

Video Analytics towards Vision Zero



ITS Washington Annual Conference

December 7, 2016

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Senior Transportation Planner
City of Bellevue, WA*

Safer People, Safer Streets



USDOT Headquarters: September 16, 2016

U.S. Department of Transportation
MAYORS' CHALLENGE

Winner!
Bellevue, Washington

Bellevue, WA, pursued a range of data collection activities during the Mayors' Challenge to identify barriers to bicycling and walking, prioritize improvements, and guide investments. In February 2015, the Bellevue City Council introduced the Pedestrian and Bicycle Implementation Initiative (PBII) to improve safety for people of all ages and abilities who walk and bike in Bellevue. Using data collected from online sources, key-pad polling at public meetings, automated bicycle and pedestrian counters, and traffic camera videos, the PBII team identified barriers to walking and bicycling and developed a \$6.8M Bicycle Rapid Implementation Program (BRIP) budget proposal to guide citywide investments through 2019. The BRIP aims to expand the city's bicycle network from 42 miles to more than 70 miles of conventional bike lanes, separated lanes or off-street paths, and to complete four continuous, cross-city bicycle corridors.

Demonstrated Successes

Innovative Data Collection Techniques Gather Real-Time and Long-Term Data with Public Input

Throughout the PBII process, Bellevue has

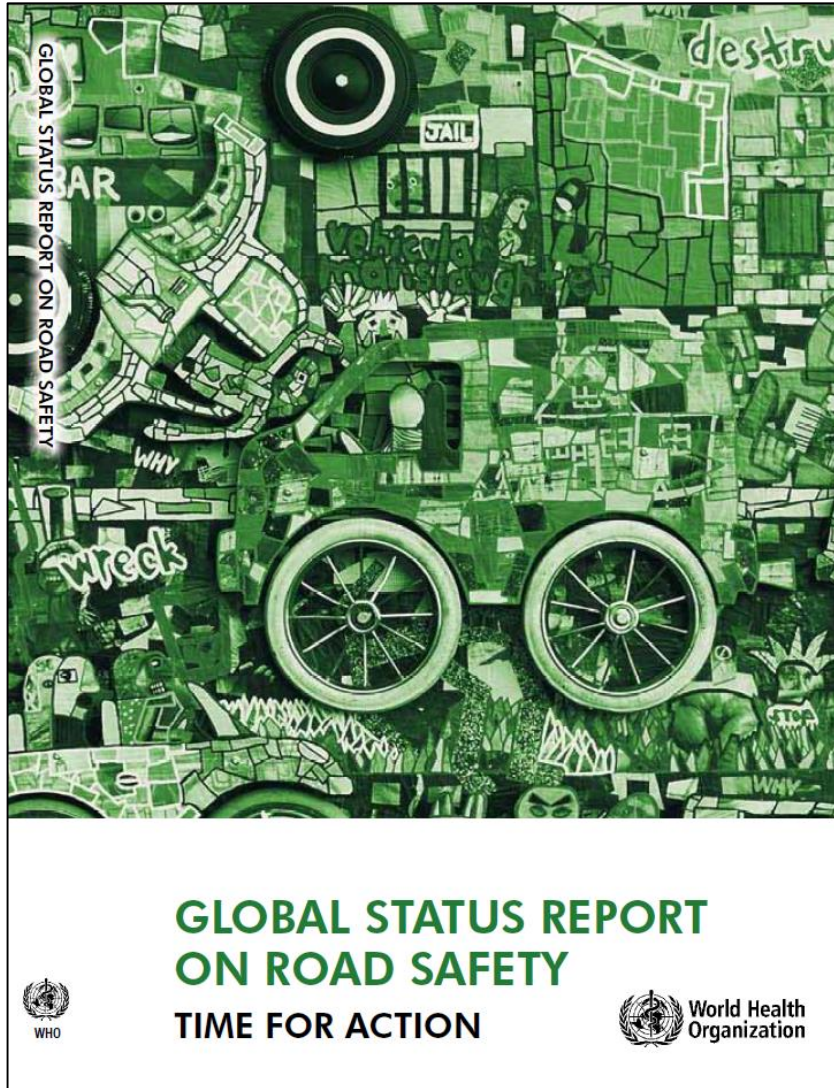
emphasized understanding long-term trends and gathering feedback from people who walk and bike. Bellevue's PBII team:

- Conducted a longitudinal assessment from 2006–2015 of non-motorized collisions using the USDOT's Pedestrian and Bicycle Crash Analysis Tool (PBCAT) system;
- Gathered input using key-pad polling and comment cards at 20 public meetings and an open house that attracted 140 attendees; and
- Used online surveys to solicit public input at two stages in the BRIP development process;
 - Over 700 people placed more than 1,600 points in the first online map to identify locations that they felt were unsafe for walking and bicycling;
 - Over 120 people submitted more than 400 comments on conceptual designs for 52 proposed projects to make the pedestrian and bicycle systems safer.

Pedestrian and Bicycle project manager Franz Loewenherz (foreground) and Councilmember Lynne Robinson (center) lead a policy ride with local bicycle advocates in Downtown Bellevue.

MAYORS' CHALLENGE: CHALLENGE ACTIVITY 3 (GATHER DATA)
1

Worldwide: Traffic Fatalities

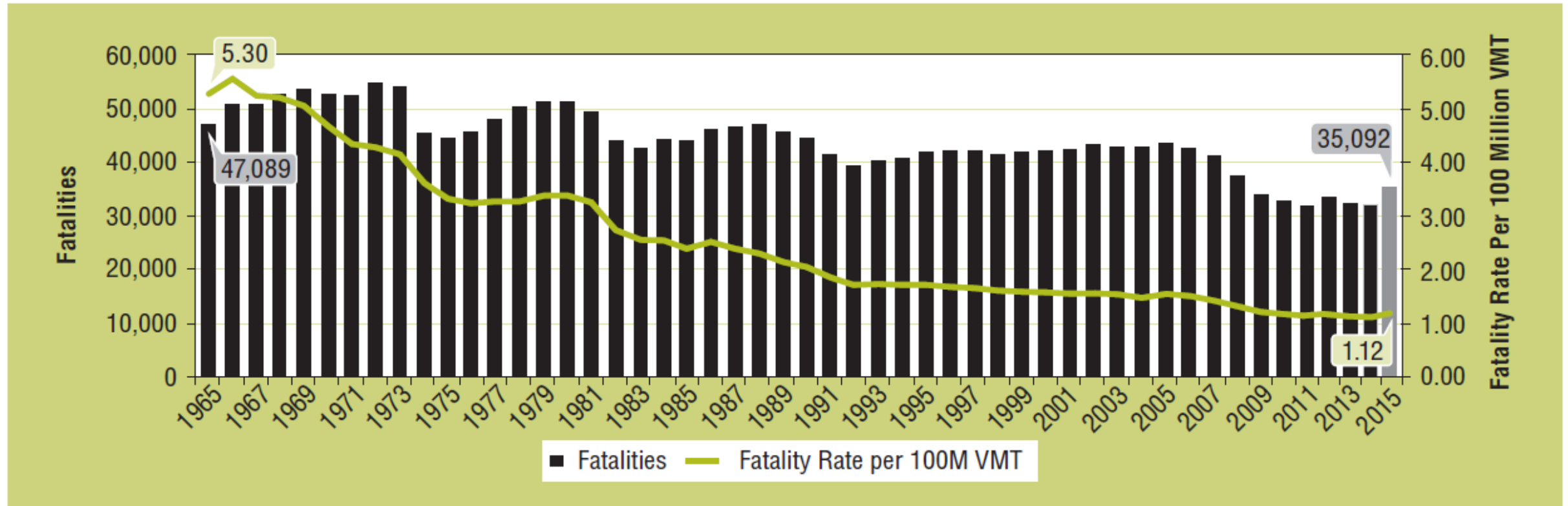


Leading Causes of Death (2004)

RANK	LEADING CAUSE	%
1	Ischaemic heart disease	12.2
2	Cerebrovascular disease	9.7
3	Lower respiratory infections	7.0
4	Chronic obstructive pulmonary disease	5.1
5	Diarrhoeal diseases	3.6
6	HIV/AIDS	3.5
7	Tuberculosis	2.5
8	Trachea, bronchus, lung cancers	2.3
9	Road traffic injuries	2.2
10	Prematurity and low birth weight	2.0
11	Neonatal infections and other	1.9
12	Diabetes mellitus	1.9
13	Malaria	1.7
14	Hypertensive heart disease	1.7
15	Birth asphyxia and birth trauma	1.5
16	Self-inflicted injuries	1.4
17	Stomach cancer	1.4
18	Cirrhosis of the liver	1.3
19	Nephritis and nephrosis	1.3
20	Colon and rectum cancers	1.1

USA: Traffic Fatalities

Fatalities and Fatality Rate per 100 Million VMT, by Year, 1965–2015



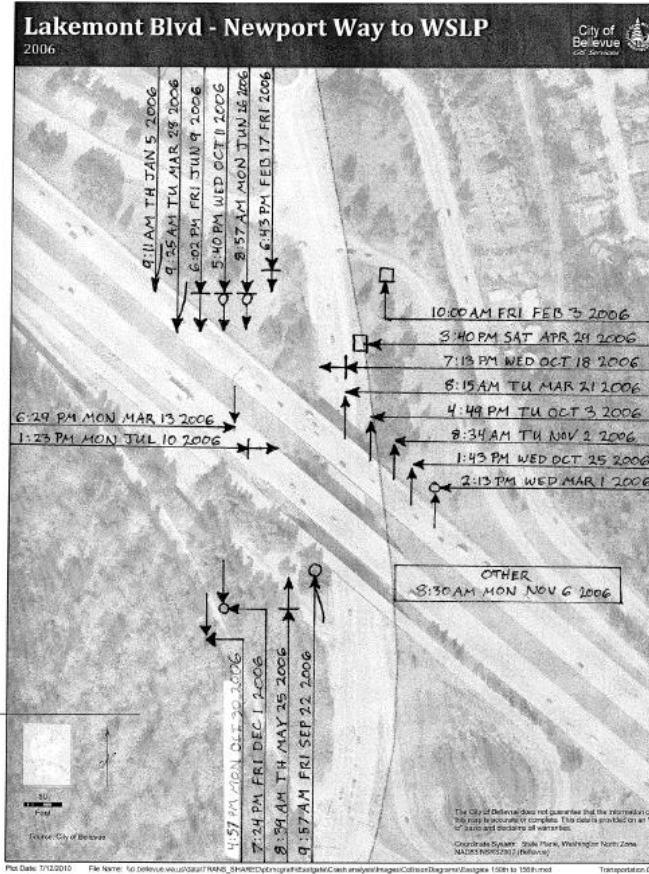
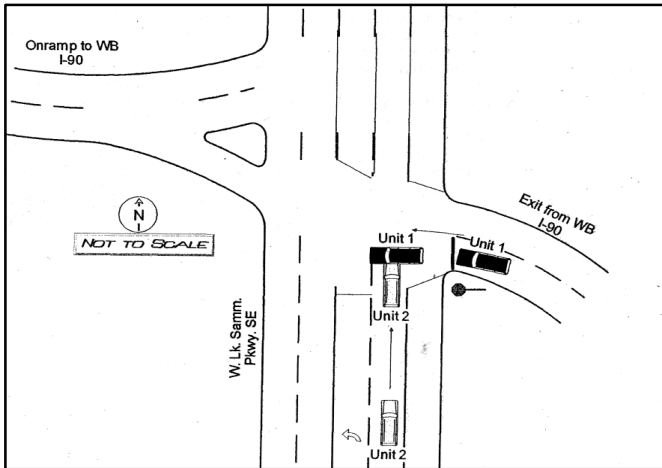
NHTSA, Impact of Crashes (2010): Economic Cost: \$242B; Societal Harm: \$836B

Vision Zero: Reframing Traffic Deaths & Injuries as Preventable



Amy Carlson, Vice President, CH2M HILL

Crash-Based Approach: Lakemont Interchange Case Study

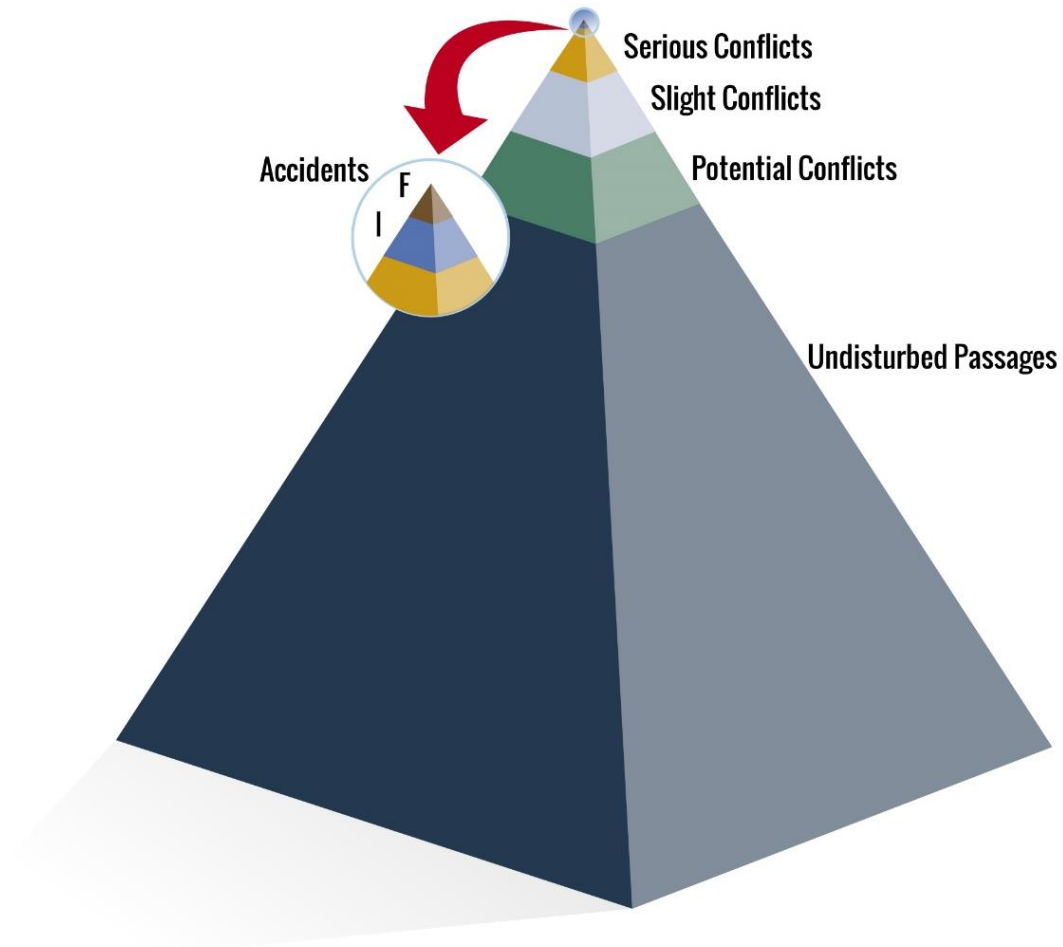


From 2005 through 2010 there were 60 collisions recorded by the Bellevue Police Department and the WSP at this location.



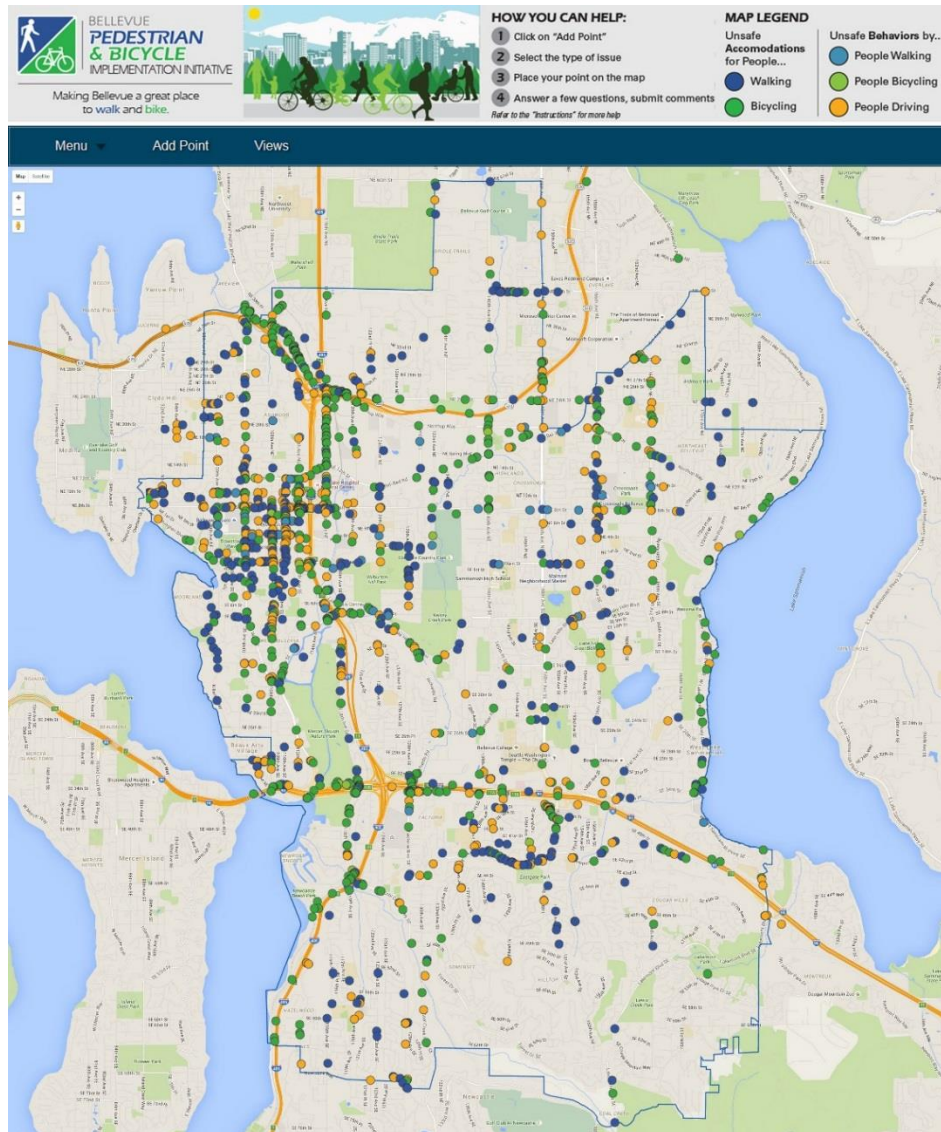
In 2013, WSDOT built a new roundabout at the intersection of the WB I-90 on- and off-ramps and WLSP SE/180 Ave SE.

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



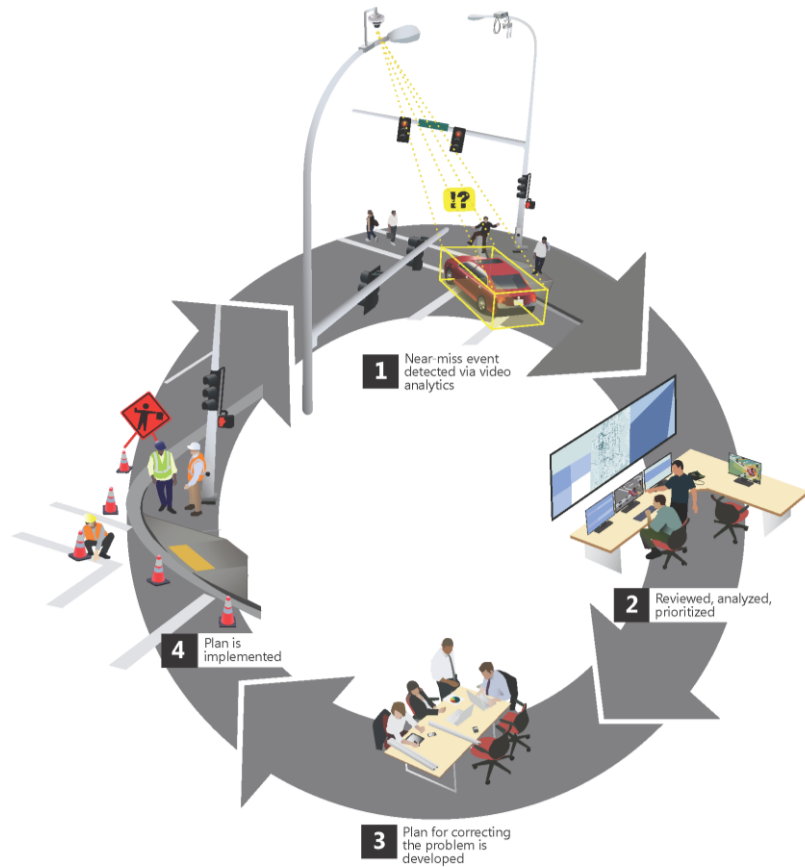
Hyden's Safety Pyramid (adapted from Hyden, 1987)

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	

Conflict-Based Approach: Video Analytics Strategy



Leverage a city's existing traffic camera system to simultaneously:

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

Partnership Momentum

OVERSIGHT



GOVERNMENT




RESEARCH




NON-PROFIT



Partnership Approach

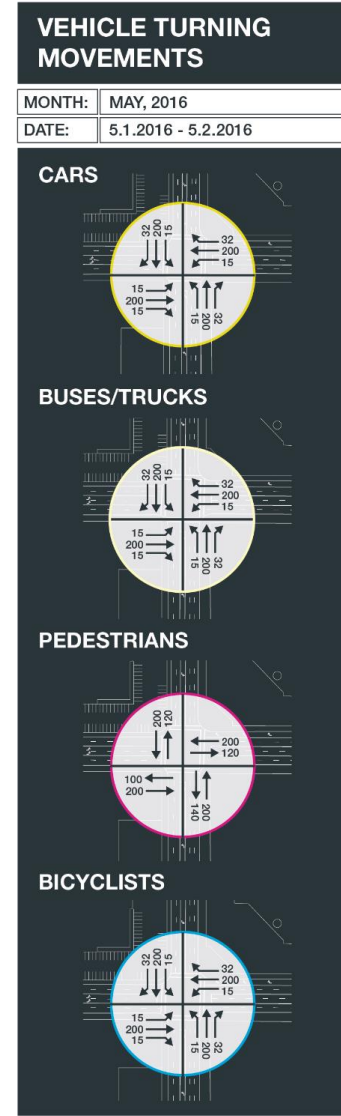
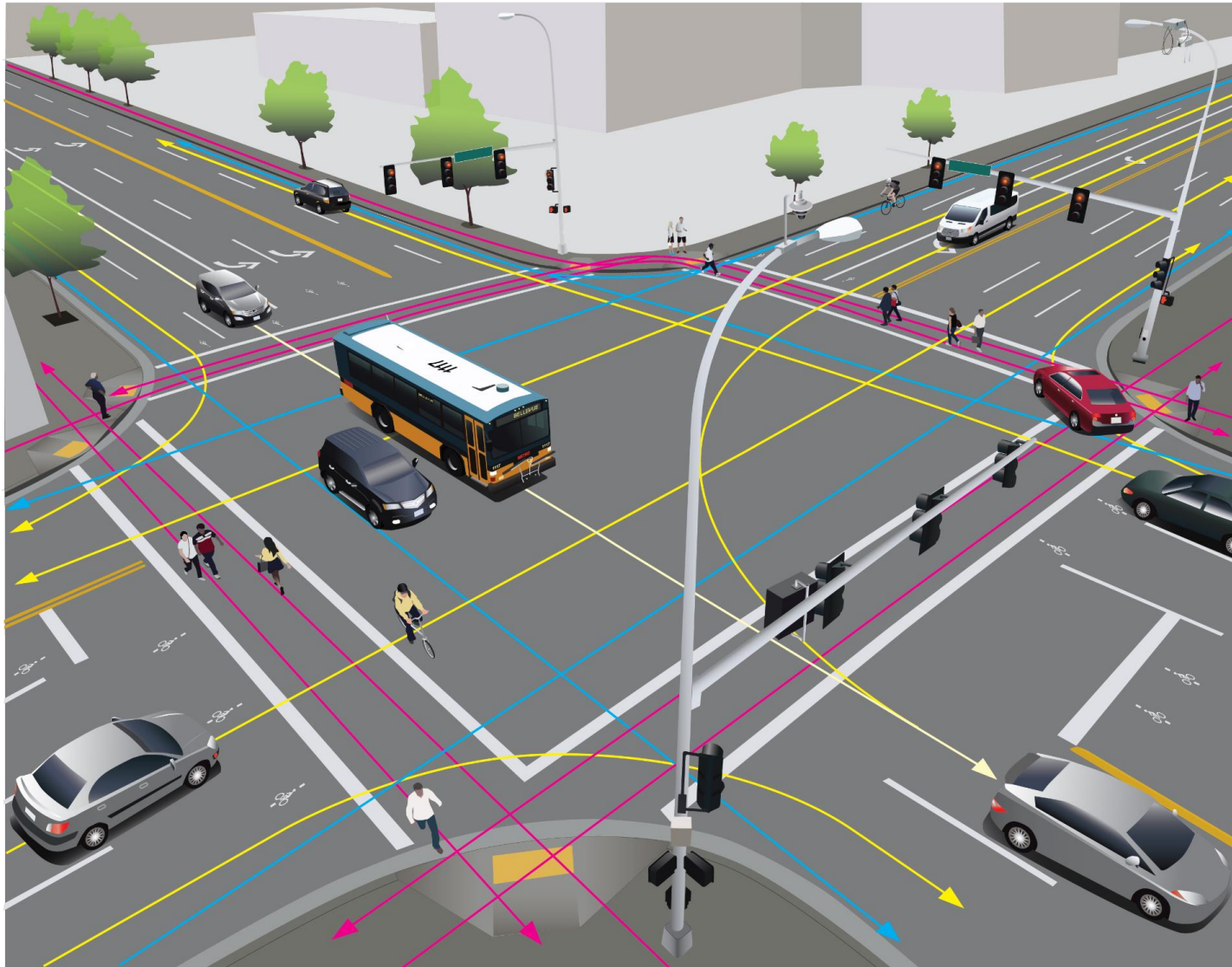
 **Milestone 1:** Demonstrate the capability of vision technologies by detecting relevant events in the sample traffic videos (e.g., detecting cars, pedestrians, and bikes and tracking their movements).

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

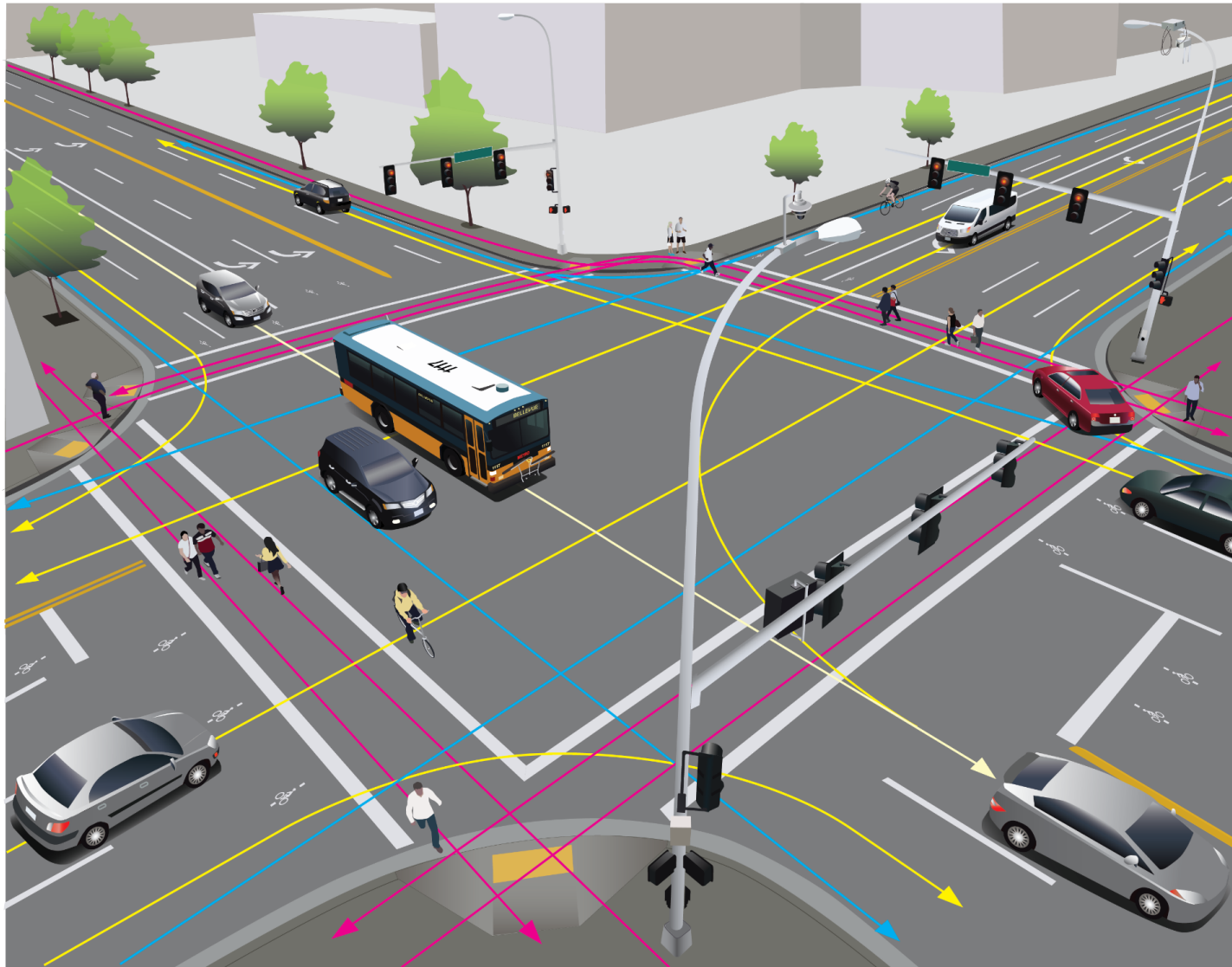
Milestone 3: Pilot deployment of end-to-end system (running on servers provided by Microsoft) in the City of Bellevue traffic control center. The system will run off of a live feed.

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

Trajectory Detection & Turning Movement Counts



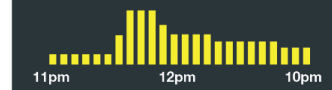
Volume Charts



VEHICLE DISTRIBUTION CHARTS BY TIME OF DAY

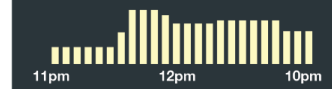
MONTH:	MAY, 2016
DATE:	5.1.2016 - 5.1.2016

CARS



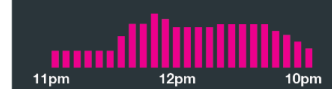
30,000 cars/day

BUSES/TRUCKS



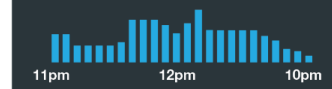
400 buses & trucks/day

PEDESTRIANS



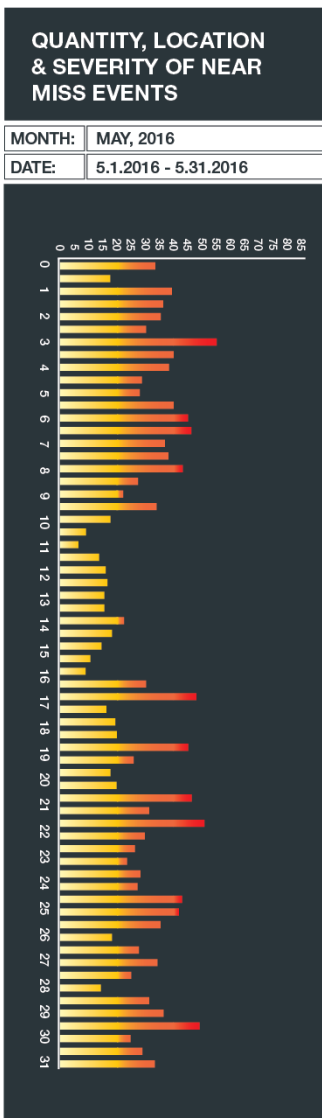
1,000 pedestrians/day

BICYCLISTS

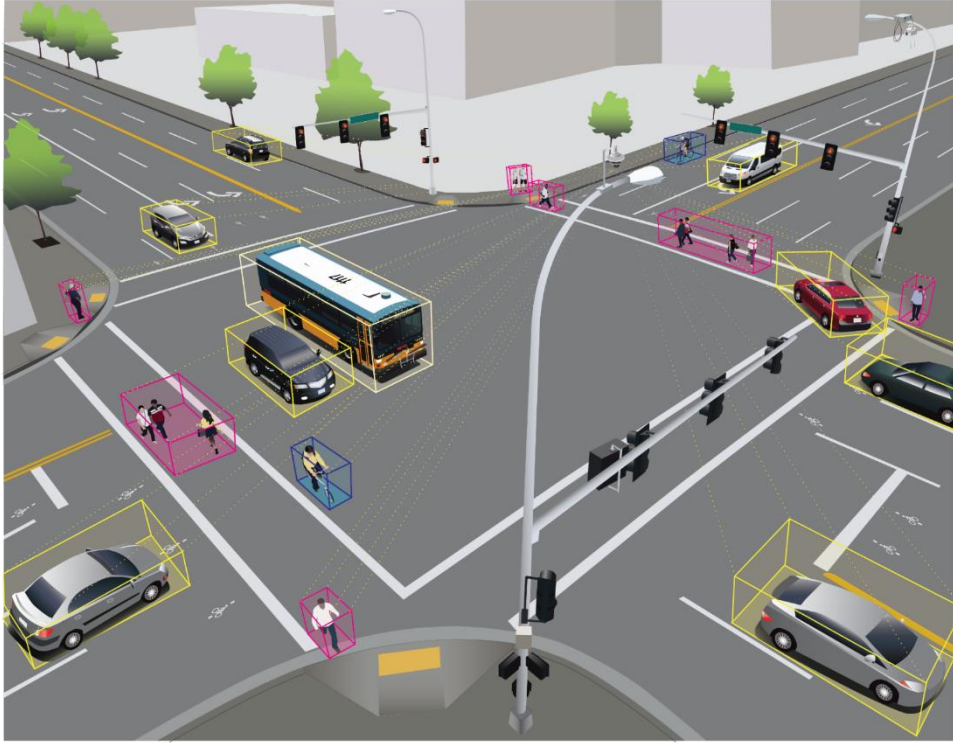


100 bikes/day

Near-Miss Detection



Object Classification Accuracy

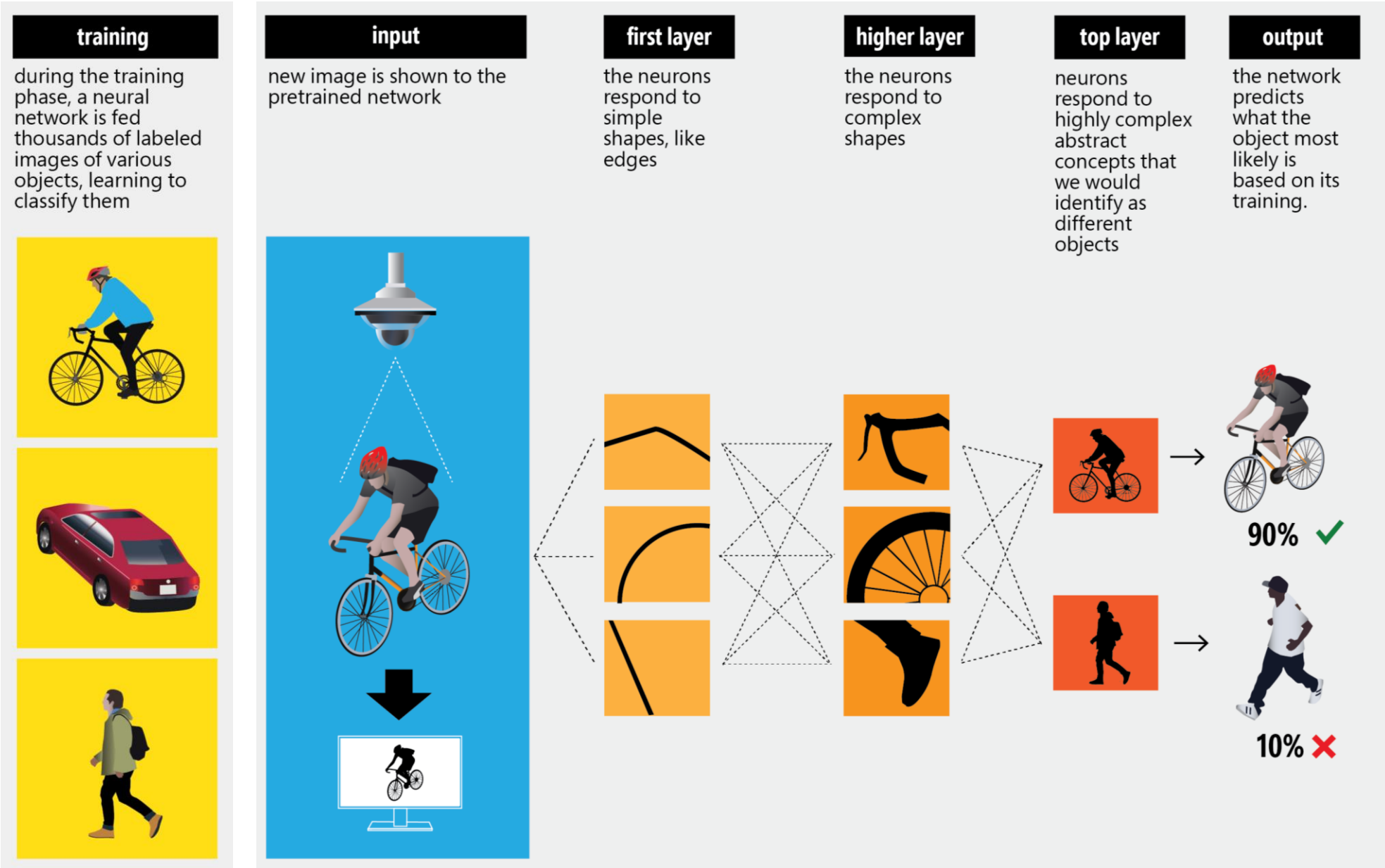


When it really is...

We recognized it as...

Classified-as → Truth ↓	<i>Vehicles</i>	<i>Bikes</i>	<i>Peds</i>	<i>None</i>
<i>Vehicles</i>	0.95	0.01	0.02	0.02
<i>Bikes</i>	0.08	0.67	0.16	0.08
<i>Peds</i>	0.15	0.15	0.73	0.05
<i>None</i>	0.09	0.03	0.11	0.81

How Neural Networks Work



Winter 2017: Collect Pre-Recorded Traffic Camera Footage



Winter 2017: Finalize Video Annotation User Interface



✓ Skip and Get Next Task ✓ Submit and Get Next Task ✓ Submit and Exit ✓ Exit [Instructions] + New Object

Annotate all objects of interest, moving, stationary, or obstructed, for the entire video.

2015-Sep-10 08:49:30.867 AM (PDT)

What type of object did you just annotate?

- Pedestrian
- BiCycle
- PedestrianWithStroller
- MotorBike
- Car
- Bus
- Truck
- WheelChair

Pedestrian 2 [Image] [Share] [Delete]

- Outside of view frame
- Temporarily not visible
- Crossing Road

Pedestrian 1 [Image] [Share] [Delete]

- Outside of view frame
- Temporarily not visible
- Crossing Road

In this video, please track all of these objects:

- Pedestrian
- BiCycle
- PedestrianWithStroller

[Rewind] [Play] [Progress Bar]

[Disable Resize] [Hide Boxes] [Hide Labels] [Slower] [Slow] [Normal] [Fast]

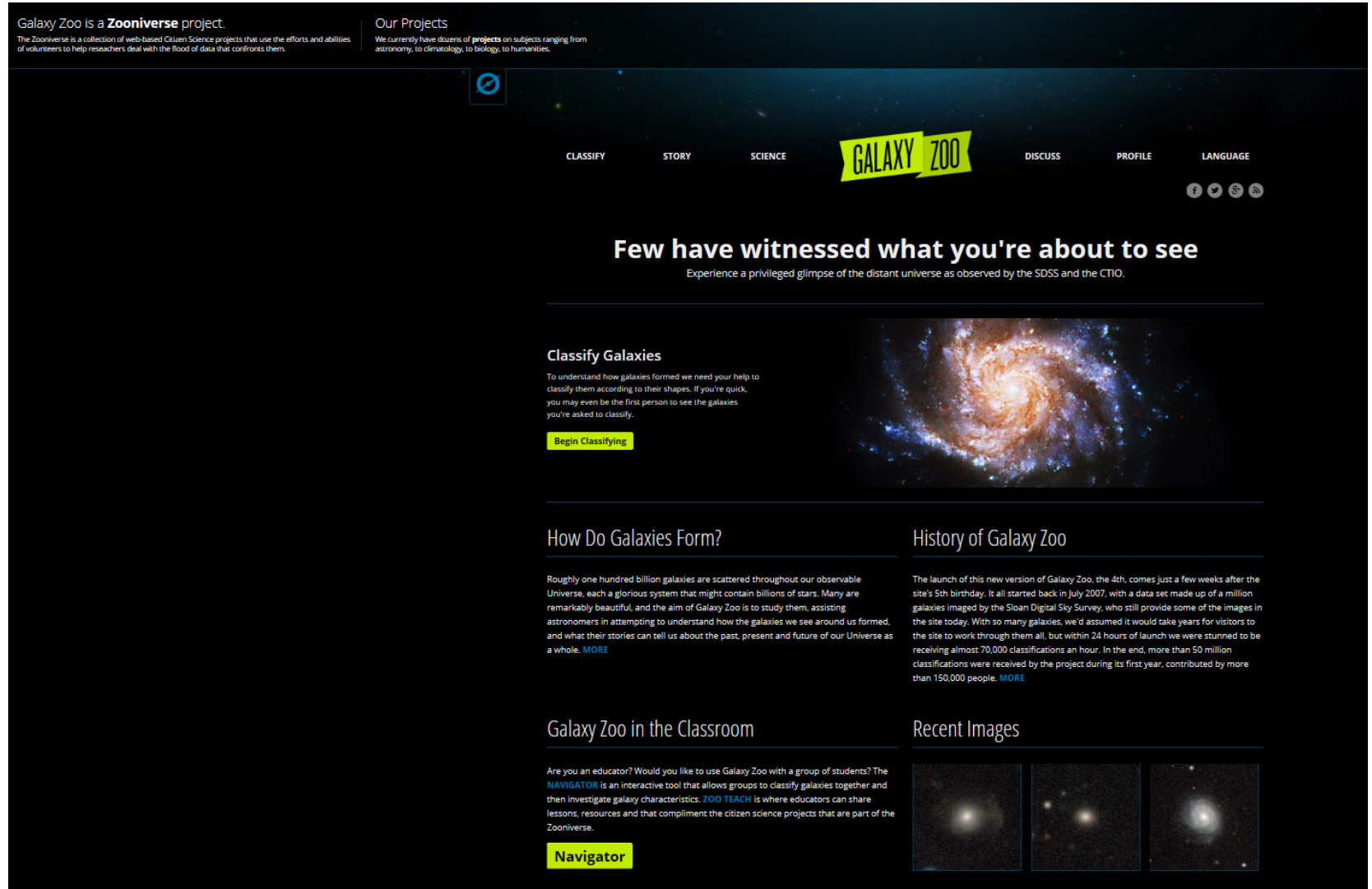
Winter/Spring 2017: Launch Public Facing Webpage

ITS  AMERICA



A Community of Transportation Professionals

VISION 4 ERONETWORK



Galaxy Zoo is a **Zooniverse** project.
The Zooniverse is a collection of web-based Citizen Science projects that use the efforts and abilities of volunteers to help researchers deal with the flood of data that confronts them.

Our Projects
We currently have dozens of **projects** on subjects ranging from astronomy, to climatology, to biology, to humanities.

CLASSIFY STORY SCIENCE **GALAXY ZOO** DISCUSS PROFILE LANGUAGE

[f](#) [t](#) [s](#) [a](#)

Few have witnessed what you're about to see

Experience a privileged glimpse of the distant universe as observed by the SDSS and the CTIO.

Classify Galaxies

To understand how galaxies formed we need your help to classify them according to their shapes. If you're quick, you may even be the first person to see the galaxies you're asked to classify.

[Begin Classifying](#)

How Do Galaxies Form?

Roughly one hundred billion galaxies are scattered throughout our observable Universe, each a glorious system that might contain billions of stars. Many are remarkably beautiful, and the aim of Galaxy Zoo is to study them, assisting astronomers in attempting to understand how the galaxies we see around us formed, and what their stories can tell us about the past, present and future of our Universe as a whole. [MORE](#)

History of Galaxy Zoo


The launch of this new version of Galaxy Zoo, the 4th, comes just a few weeks after the site's 5th birthday. It all started back in July 2007, with a data set made up of a million galaxies imaged by the Sloan Digital Sky Survey, who still provide some of the images in the site today. With so many galaxies, we'd assumed it would take years for visitors to the site to work through them all, but within 24 hours of launch we were stunned to be receiving almost 70,000 classifications an hour. In the end, more than 50 million classifications were received by the project during its first year, contributed by more than 150,000 people. [MORE](#)

Galaxy Zoo in the Classroom

Are you an educator? Would you like to use Galaxy Zoo with a group of students? The **NAVIGATOR** is an interactive tool that allows groups to classify galaxies together and then investigate galaxy characteristics. **ZOO TEACH** is where educators can share lessons, resources and that compliment the citizen science projects that are part of the Zooniverse.

[Navigator](#)

Recent Images



Winter/Spring 2017: Invite Public to Participate



Summer 2017: Classify Near-Miss Events

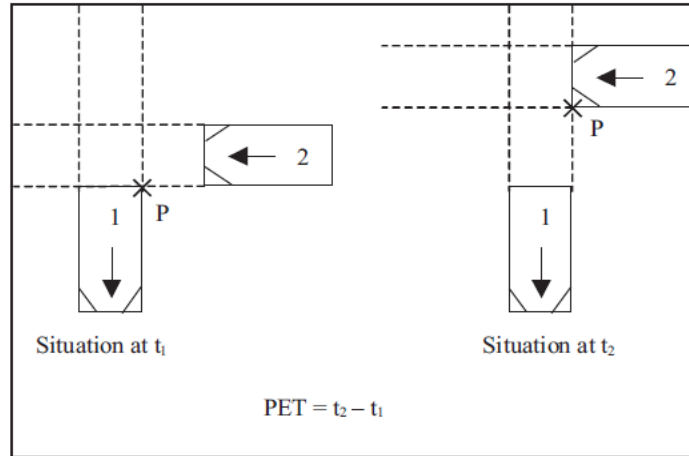


LUND
UNIVERSITY



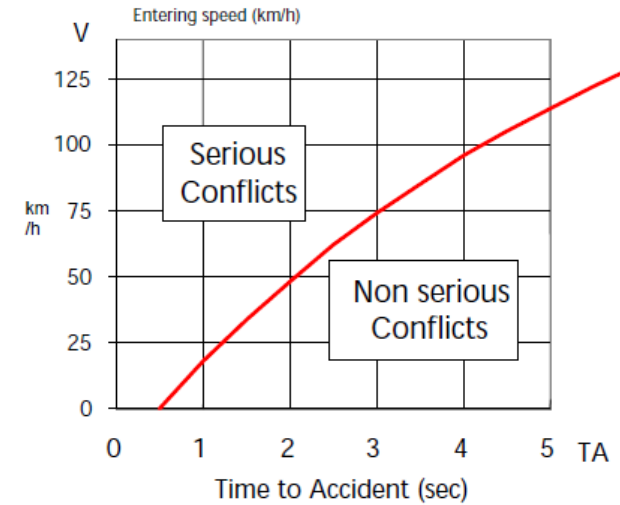
Focused object	Vehicle	Pedestrian
Time	Vehicle time to collision (Vehicle TTC)	Pedestrian time to vehicle (Pedestrian TTV)
Definition	 $\text{Vehicle TTC} = \frac{L}{v}$	 $\text{Pedestrian TTV} = \frac{Ld}{v}$
Study	Previous study (Matsui et al. 2011b)	Present study

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)

Transportation Research Board 96th Annual Meeting

January 8–12, 2017 ■ Washington, D.C.

ITS  AMERICA will coordinate a breakfast meeting for partnership stakeholders. Additional details (date/time/location) to follow.

For More Information



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