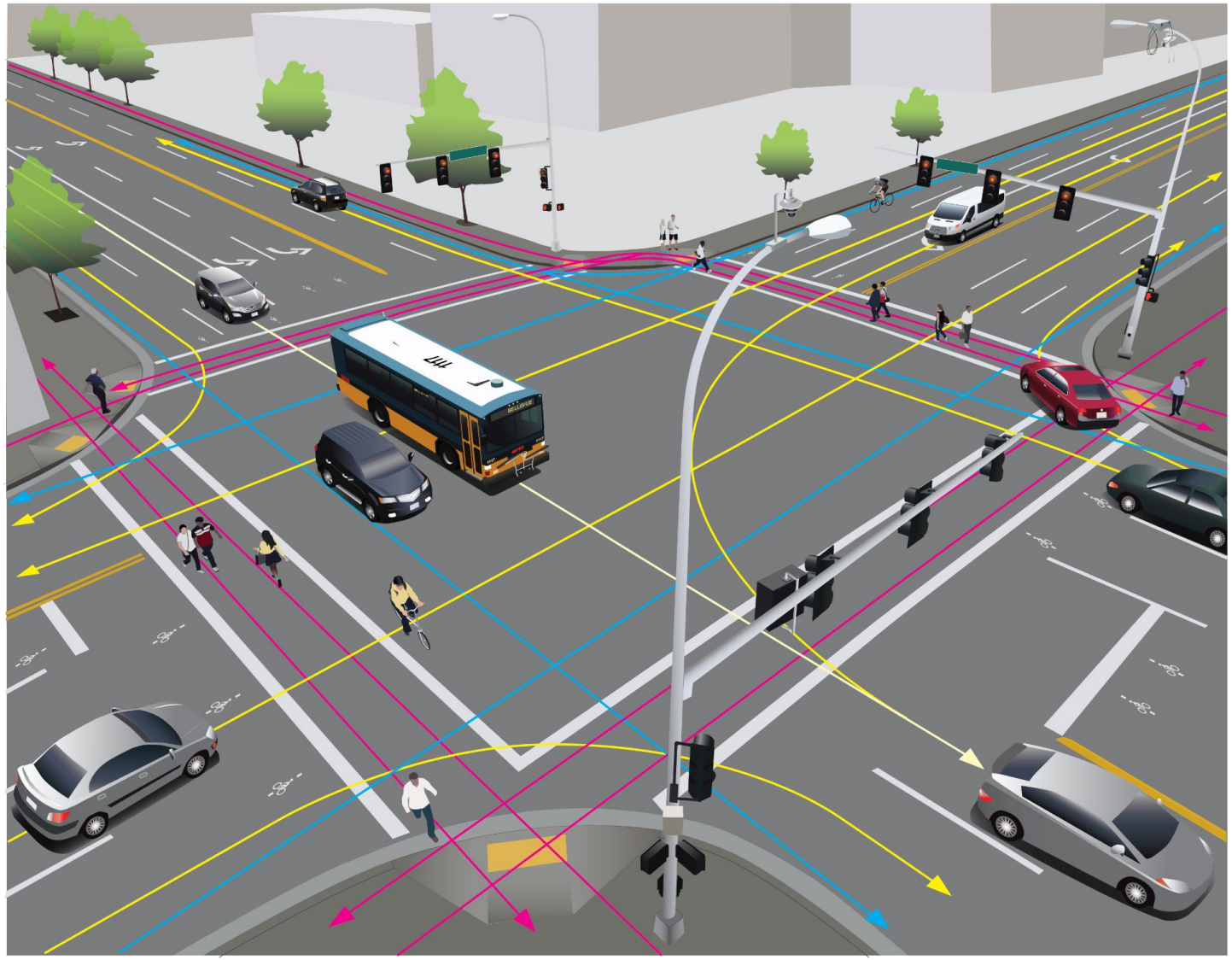
v = Speed when the evasive action is taken

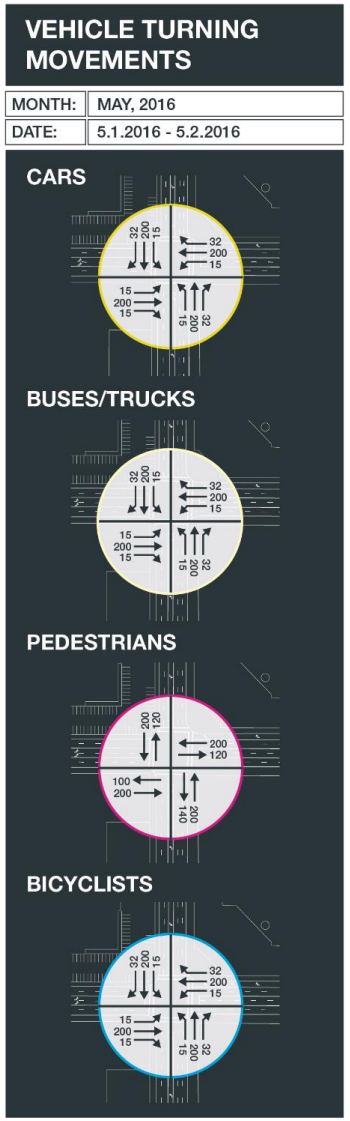
Swedish Conflict Technique (Hyden et. al., 1987)

Object Detection

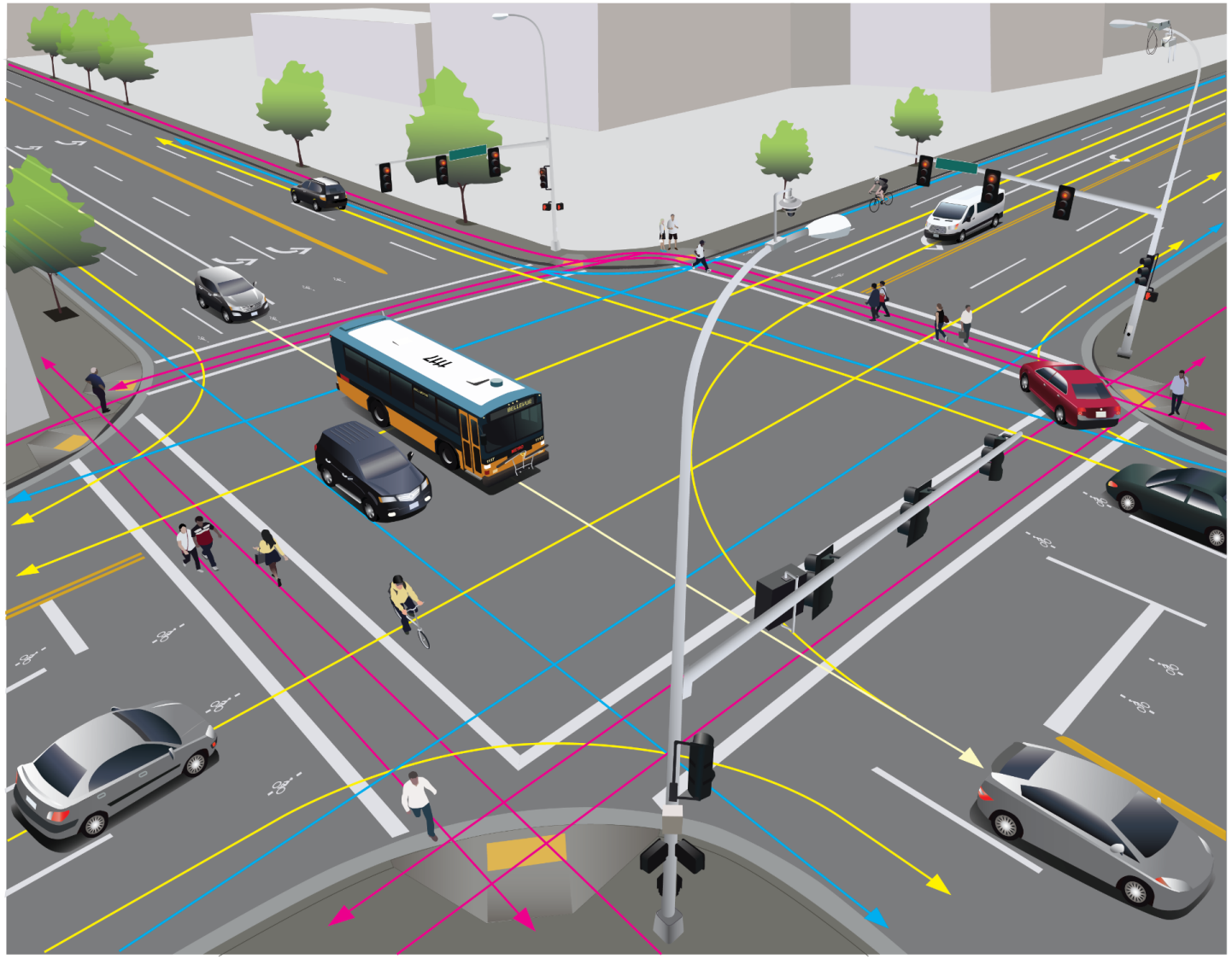


Trajectory Detection & Turning Movement Counts





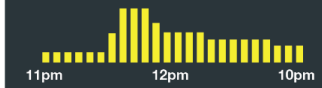
Vehicle Distribution Charts



VEHICLE DISTRIBUTION CHARTS BY TIME OF DAY

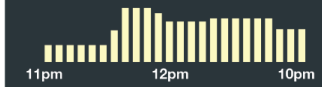
MONTH:	MAY, 2016
DATE:	5.1.2016 - 5.1.2016

CARS



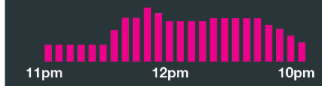
30,000 cars/day

BUSES/TRUCKS



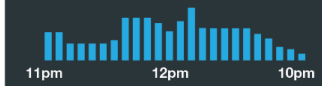
400 buses & trucks/day

PEDESTRIANS



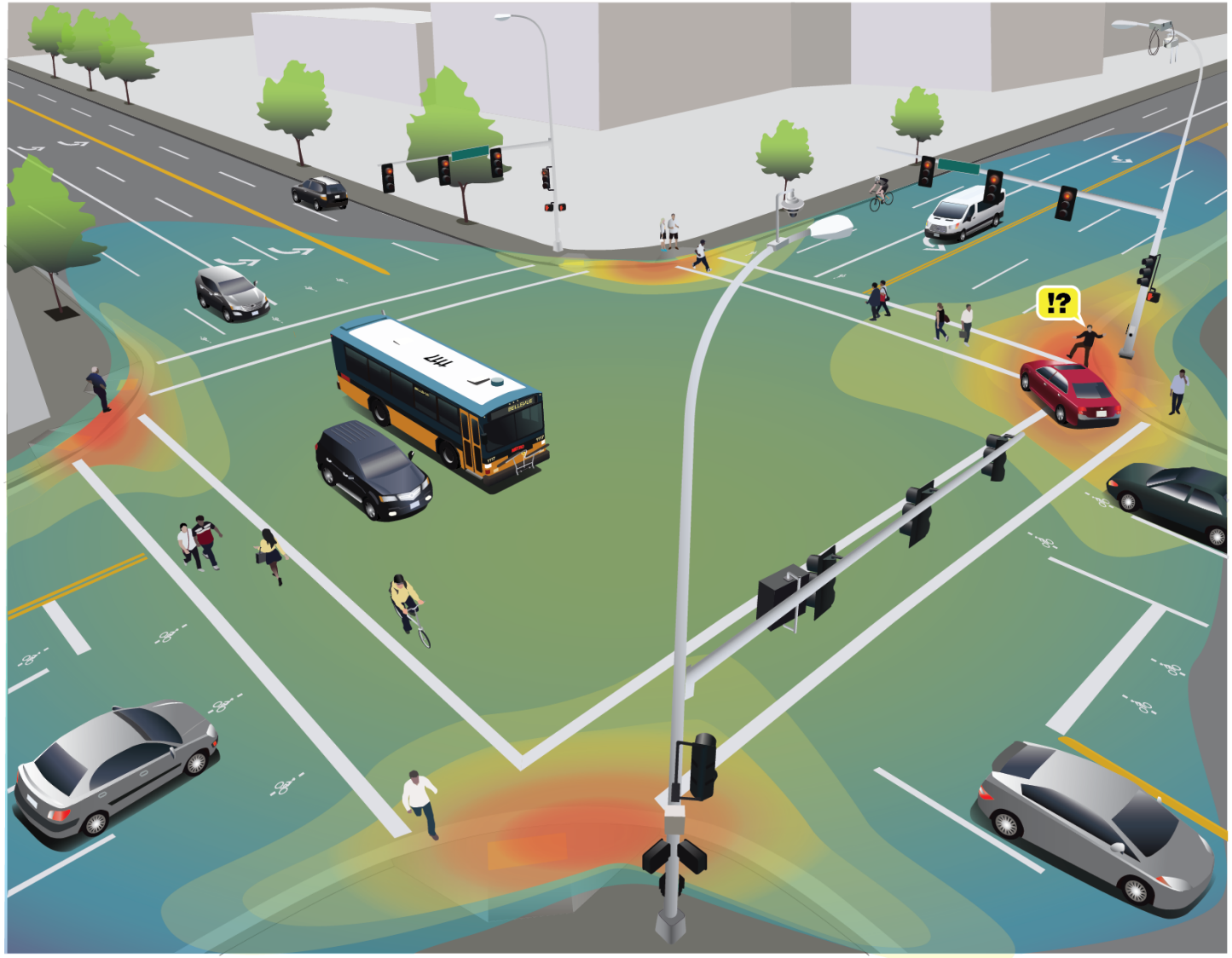
1,000 pedestrians/day

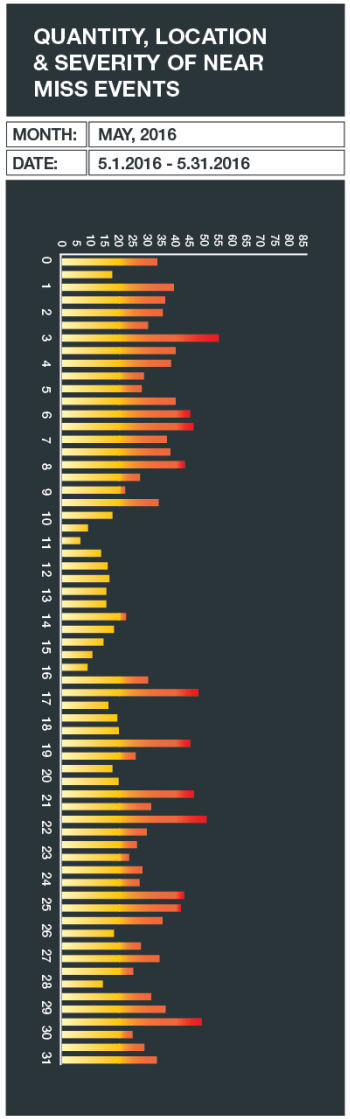
BICYCLISTS



100 bikes/day

Near-Miss Detection

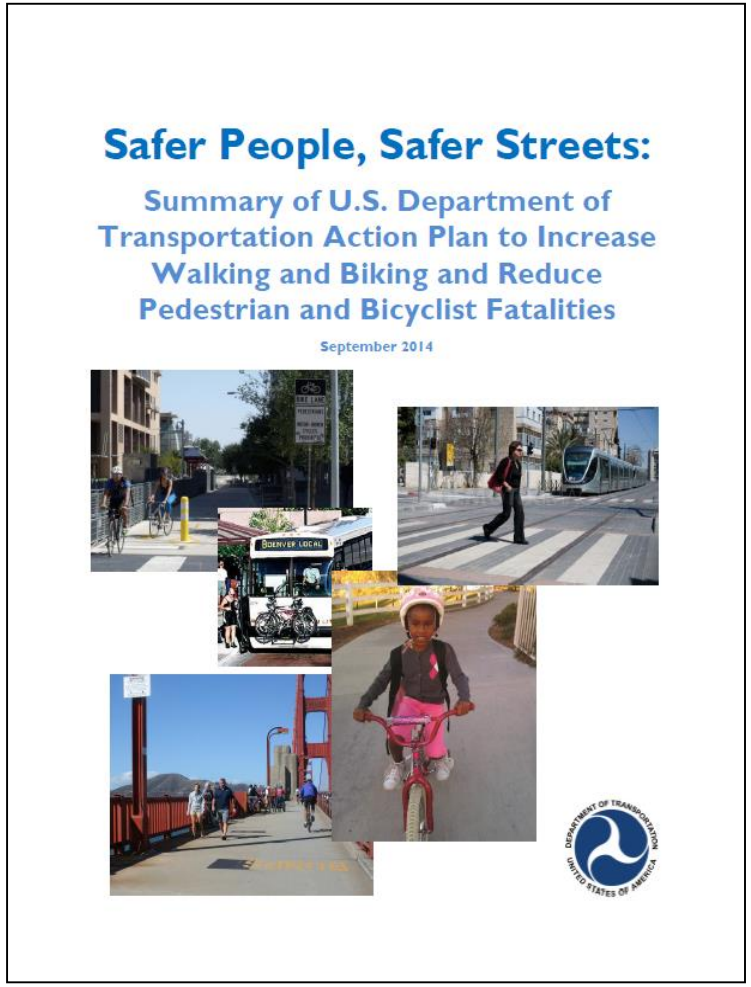




Potential Research Questions

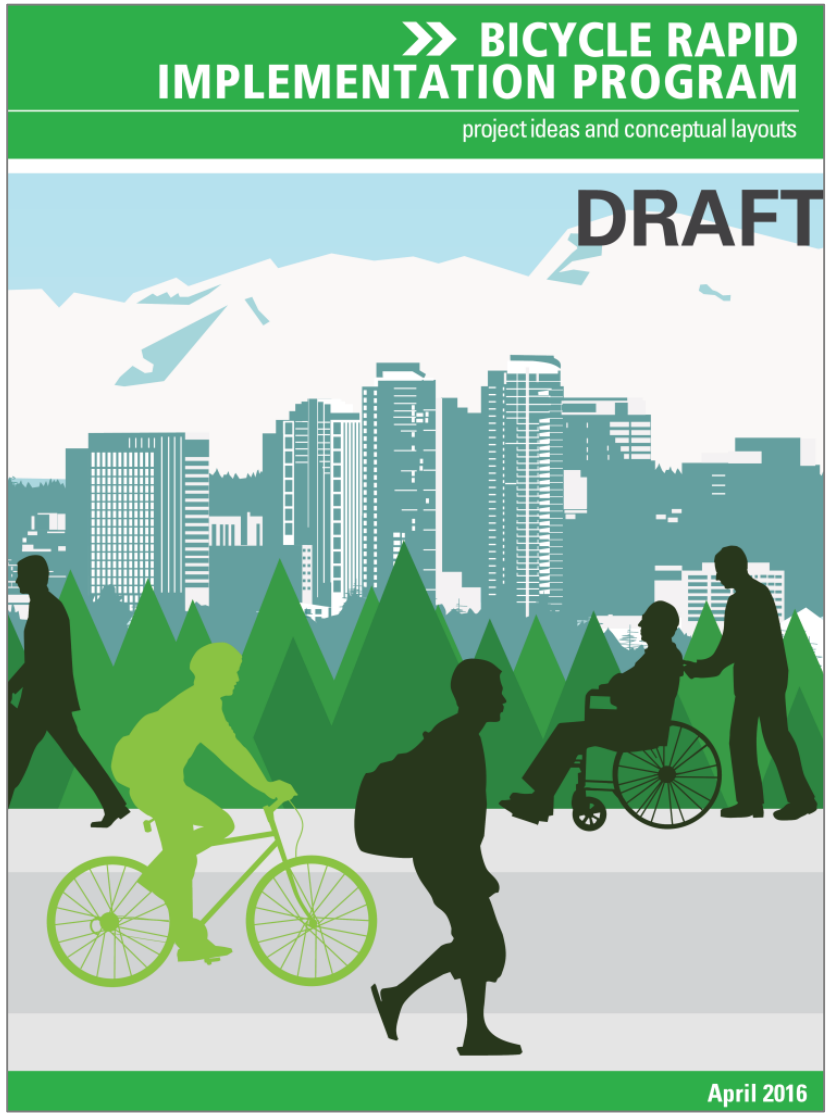
1. How often are vehicles speeding and failing to yield to pedestrians?
2. How often do pedestrians disregard traffic signals?
3. How often do bicyclists fail to stop at stop signs or run red lights?
4. Are there any identifiable trends that hint at the reasons why certain laws are broken in certain places?
5. Did a countermeasure have the desired effect?

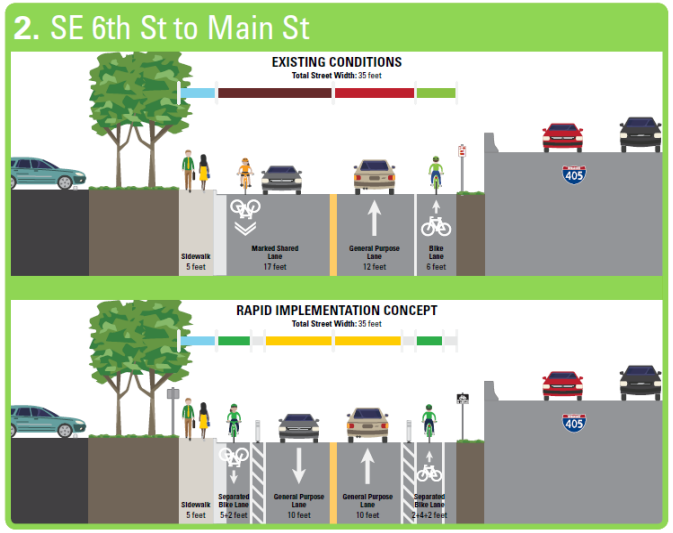
Opportunity for USDOT Partnership?

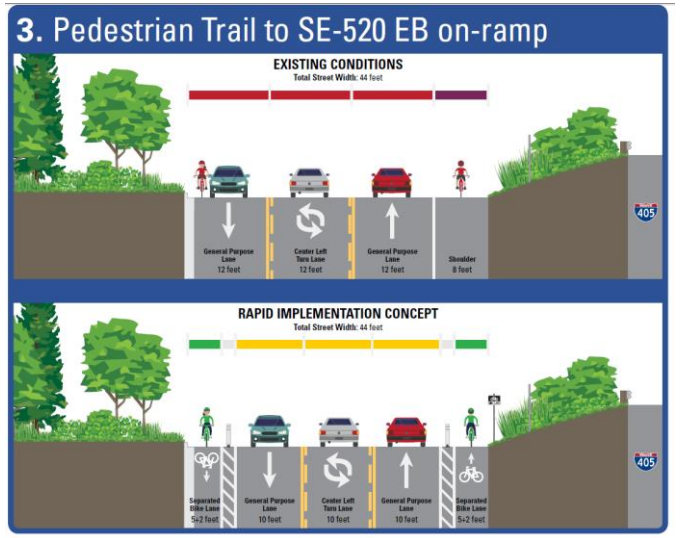


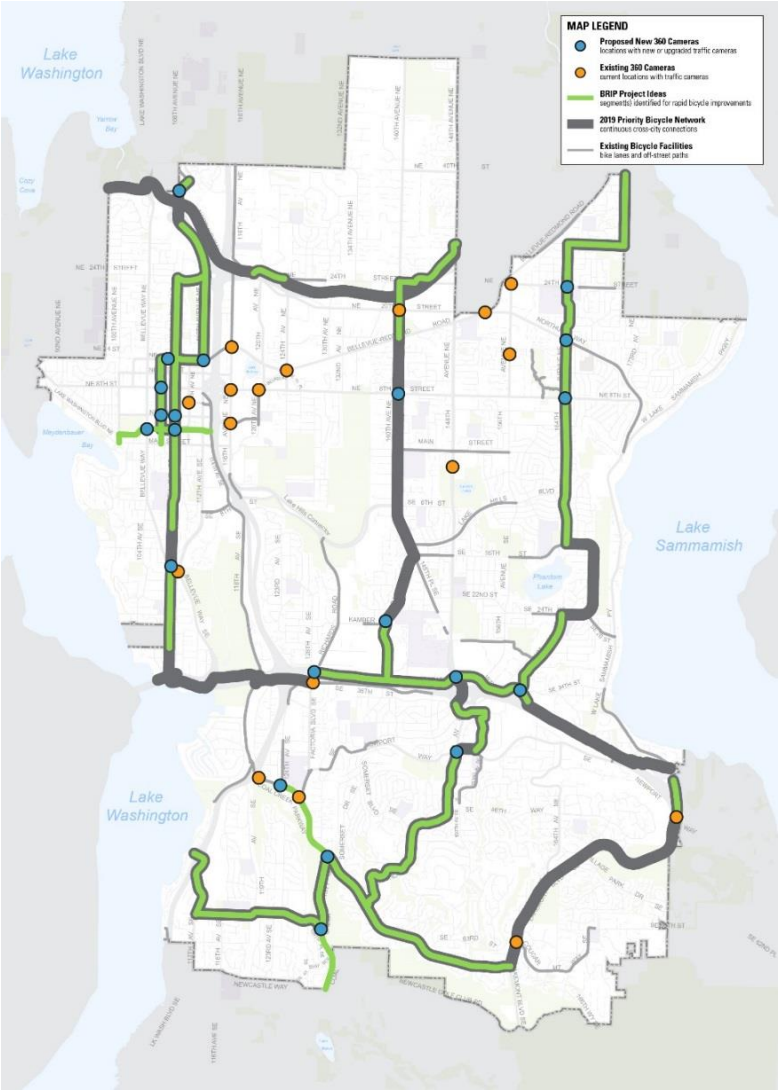
1. Take a Complete Streets approach
2. Identify and address barriers to make streets safe and convenient for all road users, including people of all ages and abilities and those using assistive mobility devices
3. Gather and track biking and walking data
4. Use designs that are appropriate to the context of the street and its uses
5. Take advantage of opportunities to create and complete pedestrian and bicycle networks through maintenance
6. Improve walking and biking safety laws and regulations
7. Educate and enforce proper road use behavior by all

Safer People, Safer Streets: City of Bellevue

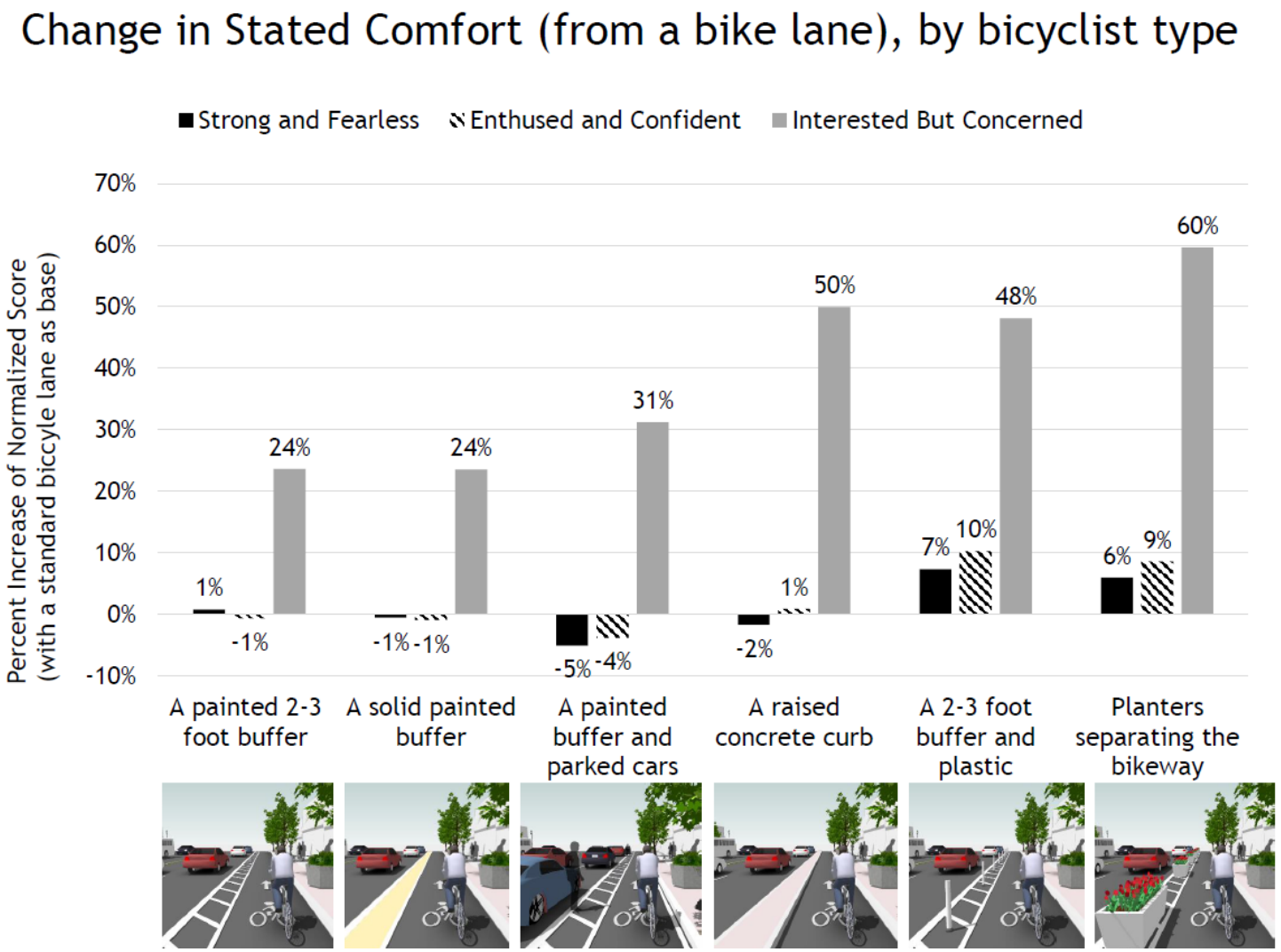








Does Bicycle Usage Increase?



Source: Portland State University, Lessons from the Green Lanes: Evaluating Protected Bike Lanes, 2014.

Does the Conflict Rate Decrease?

$$R = \frac{A \text{ X } 1{,}000{,}000}{V * 365}$$

Where:

A = Average number of conflicts at the study location per year

V = Intersection ADT (total daily approach volume)

Funding Requirement

Virtual Server
Storage
Avigilon License Groups ~ $260K
360 HD Cameras
Camera Installation

For More Information

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