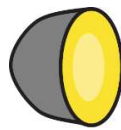


Road User Safety and Behaviour within Marked Crosswalks

Maurice Masliah
mmasliah@headlightconsulting.ca
Headlight Consulting Inc.



HEADLIGHT CONSULTING INC.
Human Factors & Road Safety

1

PEDESTRIAN CROSSWALK STUDY: ACCIDENTS IN PAINTED AND UNPAINTED CROSSWALKS

Bruce F. Herms, Traffic Engineering Section, City of San Diego

1972 study by Herms

Study Design

- Five years of collision data (1965-1969)
- 400 two-way stop-controlled intersections in San Diego with one marked and one unmarked crosswalk across the major road
- School crosswalks and midblock crossings were excluded

2

2

1972 Herms Findings

	Fatal Pedestrian Collisions	Total Pedestrian Collisions
Marked Crosswalks	18	177
Unmarked Crosswalks	3	31

Herms concluded that marked crosswalks may:

- Increase collision risk
- Cause pedestrians to have a false sense of security and to place themselves in a hazardous position with respect to vehicular traffic
- Herms noted that a high number of the collisions where pedestrian was at the “far-side finish” position

3

3

Problems with the Herms Study

- Did not control for traffic volume, pedestrian volume, number of lanes, or other roadway features
- The Herms study was not a study of pedestrian behavior
- Therefore, the conclusion that crosswalks create a false sense of security is based upon speculation and not data

The 1962 warrant for the installation of crosswalks in San Diego:

- Few traffic gaps
- High pedestrian volume
- Moderate speeds (not low and not high)
- High collision history

4

4

High Visibility Crosswalks: Study of Behaviour

- 2001 study in Clearwater, Florida
- Installation of an illuminated crosswalk sign and high-visibility ladder style crosswalk
- Two experimental locations compared against two control locations

Nitzburg, M., and Knoblauch, R. L. An Evaluation of High-Visibility Crosswalk Treatment-Clearwater, Florida. Report FHWA-RD-00-105. FHWA, U.S. Department of Transportation, 2001



5

High Visibility Crosswalk Findings

- No difference in pedestrian looking behaviour with or without crosswalks
- No difference in pedestrian running frequency or the number of conflicts
- Vehicles were more likely to yield to pedestrians
- Pedestrians were more likely to use the crosswalks
- No evidence that pedestrians crossed more aggressively with an illuminated crosswalk sign and high-visibility ladder style crosswalk

Nitzburg, M., and Knoblauch, R. L. An Evaluation of High-Visibility Crosswalk Treatment-Clearwater, Florida. Report FHWA-RD-00-105. FHWA, U.S. Department of Transportation, 2001

6

Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations

Final Report and Recommended Guidelines

FHWA PUBLICATION NUMBER: HRT-04-100

SEPTEMBER 2005

- Five years of collision data
- 1,000 marked crosswalk sites matched with 1,000 unmarked uncontrolled crosswalk sites across 30 major US cities
- Data collected: pedestrian collision history, pedestrian average daily traffic (ADT), vehicle ADT, number of lanes, presence of a raised median (speed limit, area type, crosswalk pattern, crosswalk condition, midblock vs intersection location)
- School crosswalks were excluded

7

7

FHWA Study Findings -Zeeger et al.

- Under no condition was the presence of a marked crosswalk alone at an uncontrolled location associated with a significantly lower pedestrian crash rate compared to an unmarked crosswalk.
- On multilane roads with traffic volumes greater than 12,000 vehicles per day, having a marked crosswalk was associated with a higher pedestrian crash rate (after controlling for other site factors) compared to an unmarked crosswalk.
- Crosswalks should be installed as part of more substantial improvements: raised medians, traffic signals, speed reduction countermeasures.

8

8

Crosswalk Installation Guidelines – Zeeger et al.

Design Guidelines												
RECOMMENDATIONS FOR INSTALLING MARKED CROSSWALKS AND OTHER PEDESTRIAN IMPROVEMENTS AT UNCONTROLLED LOCATIONS												
Roadway Type (Number of travel lanes and median type)	Vehicle ADT ≤ 9,000			Vehicle ADT > 9,000 to 12,000			Vehicle ADT > 12,000 to 15,000			Vehicle ADT > 15,000		
	≤ 48 km/h	56 km/h	64 km/h	≤ 48 km/h	56 km/h	64 km/h	≤ 48 km/h	56 km/h	64 km/h	≤ 48 km/h	56 km/h	64 km/h
2 lanes	C	C	P	C	C	P	C	C	N	C	P	N
3 lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multilane (≥ 4 lanes) with raised median	C	C	P	C	P	N	P	P	N	N	N	N
Multilane (≥ 4 lanes) without raised median	C	P	N	P	P	N	N	N	N	N	N	N

C: Candidate site for marked crosswalk. Marked crosswalk can be considered after an engineering study and confirmation of 20 pedestrian (or 15 elderly/child) crossings per peak hour.

P: Possible increase in pedestrian crash risk may occur if crosswalks are added without other crossing improvements; locations should be monitored and enhanced with other improvements if necessary before adding a crosswalk.

N: Marked crosswalks should not be added alone because pedestrian crash risk may increase; treatments such as traffic calming measures, traffic signals with pedestrian signals, or other crossing safety improvements should be considered.

NCHRP Report 600

9

9

Supplemental Crosswalk Countermeasures

- Traffic signals
- Rumble strips
- Flashing beacons
- Crosswalk lighting
- Pedestrian warning signs
- Overhead crosswalk signs
- In-pavement flashing lights
- Advanced stop lines and signs
- Curb extensions, lane reductions
- Increasing available sight distance
- Raised medians and refuge islands
- Install “Yield Here to Pedestrians” signs & yield lines
- Prohibit parking between the yield line and the crosswalk
- Speed tables (elevated crosswalks, flat-topped speed humps)

Zeeger, C. V. et al. Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations. FHWA Publication No: HRT-04-100. 2005.

10

10

Pedsafe <http://www.pedbikesafe.org/pedsafe/>



11

11

Impact of Removing a Crosswalk

- Study of unsignalized 4-lane roads with raised medians in Israel that had crosswalks removed
- Speed measurements and video recording of pedestrian and vehicle behaviours
- Higher percentage of pedestrians observed following safe crossing rules along with longer pedestrian wait times
- Concluded that there was an overall reduction in safety due to:
 - Higher vehicle speeds
 - Lower rates of vehicles giving-way to pedestrians

Gitaelman, V.; Carmel, R.; Pesahov; Hakkert, S. An examination of the influence of crosswalk marking removal on pedestrian safety as reflected in road user behaviours. Transportation Research Part F 46 (2017) 342–355. ¹²

12

Factors Affecting Driver Yielding to Pedestrians in Crosswalks

Sandt, L. S. et al. Effect of a community-based pedestrian injury prevention program on driver yielding behavior at marked crosswalks. *Accident Analysis and Prevention*. Vol. 93, 2016, pp. 169–178

Driver <ul style="list-style-type: none"> • Awareness/distraction • Awareness of traffic laws • Perception of risks/consequences of non-compliance • Perception of safety in yielding • Perception of yielding norms 	Roadway and Vehicle <ul style="list-style-type: none"> • Posted speed/operating speed • Traffic volume • Pedestrian volume • Direction of traffic • Number of lanes • Crosswalk location (e.g. midblock) • Roadway connectivity/intersection density • Vehicle weight & braking capabilities
Pedestrian <ul style="list-style-type: none"> • Personal characteristics (build, gender, maturity) • Crossing/communication style (aggressive, cautious) • Visibility (clothing, nearness to crossing, etc.) 	Social & Cultural Environment <ul style="list-style-type: none"> • Law enforcement priorities • Law enforcement presence • Laws/polices supporting pedestrian safety • Culture of pedestrian support

13

What factors make a driver more likely to yield to a pedestrian at a crosswalk?

2004 study by Harrell in Edmonton (University of Alberta) at a non-signalized crosswalk with a pedestrian attempting to cross and a single approaching vehicle

- Pedestrians who are assertive (someone who moves into the crosswalk rather than waiting on the curb)
- Pedestrians who are wearing higher visibility clothing (neon bright colors versus gray)

Pedestrians who prompt drivers by raising their hand or extending their arm also increases driver yielding (Crowley-Koch & Van Houten, 2011)

14

14

Driver Approach Speed and Driver Yielding

- Study of nine uncontrolled, marked crosswalks in the Boston area:
 - Three with an 85th percentile operating speed of 20 mph (32 km/h)
 - Three with an 85th percentile operating speed of 30 mph (48 km/h)
 - Three with an 85th percentile operating speed of 40 mph (64 km/h)
- Observer in a parked vehicle to collect yielding data and speed
- Free flow vehicles moving within 2 mph of the 85th percentile
- Pedestrian steps into the street as a driver is approaching, but with enough lead time for the driver to notice and brake
- 100 observations per site

Bertulis, T. and Dulaski, D. M. Driver Approach Speed and Its Impact on Driver Yielding to Pedestrian Behavior at Unsignalized Crosswalks. Transportation Research Record: Journal of the Transportation Research Board, No. 2464, Transportation Research Board of the National Academies, Washington, D.C., 2014, pp. 46–51.

15

Speed and Yielding



FIGURE 4 Driver speed and yielding compliance at nine study locations in Boston and Brookline.

Bertulis, T. and Dulaski, D. M. Driver Approach Speed and Its Impact on Driver Yielding to Pedestrian Behavior at Unsignalized Crosswalks. Transportation Research Record: Journal of the Transportation Research Board, No. 2464, Transportation Research Board of the National Academies, Washington, D.C., 2014, pp. 46–51.

16

Speed and Yielding

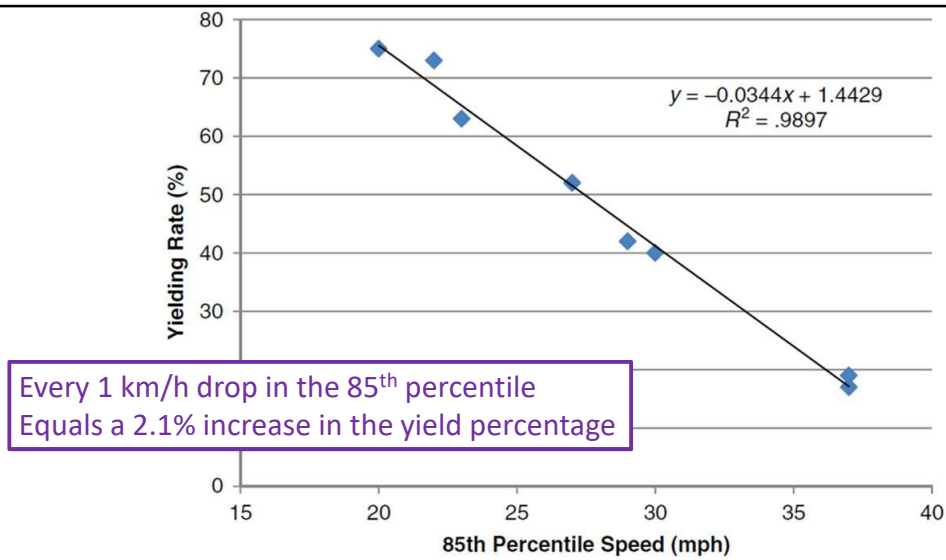


FIGURE 5 Relationship between yielding rate and approach speed for eight two-lane road locations.

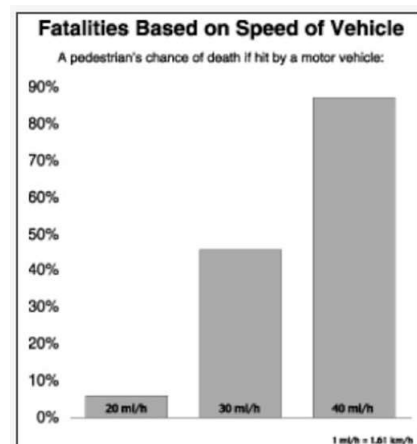
Bertulis, T. and Dulaski, D. M. Driver Approach Speed and Its Impact on Driver Yielding to Pedestrian Behavior at Unsignalized Crosswalks. Transportation Research Record: Journal of the Transportation Research Board, No. 2464, Transportation Research Board of the National Academies, Washington, D.C., 2014, pp. 46–51.

17

Speed and Injury Severity

An analysis of severe and fatal pedestrian collisions found that the direction of the vehicle (turning right, turning left, going straight) was not a factor in the severity of the collision.

Vehicle impact speed accounts for the increased injury risk and not vehicle trajectory.



Source: U.K. Department of Transportation, Killing Speed and Saving Lives, London, 1987.

Roudsari, B.; Kaufman, R.; Koepsell, T. Turing at Intersections and Pedestrian Injuries. Traffic Injury Prevention, Vol 7, pp. 283-289, 2006

18

18

What is the impact of public awareness and enforcement on yielding? (1 of 2)



www.watchformenc.org

- Widespread community-based media and local outreach campaign designed to increase awareness of pedestrian safety and related laws
- High-visibility law enforcement activities and public outreach at selected crossing locations
- Re-striped crosswalks, in-street signs, and/or rectangular rapid flashing beacons

Sandt, L. S. et al. Effect of a community-based pedestrian injury prevention program on driver yielding behavior at marked crosswalks. *Accident Analysis and Prevention*. Vol. 93, 2016, pp. 169–178

19

19

What is the impact of public awareness and enforcement on yielding? (2 of 2)

- 16 uncontrolled (mostly midblock) marked crosswalk locations in five cities
- Before-after study design with comparison locations
- 24,941 drivers were observed in 11,817 pedestrian and motor vehicle crossing interactions (3397 natural and 8420 staged)
- 4% to 7% increase in driver yielding

Sandt, L. S. et al. Effect of a community-based pedestrian injury prevention program on driver yielding behavior at marked crosswalks. *Accident Analysis and Prevention*. Vol. 93, 2016, pp. 169–178

20

20

High Visibility Crosswalks

Recommended in place of transverse lines at uncontrolled crossings:

- More visible to approaching motorists
- Better emphasize pedestrian crossing areas
- Some evidence that drivers are more likely to yield to pedestrians

McGrane, A. and Mitman, M. An Overview and Recommendations of High-Visibility Crosswalk Marking Styles. Federal Highway Administration Report DTFHGI-11-H-00024, 2013

21

21

Impairment

Based upon US fatal pedestrian collision data:

- 33% involved an impaired pedestrian
- 15% involved an impaired driver
- 6% involved both an impaired pedestrian and driver

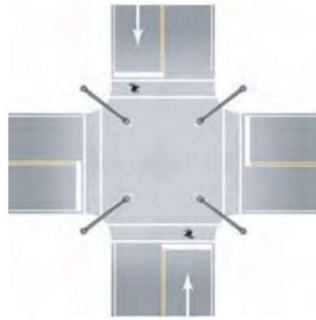
In a fatal pedestrian collision, the pedestrian is more likely to be impaired than the driver.

Shankar, U. Pedestrian roadway fatalities. National Highway Traffic Safety Administration, US Department of Transportation, DOT HS 809 456, 2003

22

22

Lighting



A. Traditional layout – Good for illuminating conflict areas in the intersection, but poorer for visibility of pedestrians.



B. Alternative layout – Better for visibility of pedestrians, but harder to illuminate conflict areas in the intersection.

- Place streetlights 10 to 15 feet ahead of a crosswalk in each direction of vehicle travel
- Include a sharp cutoff to minimize exposure of glare to oncoming vehicles

NCHRP Report 600

23

23

Does being Distracted Increase Collision Risk?

- Observational study of 1,102 pedestrians crossing at the 20 highest risk intersections in Seattle (94% at crosswalks)
- Mean crossing times across 3.4 lanes:
 - -0.48 seconds listening to music
 - +0.75 seconds using a handheld phone
 - +1.29 seconds using a hands-free phone
 - +1.70 seconds when texting
 - +3.40 seconds for 65 years and older compared to 18-24 year olds
- Distracted pedestrians are more likely to disobey traffic lights, cross mid-intersection, or fail to look both ways

Thompson, L. L., et al. Impact of social and technological distraction on pedestrian crossing behaviour: an observational study. Injury Prevention 2013, vol 19, pp. 232–237.

24

24

Distracted Walking Public Awareness Campaigns

- Correlation between distraction and unsafe walking behaviour
- There have been numerous distracted walking public awareness campaigns

Mwakalonge, J.; Siuhi, S.; White, J. Distracted walking: Examining the extent to pedestrian safety problems. *Journal of Traffic and Transportation Engineering* 2015; Vol 2 (5), pp. 327-337. 25

25



Fig. 2 – The “E-Lane” in Philadelphia (NBC10 Philadelphia, 2012).
Mwakalonge et al., 2015

26

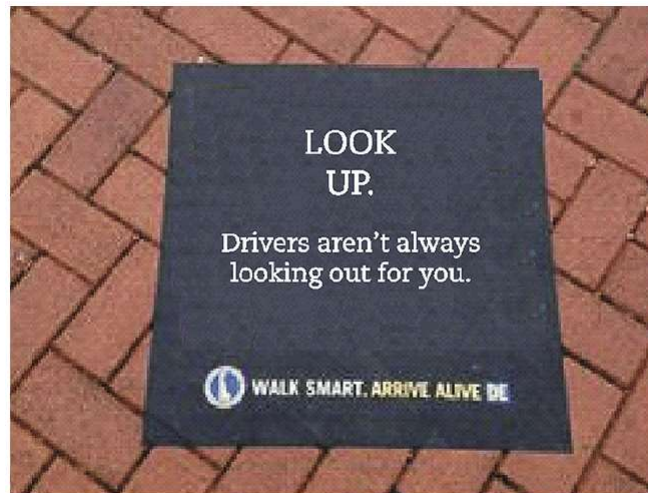


Fig. 3 – Decals in Delaware.

Mwakalonge et al., 2015 ²⁷

27



Fig. 4 – Distracted walking street campaign ad in San Francisco.

Mwakalonge et al., 2015 ²⁸

28



Fig. 5 – Seeing eye person.

Mwakalonge et al., 2015 ²⁹

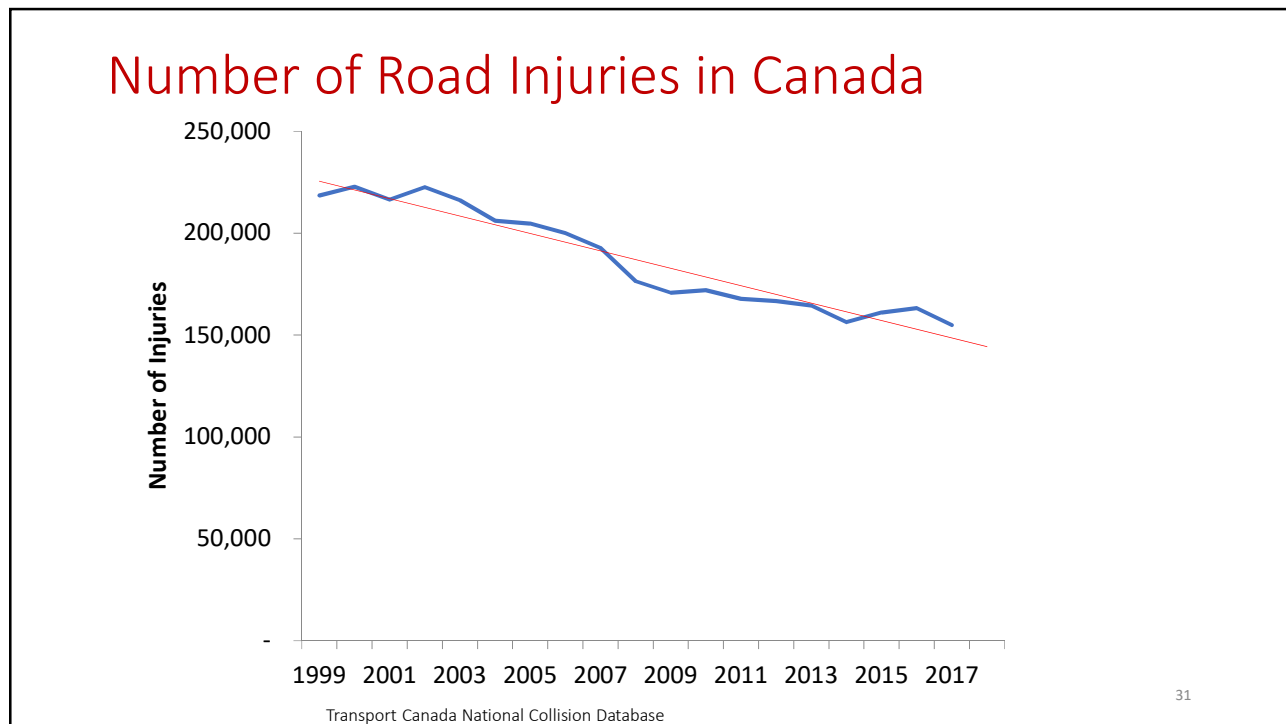
29

Distracted Behaviour is Common

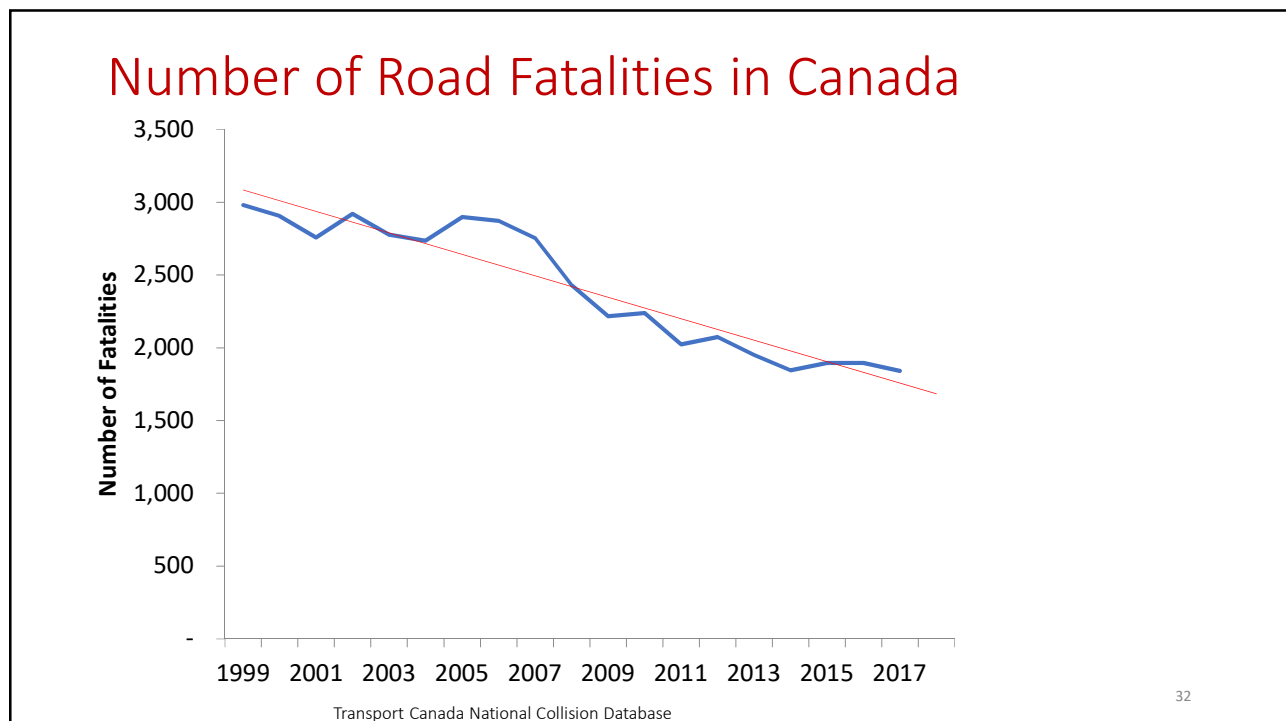
- People rarely allocate all of their attention to one task for an extended period of time
- Everybody engages in some type of distraction some of the time
- Common distractions are:
 - Listening to music
 - Manipulating audio controls
 - Viewing the roadside environment
 - Eating/drinking
 - Conversing with others
 - Being distracted by something within the vehicle/ manipulating vehicle controls
 - Cell phone use

30

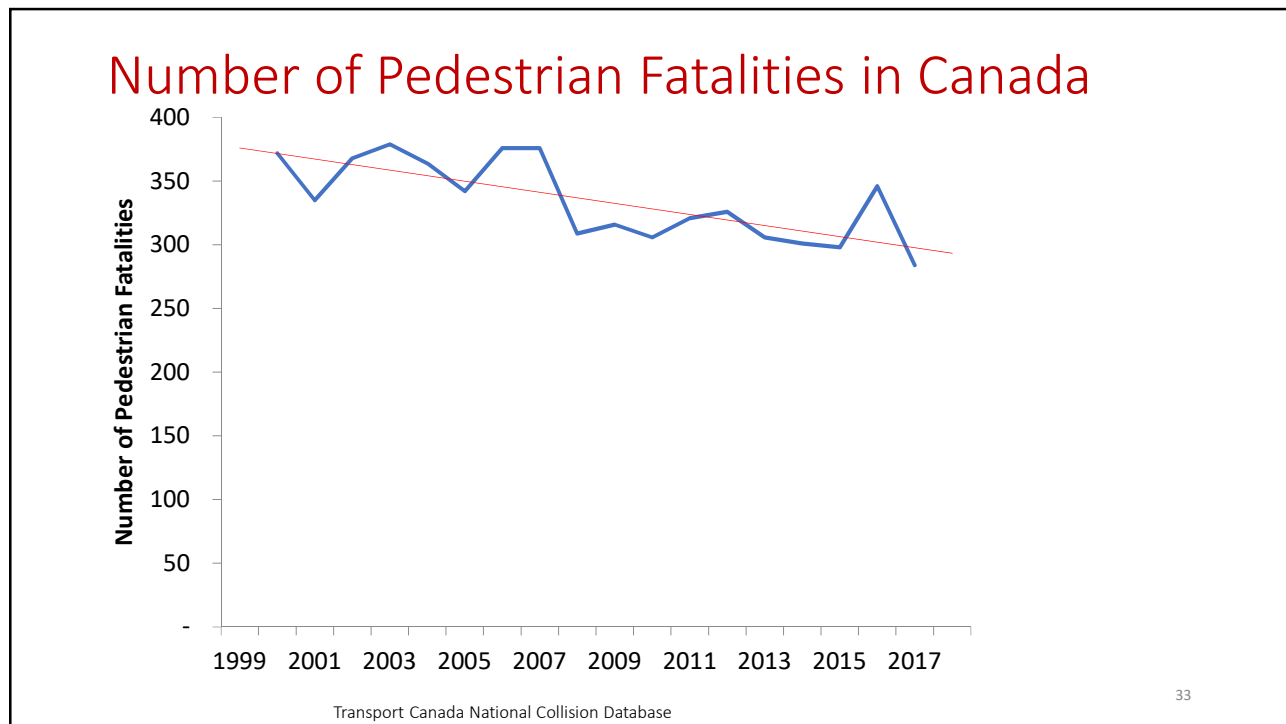
30



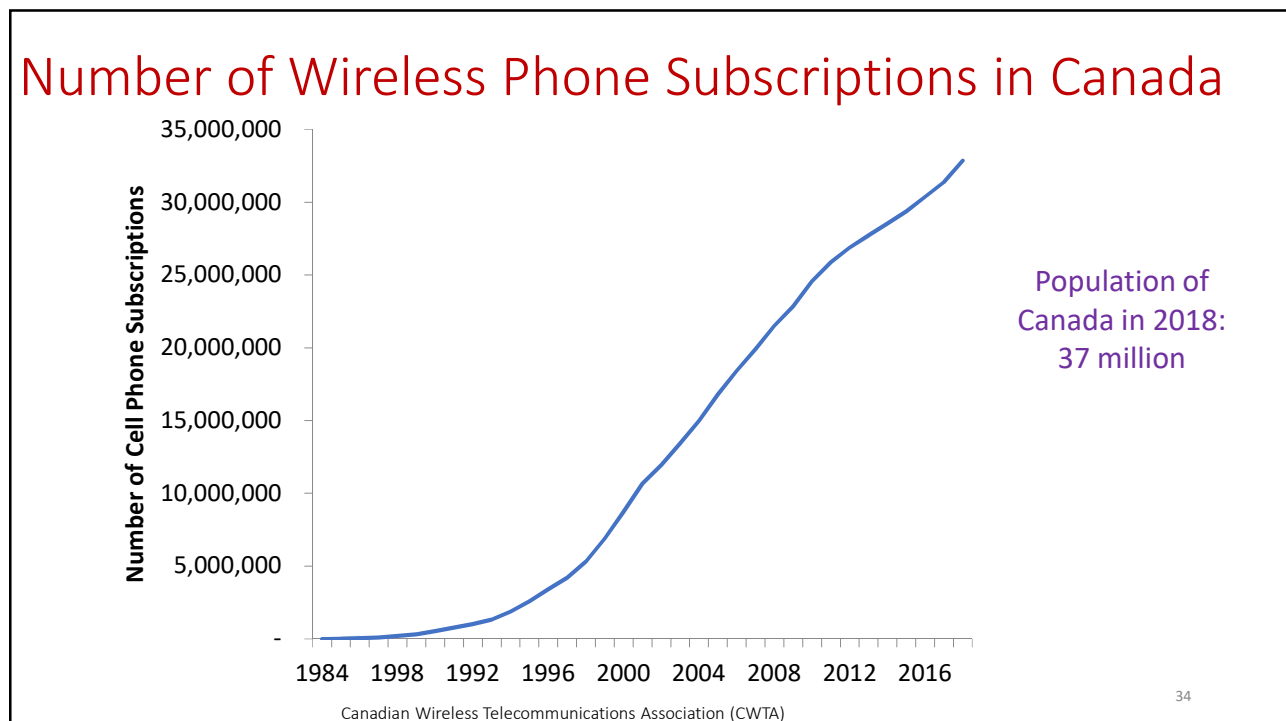
31



32



33



34

Summary

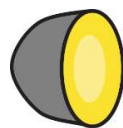
- Simply removing crosswalks will not improve safety
- Crosswalks can improve safety when applied correctly and when applied in combination with other countermeasures
- There are numerous ways to increase the percentage of driver yielding to pedestrians with speed reduction being a key component
- Distracted walking is correlated with unsafe walking behaviour however:
 - Campaigns to change behaviour require education combined with enforcement and implemented over time
 - The impact of cell phones on pedestrian safety is unclear

35

35

Contact Info

Maurice Masliah, Ph.D.
 Headlight Consulting Inc.
 t: 416-730-9744
 m: 647-701-9744
 headlightconsulting.ca
 mmasliah@headlightconsulting.ca



HEADLIGHT CONSULTING INC.

Human Factors & Road Safety

36

36