Transport Canada / Transports Canada

Evaluation of Pedestrian and Cyclist Warning Systems for Trucks

Peter Burns, peter.burns@tc.gc.ca
June 20, 2018

Outline

- Background and updated collision data

- Track testing of VRU warning systems

- Field operational test (FOT) of warning systems

VRU Task Force

- VRUs are at significant risk when they are involved in collisions with large commercial vehicles.

- Pressures to mandate side guards.

- In Sept 2016, the Minister of Transport, announced a new task force to discuss safety measures to reduce injuries and fatalities involving cyclists, pedestrians and heavy trucks.

- The task force, established through the Canadian Council of Motor Transport Administrators, will explore cameras, sensor systems, side guards, as well as educational safety and awareness programs.

- Transport Canada would also examine the benefits of sensors to reduce collisions between VRU's and heavy trucks.

Updated Canada VRU collision data

- Yearly average (2011-2015)
- Previous data used posted speed limit as filter (<40km/h) but most turning maneuvers are below the posted speed limit.
  - Posted speed limit in Canada is 50km/h in most urban settings -> data was being excluded
- Used estimated collision speed from police report and added occurrences of serious injuries

Vehicle maneuver	Cyclist fatality	(VRU-05 data)	Pedestrian fatality	(VRU-05 data)	Cyclist serious injury	Pedestrian serious injury
Reversing	0	0	10.4	0	2.2	47.6
Straight ahead*	1.4	0	9.4	4	20	55.6
Left turn* (driver side)	0	0	11.2	1	13.6	74.4
Right turn* (opposite driver side)	1.2	0	4	0	13.4	23.4

* Where estimated collision speed is <40km/h

Updated Canada VRU data

- Estimated collision speed is not available for many collisions and numbers are likely under represented.

Maneuver	Total Cyclist Fatalities	Cyclist Fatalities (No Speed Specified)	Total Pedestrian Fatalities	Pedestrian Fatalities (No Speed Specified)
Straight ahead	29.2	18.4	130	84
Left turn	2	2	30.8	18.6
Right turn	5.6	4.2	10.4	6.4

- If we redistribute the "No speed specified" proportional to the known speeds, the <40km/h values become:

Maneuver	Cyclist Fatalities	Cyclist Serious Injuries	Pedestrian Fatalities	Pedestrian Serious Injuries
Straight ahead	3.8	66.1	26.6	166.5
Left turn	(0-2)	47.5	28.3	206.8
Right turn	4.8	41.9	10.4	54.4

Investigations of Heavy Vehicle Collisions with VRU since 2005

The data from the in-depth collision investigations highlight a number of common characteristics and issues:

- A wide variety of vehicle-types, with both cab-forward and conventional cab designs, were involved;

- Every vehicle, with few exceptions, had mirrors systems that exceeded those required by CMVSS 111, however blind spots still exist;

- The incidents typically involved a low speed turning manoeuvre;

- The majority of collisions occurred in daylight at urban intersections during clear weather conditions;

- The VRU was frequently located in, or near, a crosswalk, or was at an unmarked crosswalk.

Data Summary: Observations

- The first point of contact with the VRU was commonly the front or right side of the vehicle;

- The VRU was almost always run over and fatally injured;

- Low side ground clearance and closed-in sides does not guarantee the safety of VRUs, especially in the common, right-turn collision configurations;

- Drivers were not aware that their vehicle had struck a VRU until after the incident when drivers noticed something unusual or were alerted by other motorists or VRUs;

- A number of VRUs displayed a lack of situational awareness and/or inattention.

The above suggests that commercial vehicle drivers need assistance in detecting VRUs in close proximity to the vehicle. Countermeasures should be examined to improve both direct and indirect visibility in combination with detection systems that alert drivers to VRUs.

Part 1: Track Testing

▪ Evaluated available sensor technologies to address blind spot risks on heavy vehicles (10 scenarios with 350 total tests).

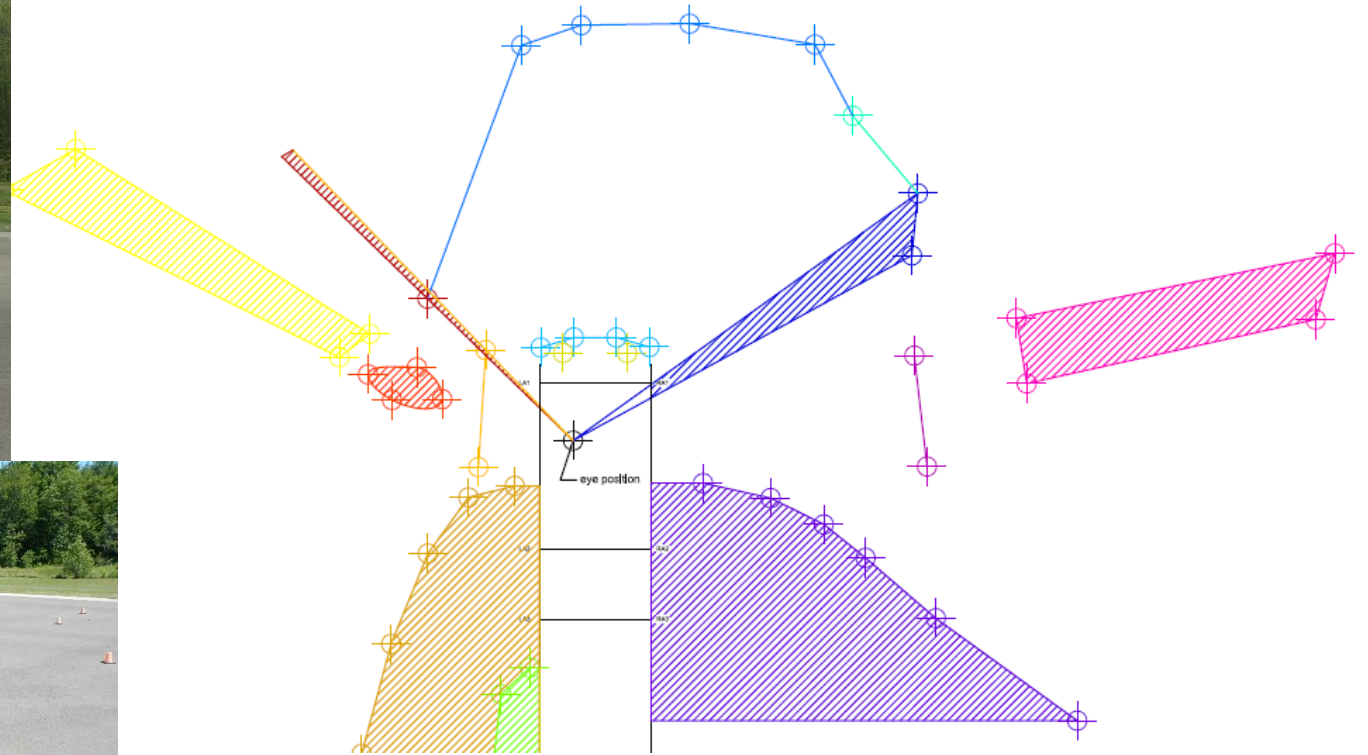▪ 3D scan of test truck to measure and visualize blind spots

Sensors/ Systems tested

- Image recognition (vehicles and VRUs)

- Image recognition (cyclist detection only)

- Camera 360 degree

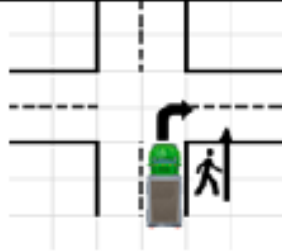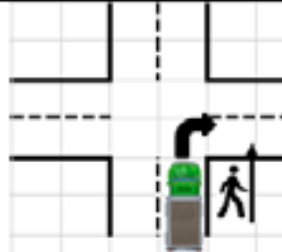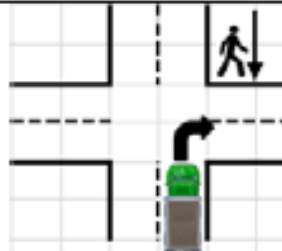- Radar & Camera (activated by turn signal)

- Ultrasonic proximity sensors
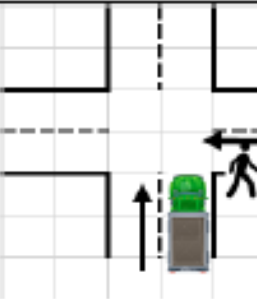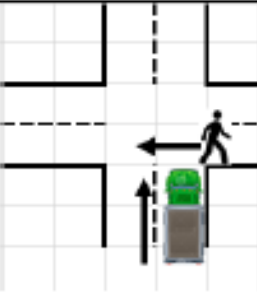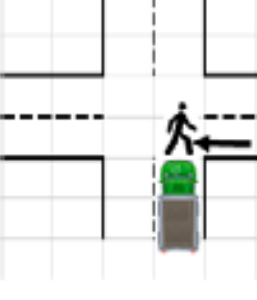
Test Targets

Scenario	Schematic	Kinematics	Collision Scenarios
#1 EPTa EPTc EBT		Vtruck = 10 km/h Vped = 5 km/h Impact zone = 50% front of truck	Determine whether the warning system will warn the driver of a pedestrian crossing the street during a right turn. For this scenario, the dummy is standing on the corner and the point of contact would be 50% of the front of the right turning vehicle. The dummy is travelling north starting at the south east corner at walking speed. The vehicle is coming from the south and turning right (east) at 10 km/h
#2 EPTa EPTc EBT		Vtruck = 10 km/h Vped = 5 km/h Impact zone = right side of truck, behind front wheel	Determine whether the warning system will warn the driver of a pedestrian crossing the street during a right turn. For this scenario, the dummy is standing on the corner and the point of contact will be behind the front wheel of the right turning vehicle. The dummy is travelling north starting at the south east corner at walking speed. The vehicle is coming from the south and turning right (east) at 10 km/h.
#3 EPTa		Vtruck = 10 km/h Vped = 5 km/h Impact zone = 25% front of truck (left corner	Determine whether the warning system will warn the driver of a pedestrian crossing across the street during a right turn. For this scenario, the dummy is standing on the corner and the point of contact will be the first 25% of the front of the vehicle. The dummy is travelling south starting on the north east corner at walking speed. The vehicle is coming from the south and turning right (east) at 10 km/h.

#4 EPTa EBT		Vtruck = 10 km/h Vped = 5 km/h Impact zone = 25% front of truck (right front)	Determine whether the warning system will warn the driver of a pedestrian crossing across the street during a left turn. For this scenario, the dummy is standing on the corner and the point of contact will be the first 25% of the front of the vehicle. The dummy is travelling south starting on the North West corner at walking speed. The vehicle is coming from the south and turning left (west) at 10 km/h.
#5 EPTa		Vtruck = 20 km/h Vped = 5 km/h Impact zone = 25% front of truck	Determine whether the warning system will warn the driver of a pedestrian in front of the vehicle, travelling in the same direction. For this scenario the dummy is travelling north at walking speed and the vehicle is coming behind at 20 km/h. The anticipated point of contact is at 25% of the front of the vehicle (right corner).
#6 EPTa EBT		Vtruck = 20 km/h Vped = 5 km/h Impact zone = 0% front of truck, 1 meter distance between truck and pedestrian	Determine whether the warning system will unnecessarily warn the driver of a pedestrian in front of the vehicle, travelling in the same direction but not in the same path. For this scenario the dummy is travelling north at walking speed and the vehicle is coming behind at 20 km/h. 1 meter should be calculated between the vehicle and the dummy.
#7 EPTa EBT		Vtruck = 0 km/h Vped = 8 km/h Impact zone = none, pedestrian between curb and truck, 1 meter zone	Determine whether the warning system will warn the driver that a pedestrian has arrived in its blind spot. Both are travelling in the same direction. The vehicle is stopped (at a red light for example) and the dummy just squeezed in between the curb and the vehicle at an upcoming speed of 20 km/h. The dummy stops at the right front corner of the vehicle. The behavior of the warning system is documented.

#8 EPTa EBT		Vtruck = 20 km/h Vped = 5 km/h Impact zone = none, stops at edge of curb	Determine whether the warning system will unnecessarily warn the driver of a pedestrian that looks like it will cross the street. The pedestrian stands on the south east corner and heading west. The dummy is approaching the sidewalk edge as the vehicle is travelling north 20 km/h. The anticipated point of impact is 0% of the front of the truck.
#9 EPTa EPTc EBT		Vtruck = 20 km/h Vped = 5 km/h Impact zone = 50% front of truck	Determine whether the warning system will warn the driver of a pedestrian that crosses the street. The pedestrian stands on the south east corner and heading west. The dummy is crossing at walking speed as the vehicle is travelling north. The anticipated point of impact is 50% of the front of the truck.
#10 EPTa		Vtruck = 0 km/h Vped = 5 km/h Impact zone = none, pedestrian walks in front of truck, 2 meters away from bumper.	Determine whether the warning system will warn the driver of a pedestrian that crosses in front of the vehicle while the vehicle is about to take off. The pedestrian is travelling west in front of a stopped vehicle. As the pedestrian approaches the middle of the vehicle, the truck starts to move forward toward the pedestrian. The distance between the vehicle and the pedestrian is 2 meter.

Track Test Results on Systems Tested

- **Ultrasonics** - if the system warned, it was too late to avoid a collision.

- **Radar** - there were issues with the narrow field of view of the radar for the tests. It also did not work in straight ahead scenarios because it was dependent on turn signals.

- **Cameras with 360 display** – did not provide alerts.

- **Multi-camera image recognition system** (i.e., Mobileye Shield+) performed best overall.

  - 2-staged warnings gave drivers more opportunity to respond (preliminary yellow visual information, escalates to a crash imminent red visual/ auditory warning).

Part 2: Field Operational Testing (FOT)

- FOT starting in 5 cities across Canada collecting data for 1-year (Hamilton, Toronto, Ottawa, Montreal and Edmonton)

- Mobileye Shield+ systems are all installed. Not limited to VRU detection and warning - includes Eyewatch ADAS functions (distance, FCW, lane departure and lane keeping alert).

- Different common urban heavy vehicles (14 in total)

- Measuring system performance under real world operation (weather, maintenance)

- Evaluation of driver acceptance (usage, workload, annoyance, false alarms, etc).

- Data collection runs from April 2018 to April 2019

Manufacturer	Model
Freightliner	108 SD Dual Axle Rear Packer
Isuzu	NRR
Freightliner	108 SD Side Packer
International	7400 SBA 6x4
International	4400 SBA 4x2
Peterbilt	PB320
Freightliner	FL80
Freightliner	FL80
Freightliner	FL80
Volvo	D13 Triaxle with dump body
Isuzu	NRR
Mack	GU713
Mack	LR600
Freightliner	M2

Field Operational Testing

- In the last 8 weeks

| Cities (#trucks)	VRU Detection	VRU Collision Warning	Radius of Operation	Kilometers travelled
Montreal (3)	17,902	562	7km	15,612
Edmonton (3)	11,516	648	13km	14,225
Hamilton (2)	7,927	510	10km	15,726
Ottawa (3)	4,824	126	9km	10,080
Toronto (3)	2,807	181	14km	2,280
TOTAL	44,976	2,027	-	57,931

Data Collection of VRU Warnings

- Next Step is to identify with our partners geofencing to assist in isolating the work related alerts (for example at the dumping site)
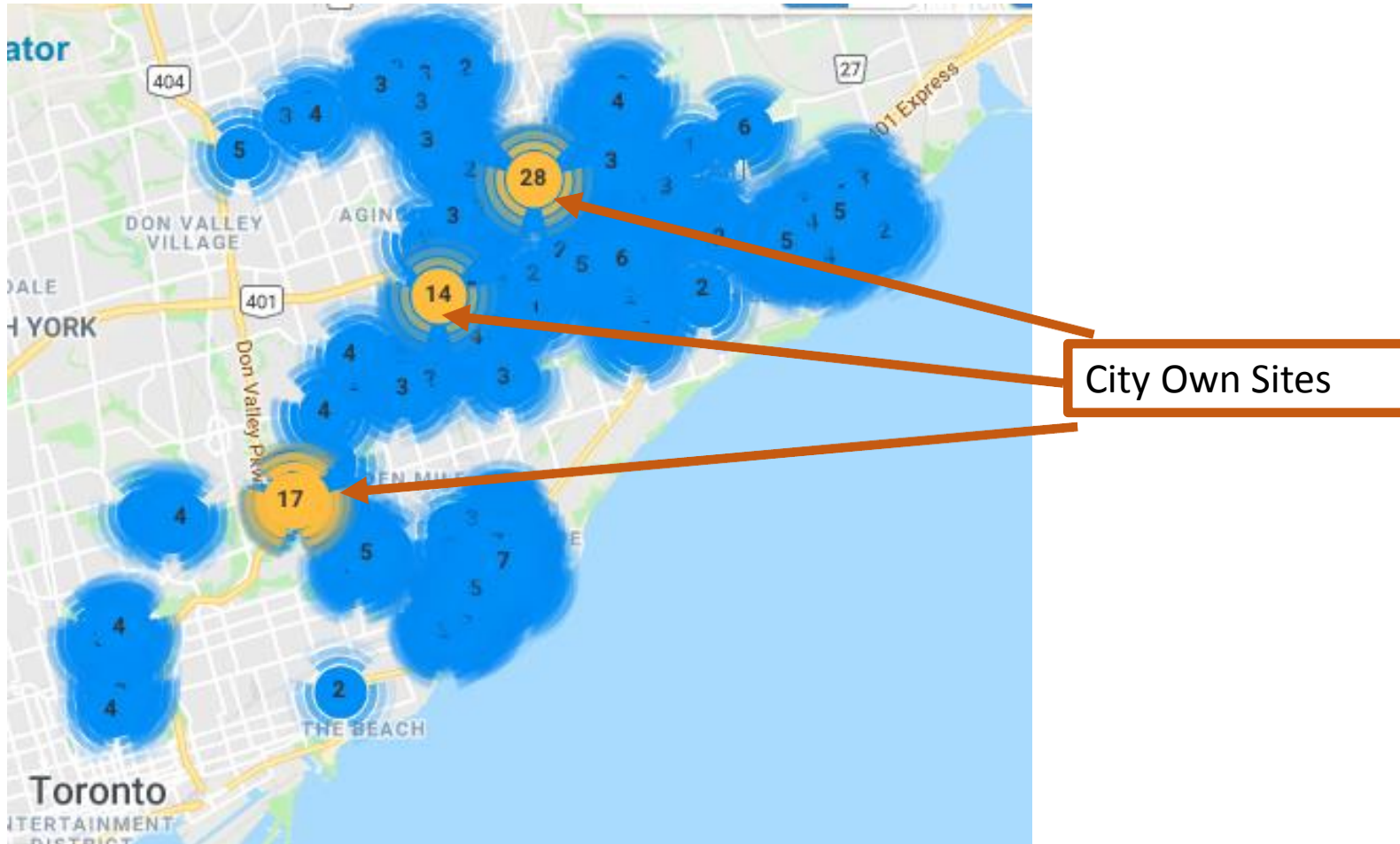
Identifying Real Hot Spots
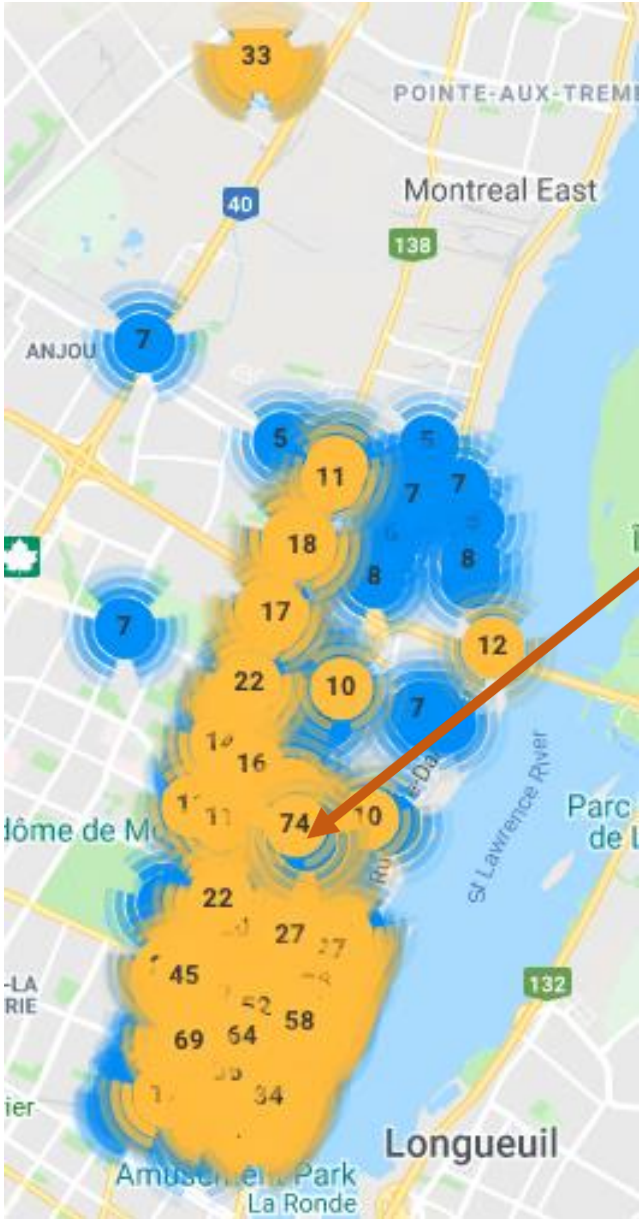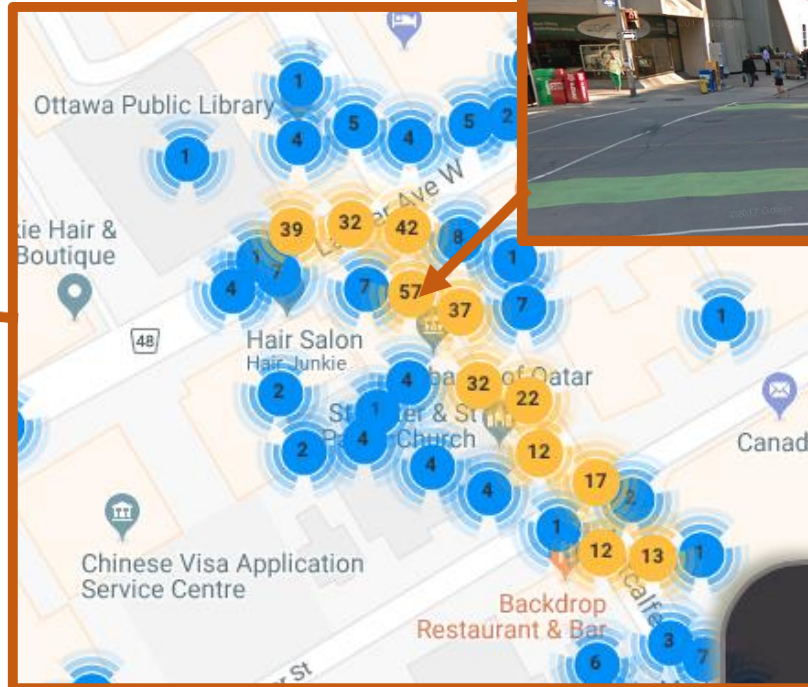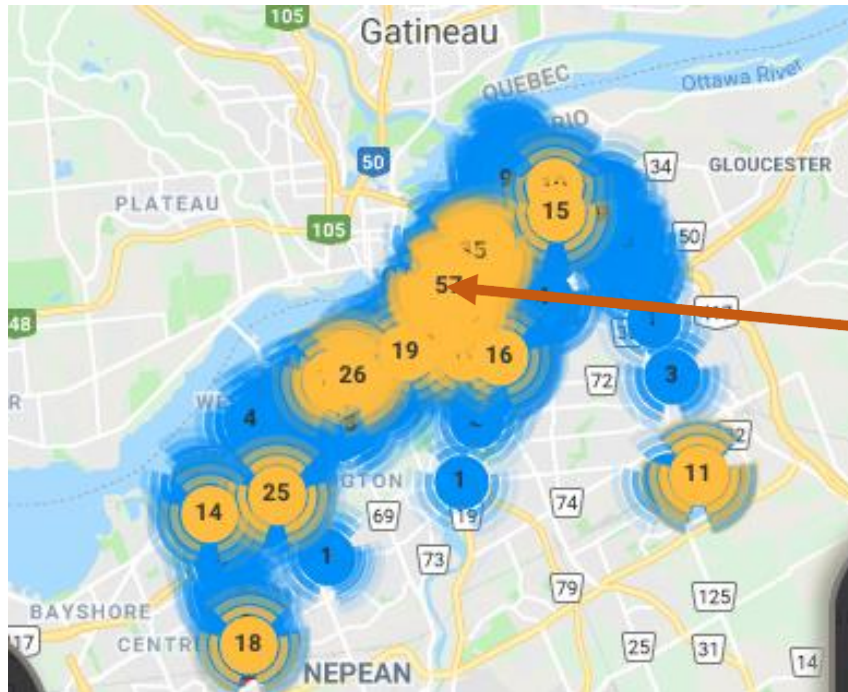

Garage to Service/Park Trucks
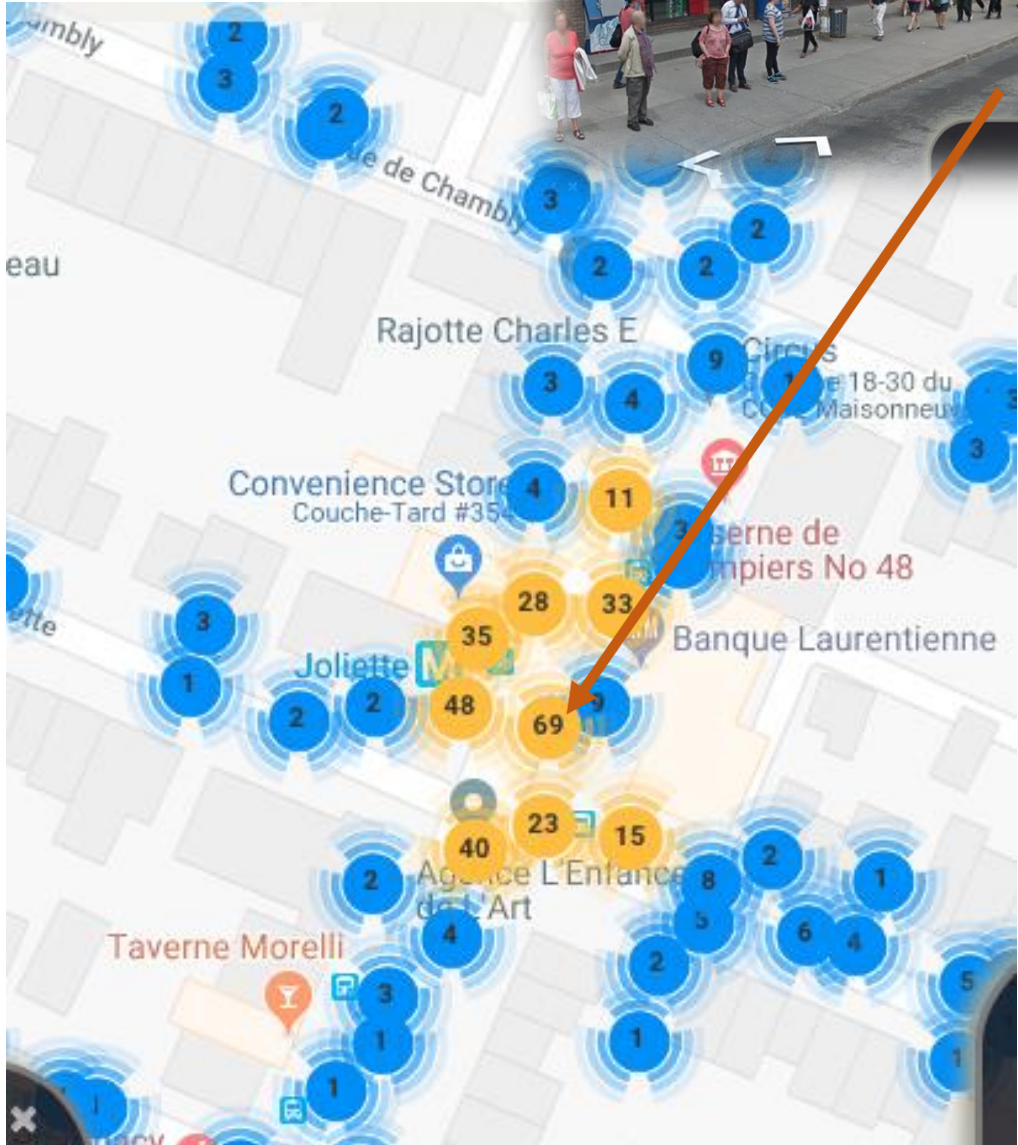
MobilEye events mapping
Total Number of Events-
46590

Working Site in Pedestrians and Cyclists Area

- The highest number of alerts is on a predefined route by 1 particular truck. It is also located at a busy intersection designed for pedestrians and cyclists.

Operators Surveys

- Administered after 3-4 weeks to the operators to be able to provide feedback on the system.

- Every city operates differently for driver rotations

- Efforts are put in place to ensure that more operators are exposed to the system.

- Surveys will be conducted seasonally and repeated to capture the various effects of environmental change, flow of traffic, flow of VRU, perception/confidence and impact on the workload.

Some Early Survey Comments…

- Limitations:
  - Direct sunlight, alleys, dirty cameras, fog

- Overall impression:
  - Feels safer, general acceptance so far,

- Initial reactions to warning:
  - Look at warning, look at onboard cameras (some trucks have supplemental driving aids such as cameras), look at pedestrians

- Other Comments:
  - "More aware of surroundings", "extra set of eyes"

Our collection of surveys will continue for the duration of this project