

# Designing for Pedestrian Safety

## Treatments at Unsignalized Pedestrian Crossings

Presented by:

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*PBIC Director*

**August 17, 2010**



# Crossing Crashes

## Part 1: General Principles

# Why do people cross the street?



Because there's someplace good on the other side

# People shouldn't have to run to cross a street



# People shouldn't have to run to cross a street



# Ideally, we'd always cross at locations with positive control



# But we can't provide signals everywhere people cross



# These people are not criminals...



They're simply trying to deal with a situation



# Pedestrian behavior varies: Some use crosswalks, others don't



# Principle # 1



**Pedestrians want & need to cross the street safely**

# Principle # 2



**Drivers need to understand pedestrians' intent**

# Principle # 3

## Keep Crossings Short

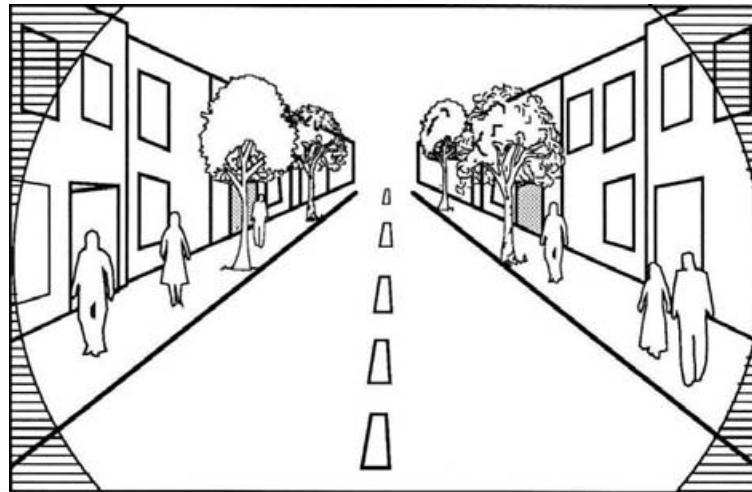
⇒ Impacts of long crossing distance:

- Increases exposure time
- Increases vehicle-pedestrian conflict
- Increases vehicle delay
- Decreases ability of slower pedestrians to cross



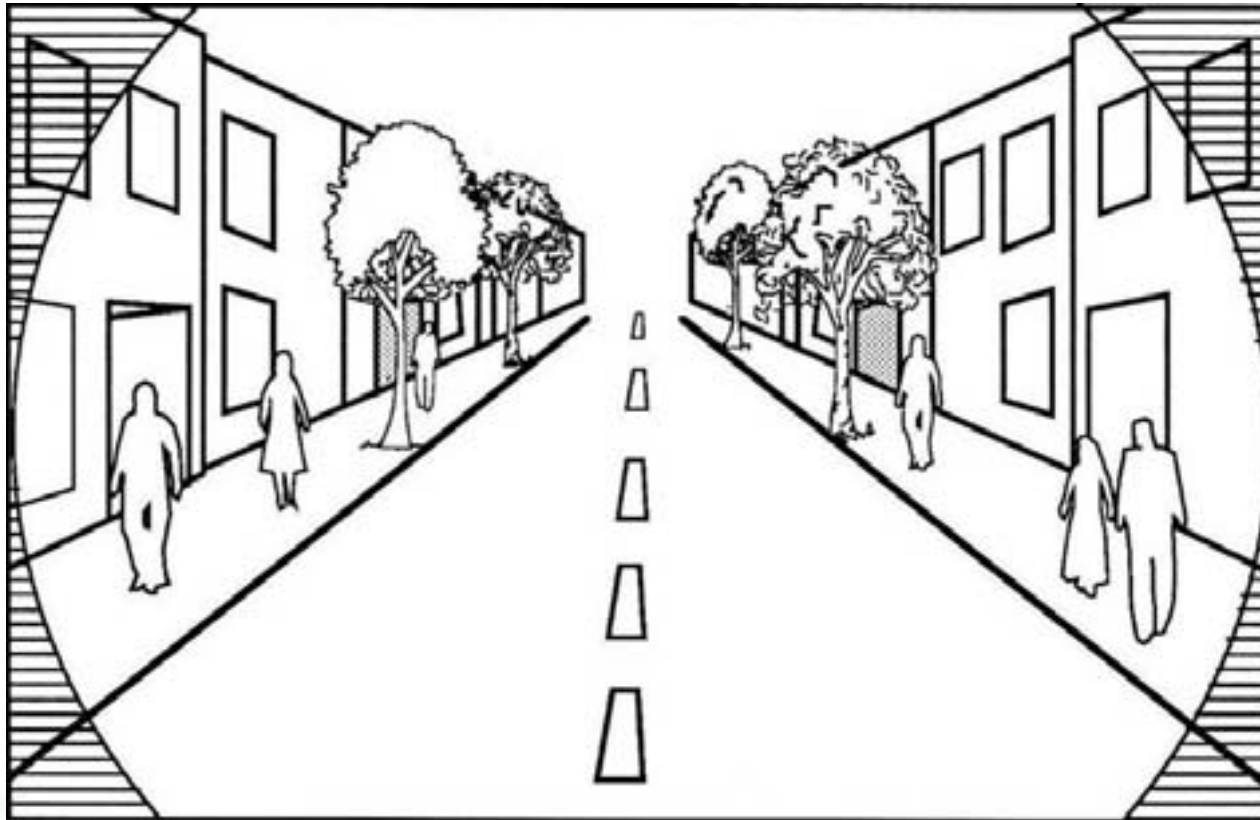
# Principle # 4: Speed Matters

1. Drivers' field of vision & ability to see pedestrians
2. Drivers' ability to react and avoid a crash
3. Crash Severity



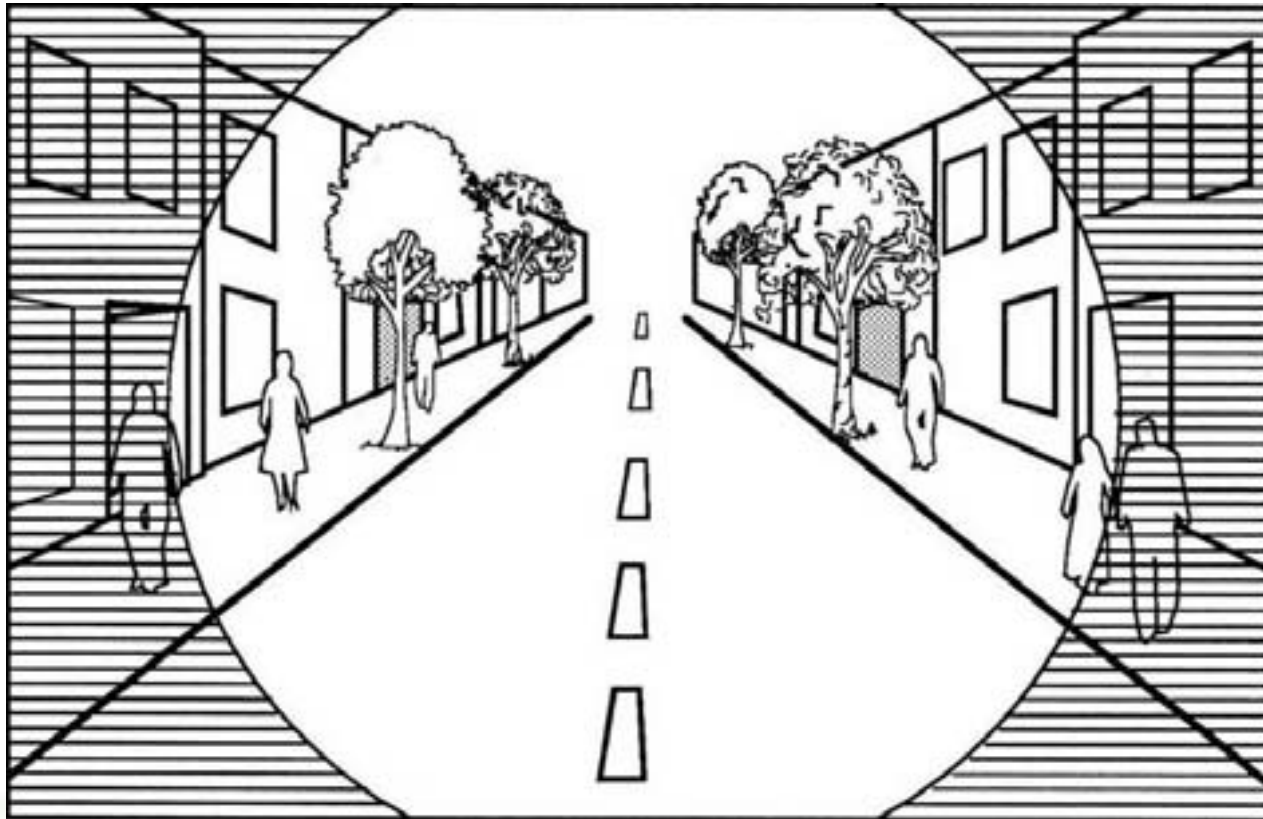
15 MPH

# As speed increases, driver focuses less on surroundings



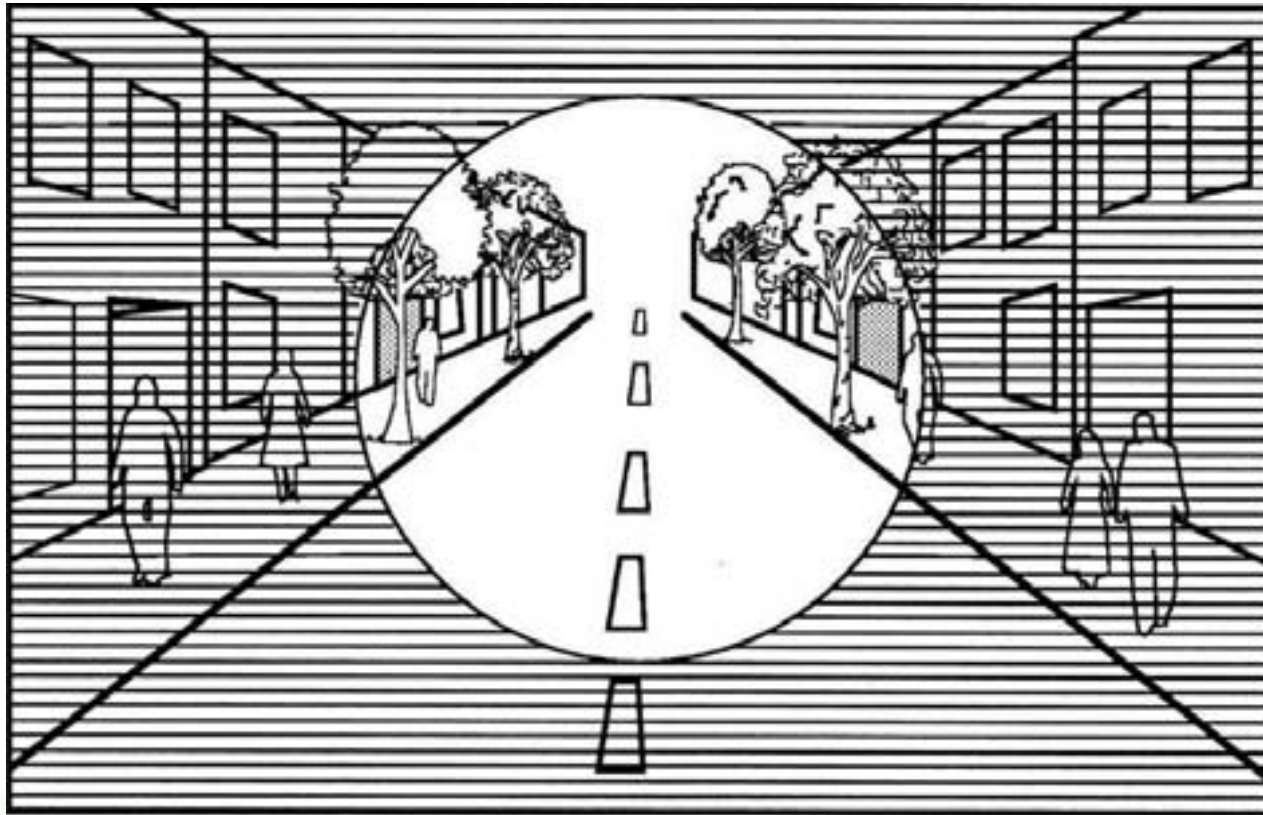
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# As speed increases, driver focuses less on surroundings



20 MPH

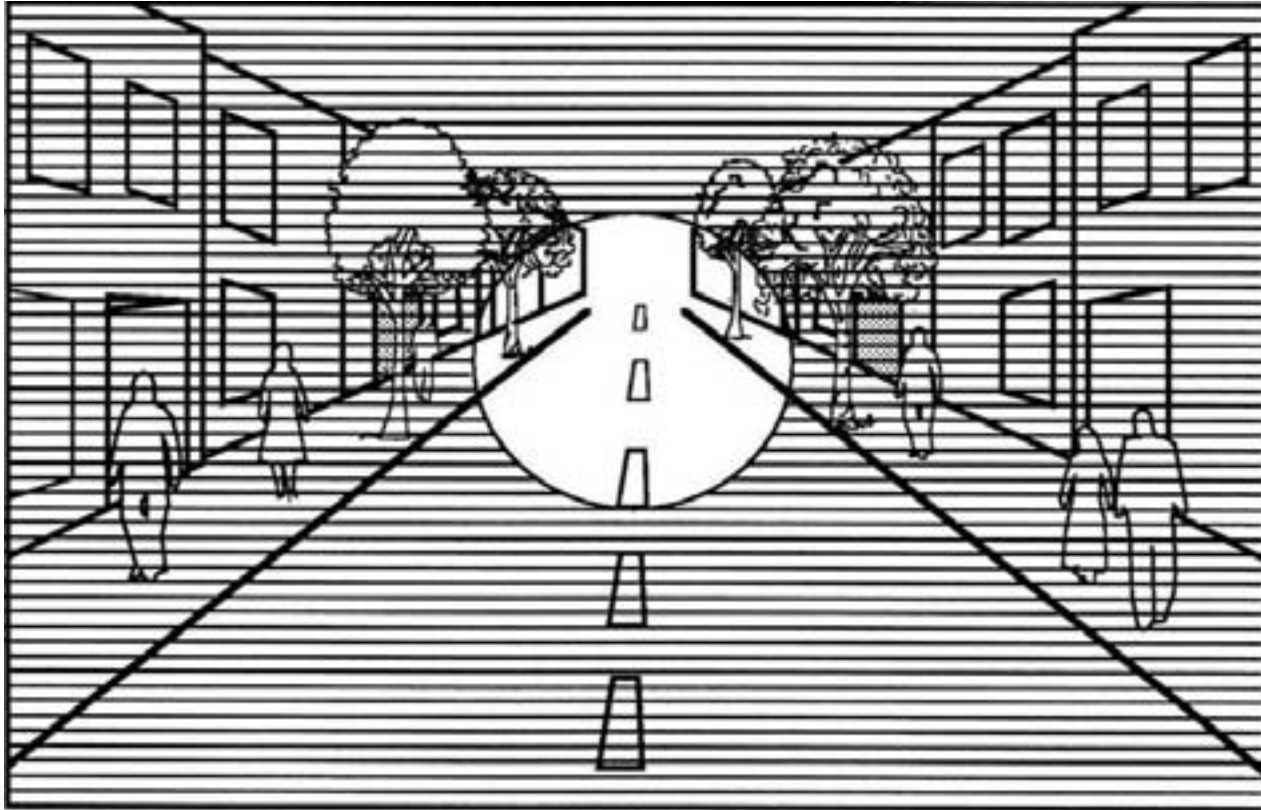
# As speed increases, driver focuses less on surroundings



25 MPH

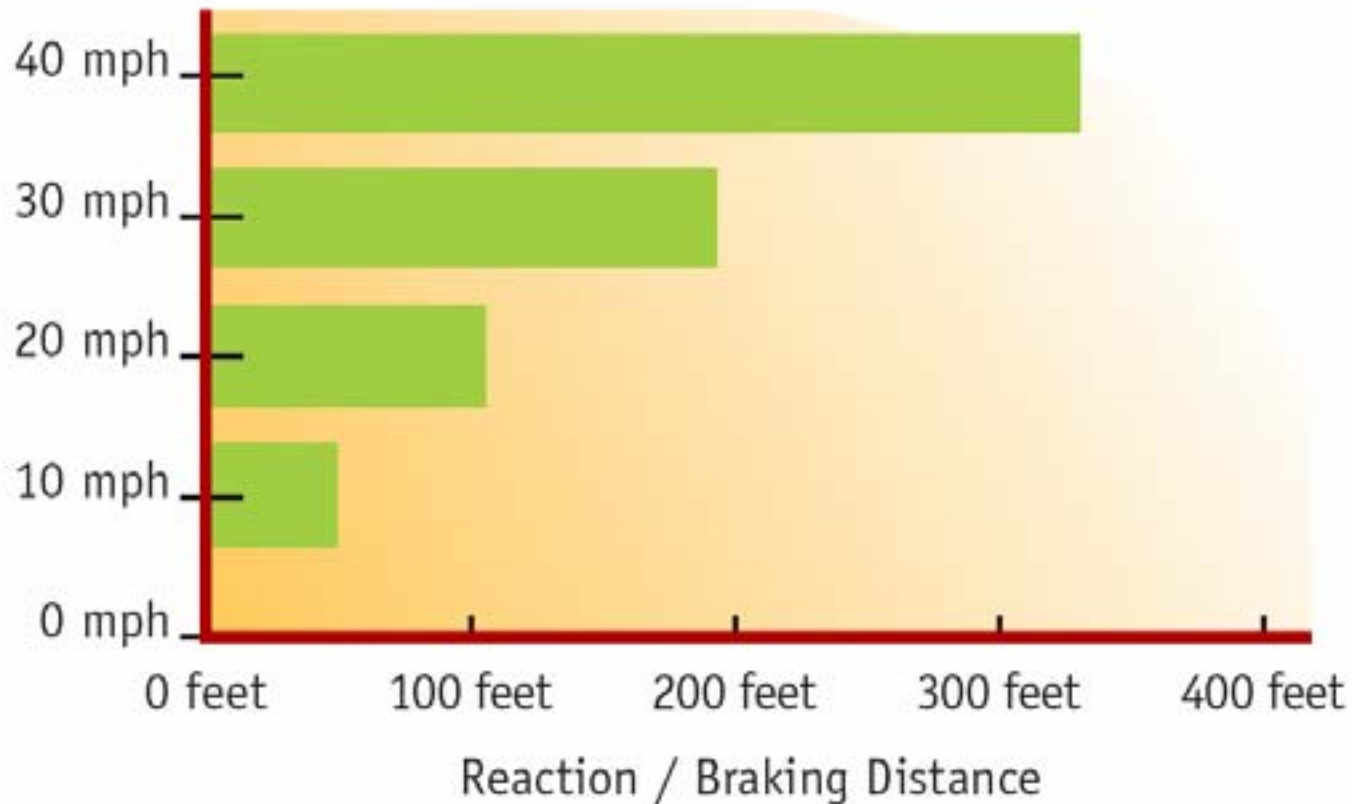


# As speed increases, driver focuses less on surroundings



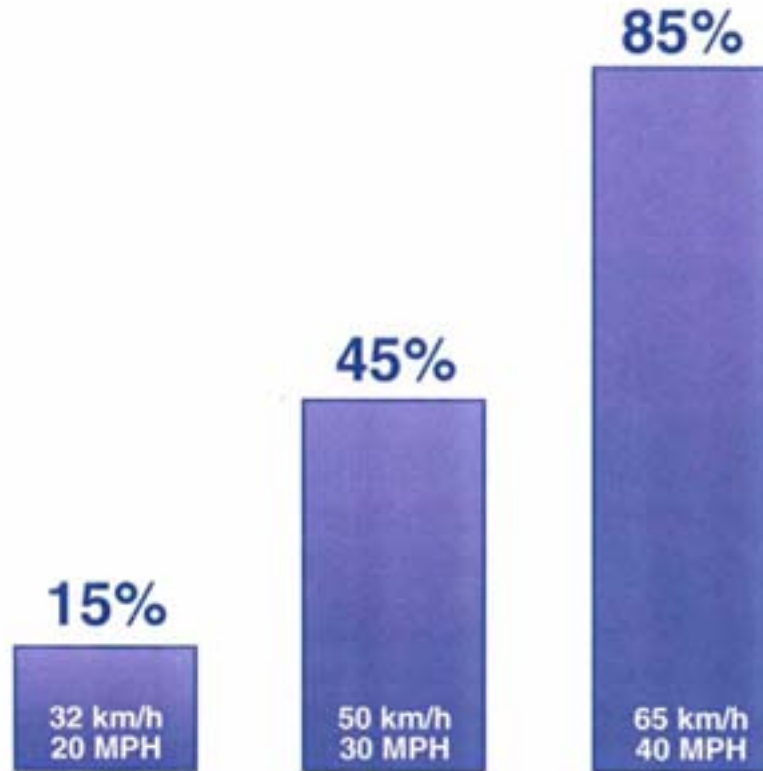
30 MPH

# Speed Affects Crash Avoidance



**High speeds equate to greater reaction and stopping distance**

# Speed Affects Crash Severity



Pedestrians' chances of death if hit by a motor vehicle  
SOURCE: *Killing Speed and Saving Lives*, UK Department of Transportation

**High speeds lead to greater chance of serious injury & death**

# Traffic-calming methods such as curb extensions help slow traffic



# Principle #5



**Pedestrians will cross where it's most convenient**

# Midblock vs. Intersection



- ⇒ People choose based on their perceived risk
- ⇒ The data is inconclusive

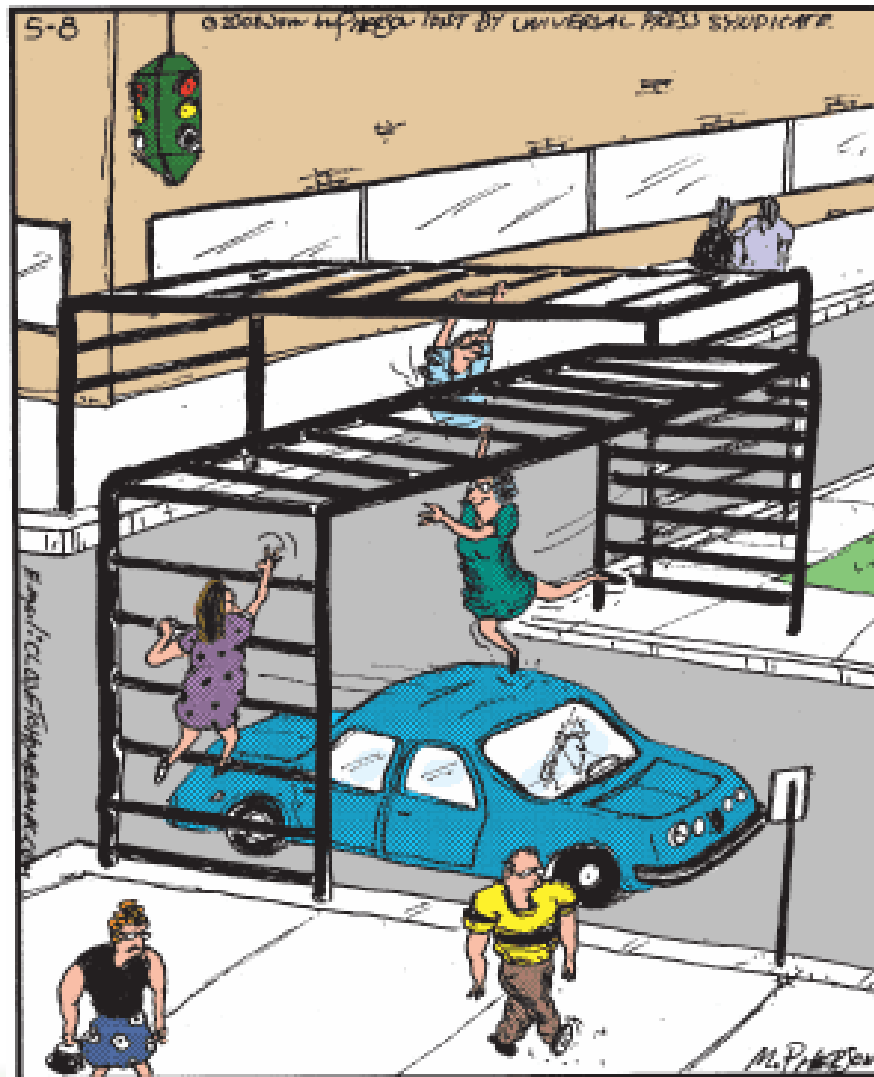
# Crossing Crashes

## Part 2: Countermeasures

# Basic Street Crossing Measures

- ⇒ **Crosswalks**
- ⇒ **Illumination**
- ⇒ **Signs**
- ⇒ **Striping**
- ⇒ **Medians/pedestrian islands**
- ⇒ **Signals**
- ⇒ **Over/undercrossings**





**Billgeville's new pedestrian monkey bars not only reduced accidents but also whipped people into great shape.**

# Crosswalks

## Crosswalk FAQ's:

- ⇒ Why are they marked?
- ⇒ Where should they be marked?
- ⇒ Do marked crosswalks increase safety, or provide a “false sense of security?”

# 1. Why are crosswalks provided?

- ⇒ To indicate to pedestrians where to cross
- ⇒ To indicate to drivers where to expect pedestrians



## 2. How to determine where to mark a crosswalk?



## **2. How to determine where to mark a crosswalk?**

### **MUTCD Guidance on Crosswalks (2009):**

- ⇒ **Crosswalk markings provide guidance for pedestrians who are crossing roadways by defining and delineating paths on approaches to and within signalized intersections, and on approaches to other intersections where traffic stops.**
- ⇒ **In conjunction with signs and other measures, crosswalk markings help to alert road users of a designated pedestrian crossing point across the roadway at locations that are not controlled by traffic control signals or STOP or YIELD signs. Crosswalk lines should not be used indiscriminately.**
- ⇒ **An engineering study should be performed before a marked crosswalk is installed at a location away from a traffic signal or an approach controlled by a STOP or YIELD sign.**

## 2. How to determine where to mark a crosswalk?



⇒ Consider origins and destinations

⇒ In this case, apartments across from bus stop & stores

# Many Locations are not Suitable for a Marked Crosswalk

# Not a good location for a marked crosswalk:



**No particular reason for driver to expect pedestrians**



# Not a good location for a marked crosswalk:



Poor sight distance

# Many Locations are Suitable for a Marked Crosswalk

# Suitable location for a marked crosswalk:



**Two-lane, high use, driver expectancy**

# Suitable location for a marked crosswalk:



**Slow speed, high use, driver expectancy**

### 3. Do marked crosswalks increase safety, or encourage people to cross without looking?



# Results of Most Recent Study (Zegeer et al 2002)

## Marked vs. Unmarked Analysis

- ⇒ Two-lane roads: No significant difference in crashes
- ⇒ Multilane roads (*3 or more lanes*)
  - Under 12,000 ADT: no significant difference in crashes
  - Over 12,000 ADT w/ no median: crashes marked > crashes unmarked
  - Over 15,000 ADT & w/ median: crashes marked > crashes unmarked



# Study Results

- ⇒ Median reduces crashes by 40%
- ⇒ Pedestrians over 65 are over-represented in crosswalk crashes
- ⇒ Pedestrians are not less vigilant in marked crosswalks:
  - *Looking behavior increased after crosswalks installed*



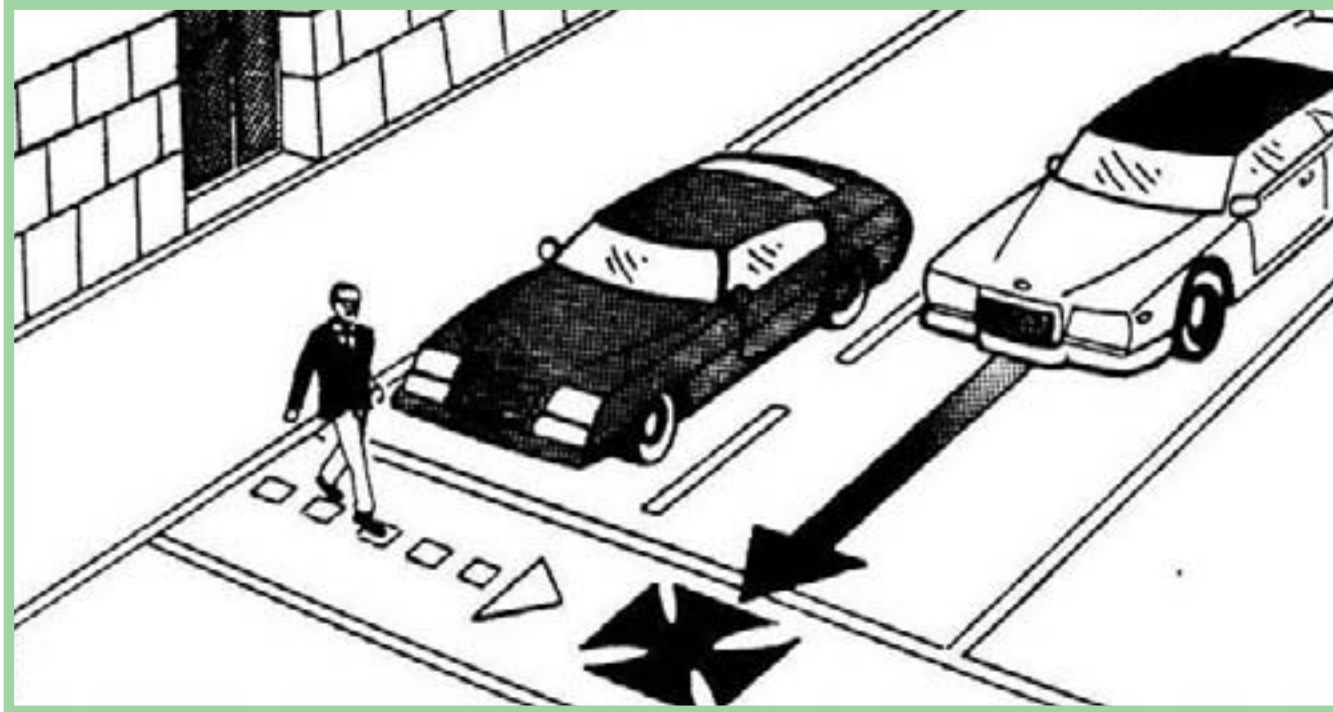
# Study Results



- ⇒ Crashes correlate with ADT & number of travel lanes.
- ⇒ Other studies have shown same results



# One explanation of higher crash rate at marked crosswalks: multiple-threat crash



- ⇒ 1st car stops too close, masks visibility for driver in 2nd lane
- ⇒ Solution: advance stop bar (comes later...)

# Study Recommendations

1. OK to mark crosswalks on 2-lane roadways
2. On multi-lane roadways, marked crosswalks alone are not recommended on roadways with:
  - ADT > 12,000 w/o median
  - ADT > 15,000 w median\*
  - Speeds greater than 40 mph
3. Use raised medians to reduce risk
4. Signals or other treatments should be considered where many young and/or elderly pedestrians

⇒ *Note: effect of advance stop bar not studied (none at any observed sites)*

# Change to 2009 MUTCD

⇒ ***“New marked crosswalks alone, without other measures designed to reduce traffic speeds, shorten crossing distances, enhance driver awareness of the crossing, and/or provide active warning of pedestrian presence, should not be installed across uncontrolled roadways where the speed limit exceeds 40 mph and either:***

***A. The roadway has four or more lanes of travel without a raised median or pedestrian refuge island and an ADT of 12,000 vehicles per day or greater;***

***or***

***B. The roadway has four or more lanes of travel with a raised median or pedestrian refuge island and an ADT of 15,000 vehicles per day or greater.”***



# Increase Effectiveness Of Crosswalks With:

- ⇒ Proper location
- ⇒ High Visibility Markings
- ⇒ Illumination
- ⇒ Signing
- ⇒ Advance Stop Bars
- ⇒ Median Islands
- ⇒ Curb Extensions
- ⇒ Signals

# Key Quotes from the Study Conclusion

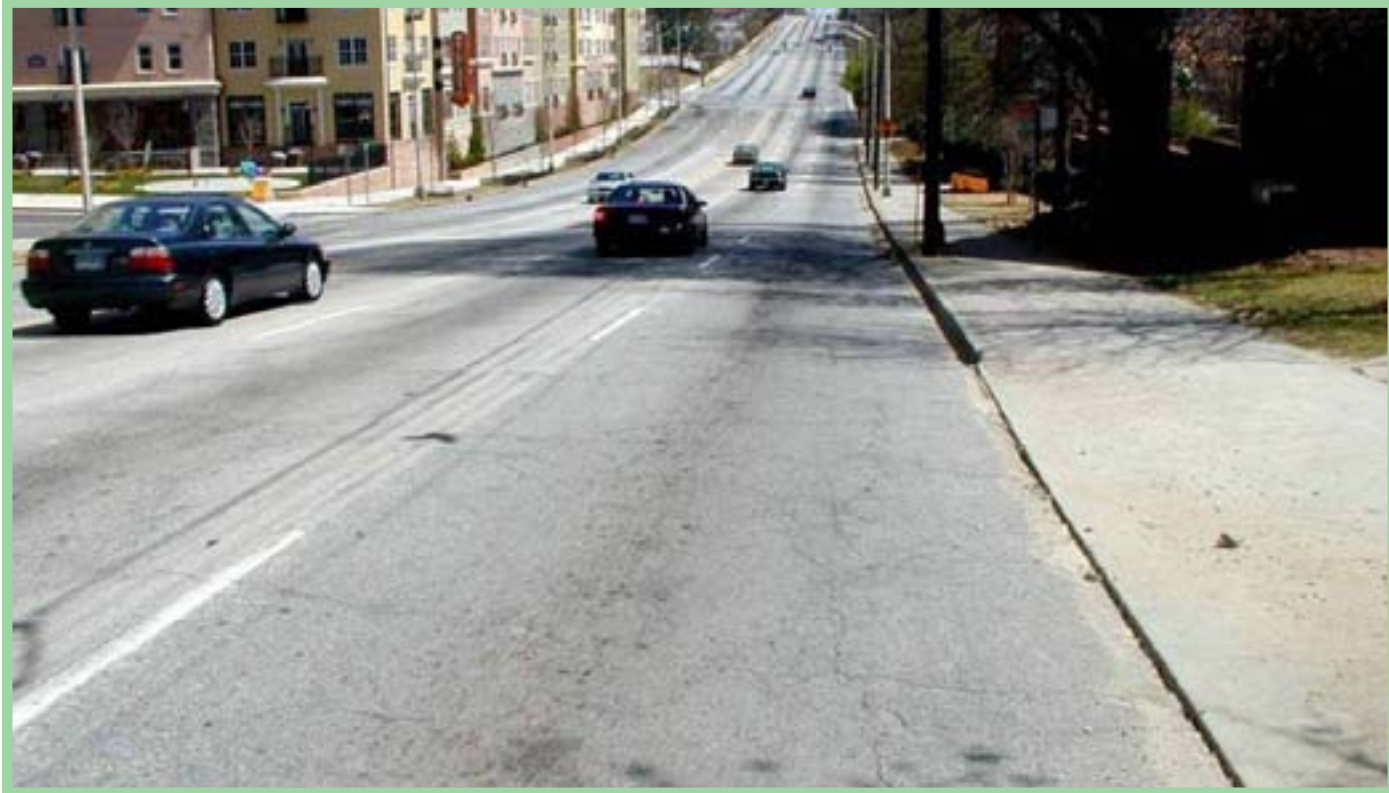
- ⇒ **“When considering marked crosswalks at uncontrolled locations, the question should not be simply, “Should I provide a marked crosswalk or not?” ...**
- ⇒ **“Regardless of whether marked crosswalks are used, there remains the fundamental obligation to get pedestrians safely across the street. In most cases, marked crosswalks are best used in combination with other treatments (e.g., curb extensions, raised crossing islands, traffic signals, roadway narrowing, enhanced overhead lighting, traffic calming measures)....”**
- ⇒ **“In all cases, the final design must accomplish the goal of getting pedestrians across the road safely....”**
- ⇒ **“The design question is, “How can this task [getting pedestrians across the road safely] best be accomplished?”**

# Marked crosswalk must be visible to the DRIVER



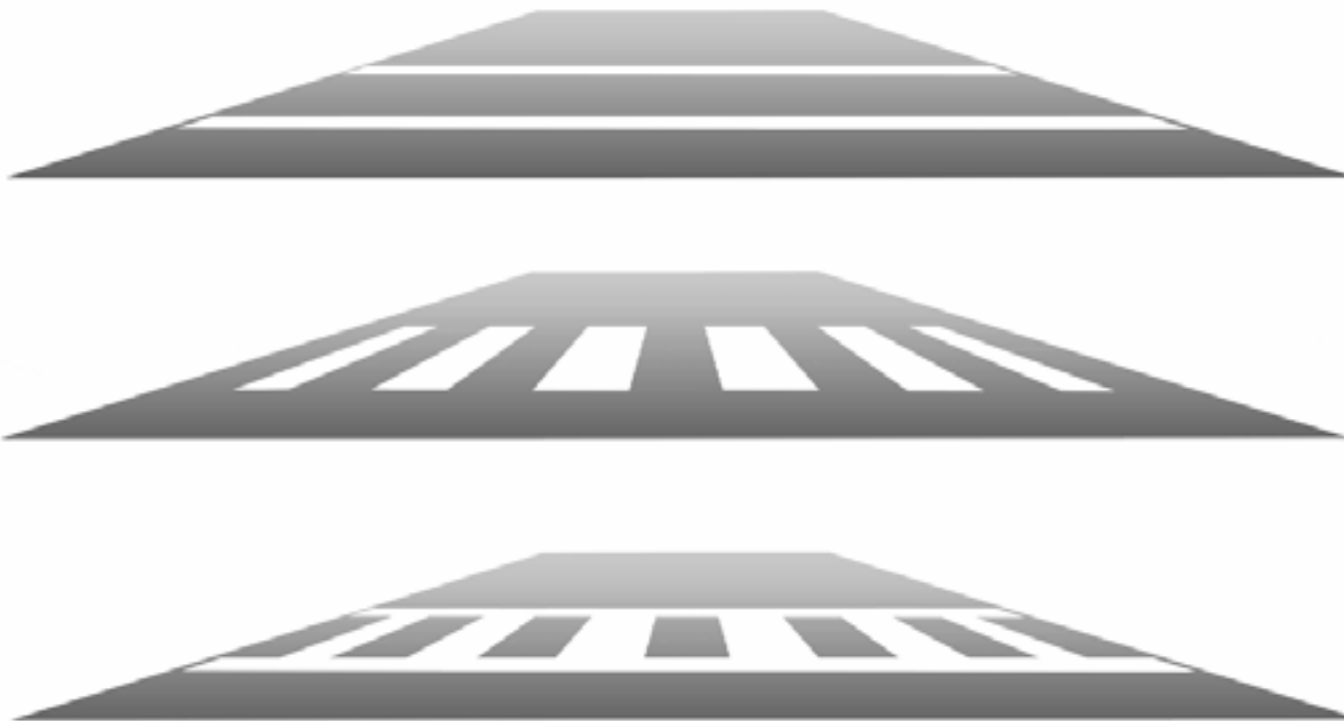
What the pedestrian sees

# Marked crosswalk must be visible to the DRIVER



What the driver sees (*same crosswalk*)

# Crosswalk Visibility



## Crosswalk Marking Types



# Longitudinal markings with transverse markings – very visible



# Place longitudinal markings placed to avoid wheel tracks, reducing wear & tear & maintenance



# Staggered ladder improves visibility from afar

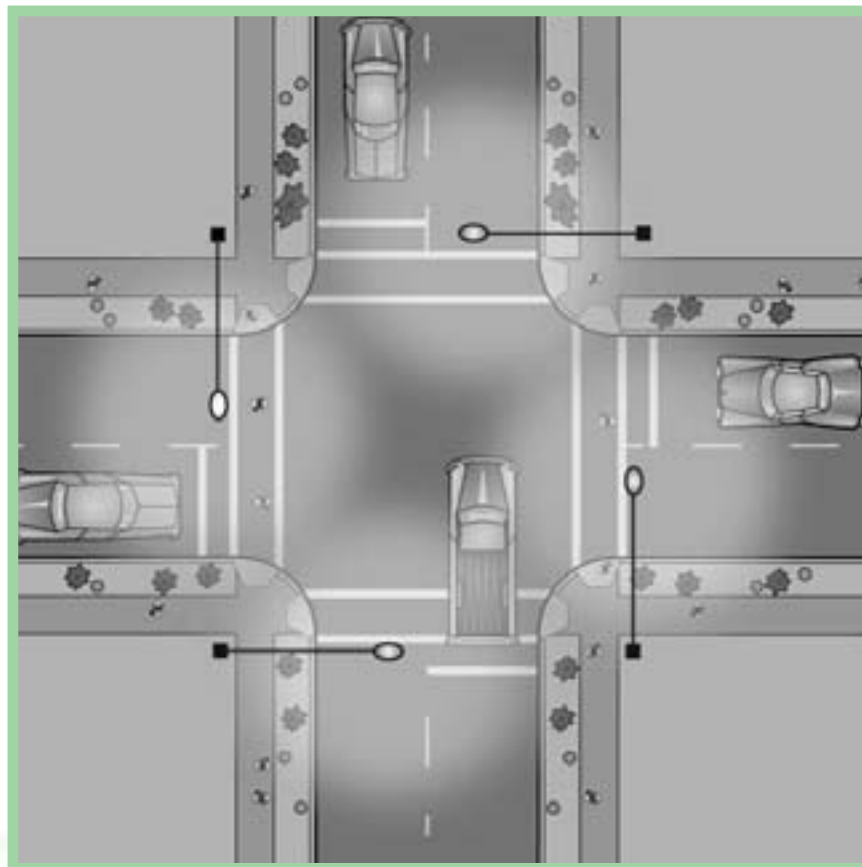




# Illumination – Essential For Any Crossing

Marked crosswalk?

- ⇒ Light it.
- ⇒ Up to 50% of ped crashes occur at night



# Illumination!



**Lighting reduces the odds of pedestrian fatalities:**

⇒ **by 42% at midblock locations**

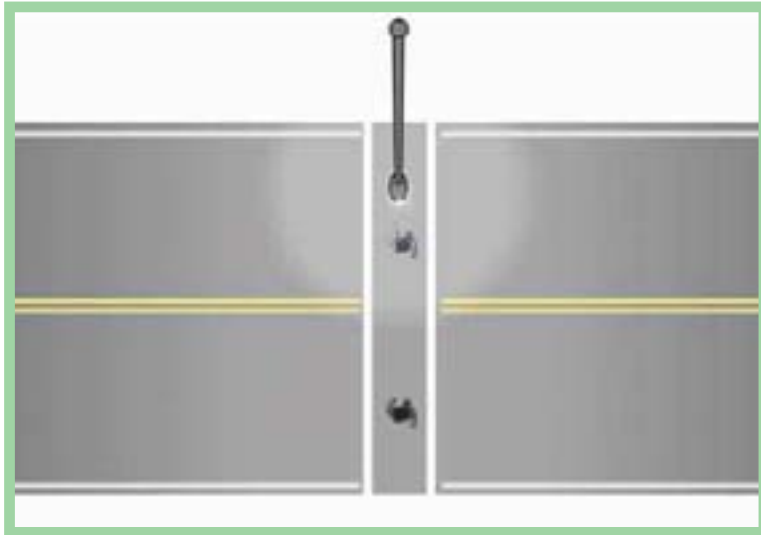
⇒ **by 54% at intersections**

# Informational Report on Lighting Design for Midblock Crosswalks

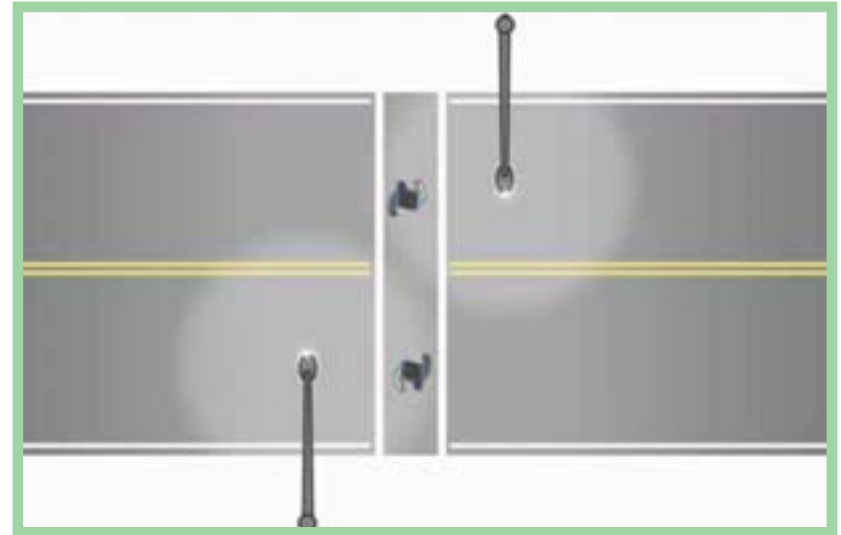
**FHWA-HRT-08-053**  
**April 2008**



# Sample Illustrations from New FHWA Report



**Fig 11. Traditional midblock crosswalk lighting layout**

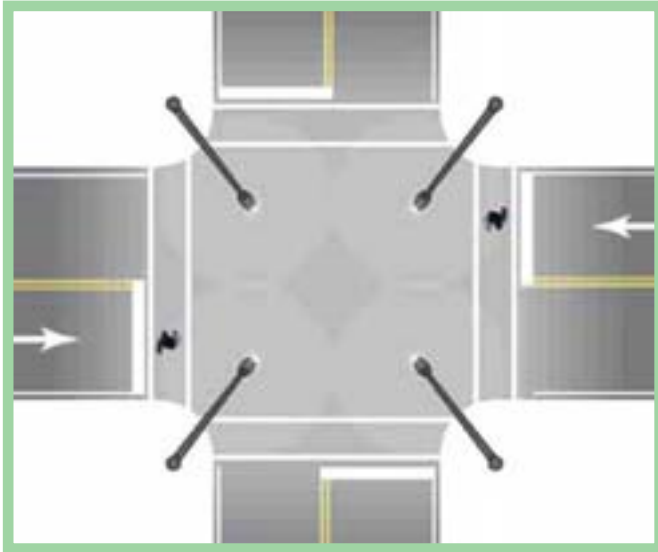


**Fig 12. New design for midblock crosswalk lighting layout**

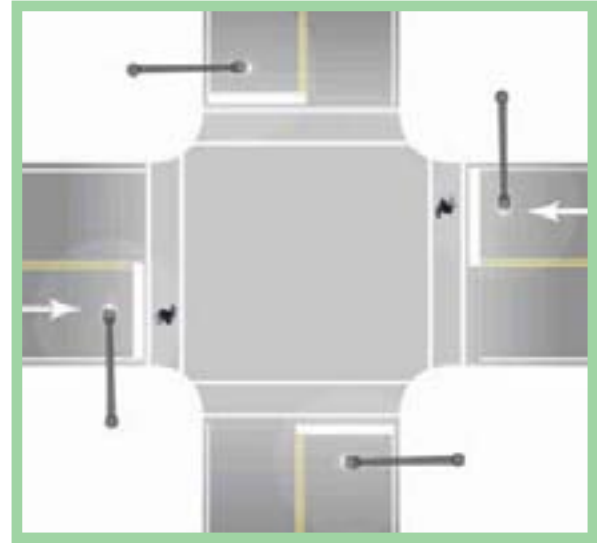
**Recommended lighting level: 20 lux at 5' above pavement**

**Available at <http://www.tfhrc.gov/safety/pubs/08053/08053.pdf>**

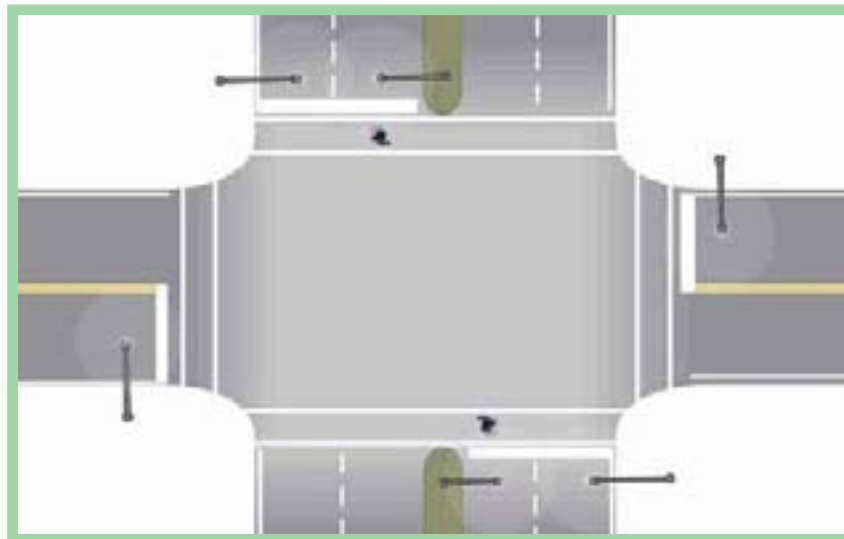




**Fig 13. Traditional intersection lighting layout**



**Fig 14. New design for intersection lighting layout for crosswalks.**



**Fig 15. New design for wide roadway intersection lighting layout for crosswalks**

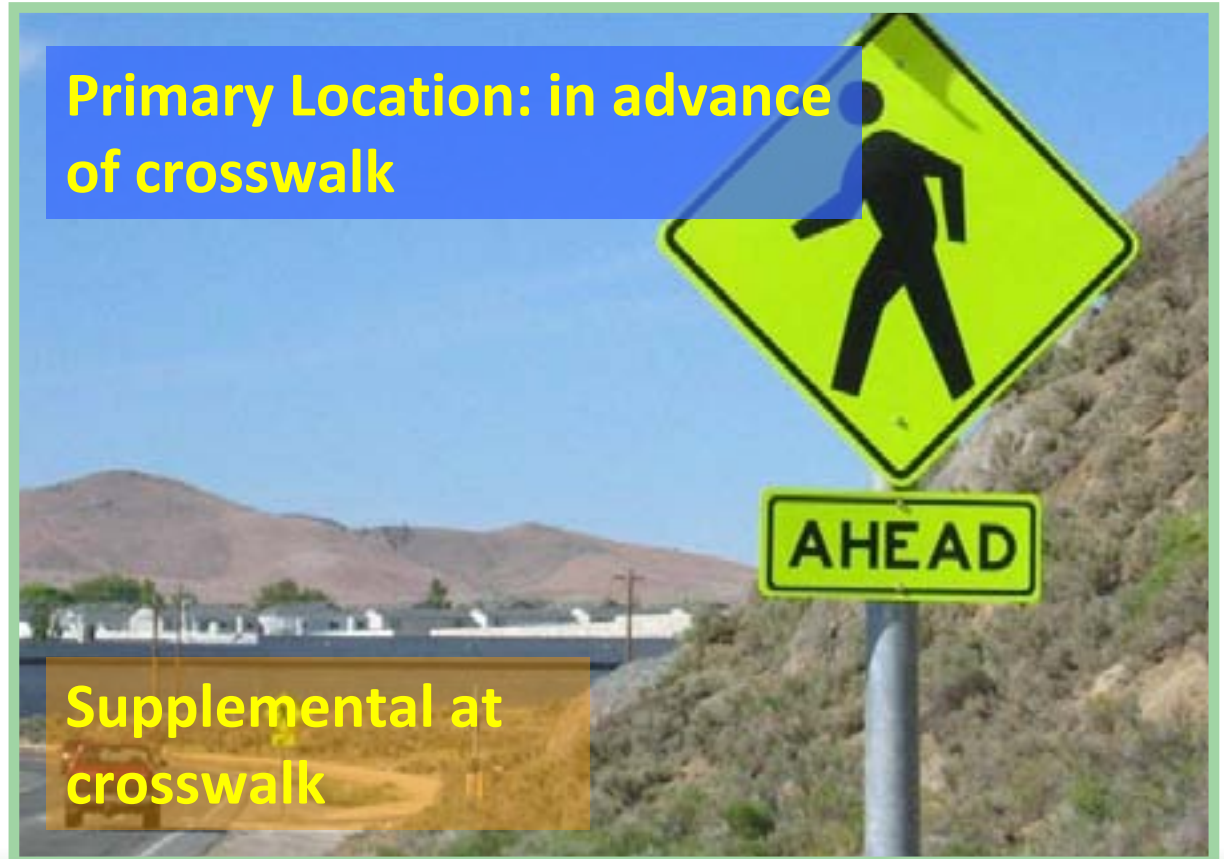
# Ped crossing signs: old vs. new MUTCD standards



Old

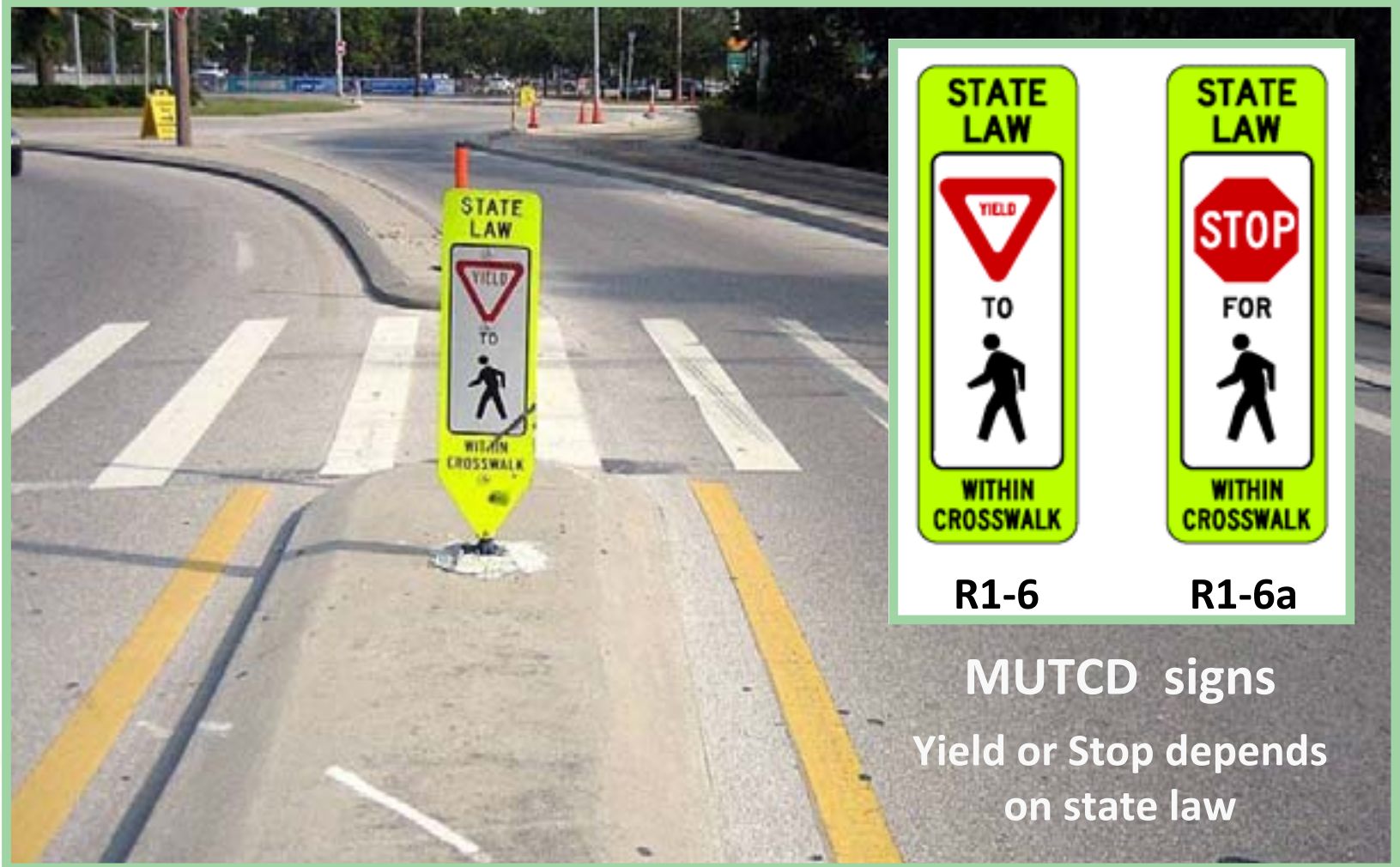


New



Placement

# In-street pedestrian crossing signs



R1-6



R1-6a

MUTCD signs

Yield or Stop depends on state law

# In-street signs increase yield rates, especially on slow-speed streets



# Rectangular Rapid Flash LED Beacon

- ⇒ Received Interim approval to MUTCD with separate warrants for use
- ⇒ Studies indicate motorist yield rates increased from about 20% to 80%
- ⇒ Beacon is yellow, rectangular, and has a rapid “wig-wag” flash
- ⇒ Beacon located between the warning sign and the arrow plaque
- ⇒ Must be pedestrian activated (pushbutton or passive)



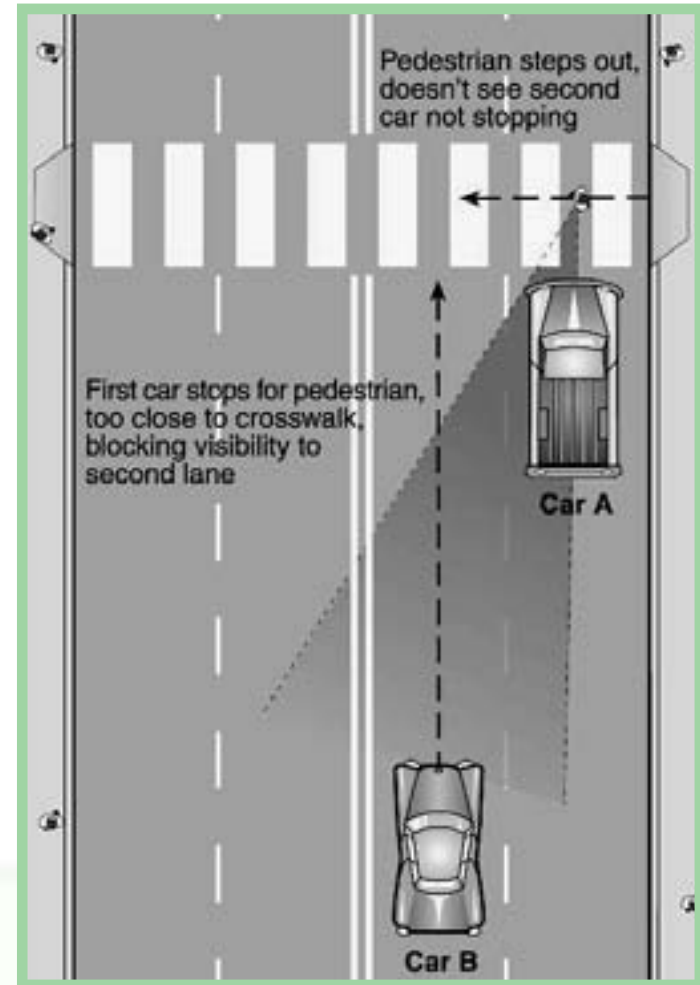
# Beacons required on the both right side and on the left side or in a median if practical



# Advance Stop or Yield Line: Reduces Multiple-threat Crashes

# Multiple Threat Crash Problem

- ⇒ 1st car stops to let pedestrian cross, blocking sight lines
- ⇒ 2nd car doesn't stop, hits pedestrian at high speed

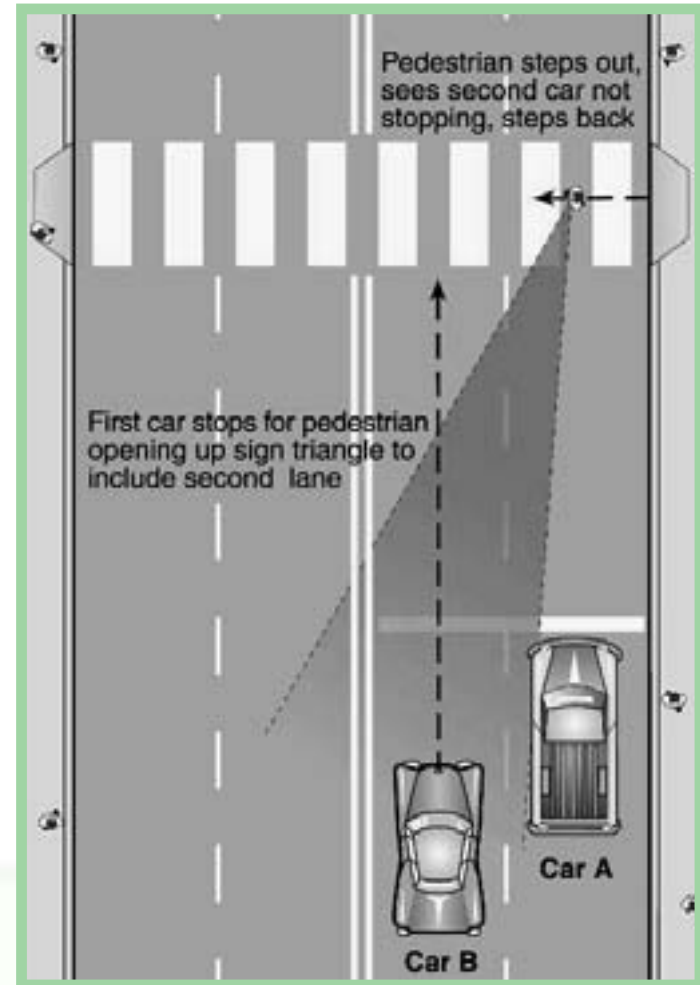




# Multiple Threat Crash Solution

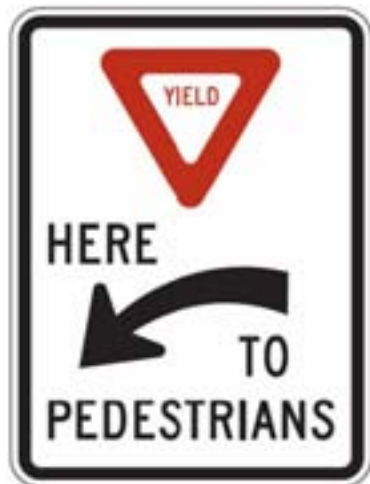
## Advance stop/yield line

- ⇒ 1st car stops further back, opening up sight lines
- ⇒ 2nd car can be seen by pedestrian





R1-5



R1-5a

**Signs in the 2003 MUTCD  
(Use where local law says yield  
to pedestrians)**



R1-5b



R1-5c

**Signs in the 2009 MUTCD  
(Use where local law says stop  
for pedestrians)**

# Advanced yield line (shark's teeth) & sign



# Advanced stop line and sign



# MUTCD recommends 20' to 50' setback 30' preferred for maximum effectiveness



# Marking a Crosswalk Summary

⇒ **When is it OK to mark a crosswalk without other treatments?**

- 2-lane roads < 40 mph
- Multi-lane roads w/ ADT < 12,000 or 15,000 (median)

⇒ **How can you increase the effectiveness of marked crosswalks?**

- **Marked crosswalk: Add median, advance stop line**
- **Textured crosswalks: Smooth and white is best**
- **Signs: In road; supplement with striping**
- **In all cases (nighttime): Illumination!**

# **Raised Medians And Islands Reduce Pedestrian Crashes:**

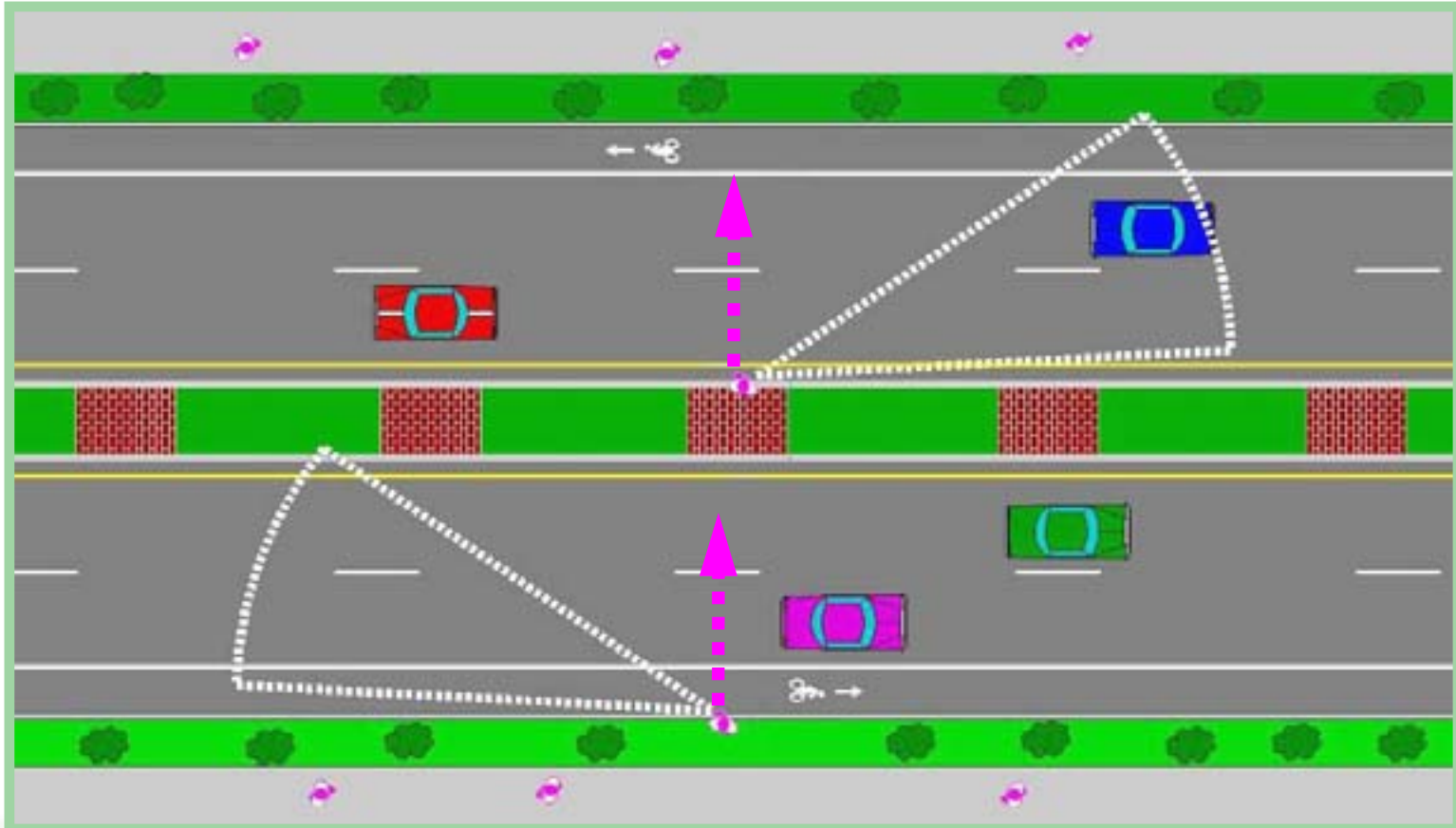
## **⇒ At marked crosswalks**

- **CRF = 46%**

## **⇒ At unmarked crosswalks**

- **CRF = 39%**

# Continuous raised median – basic principle:



Breaks long complex crossing into two simpler crossings



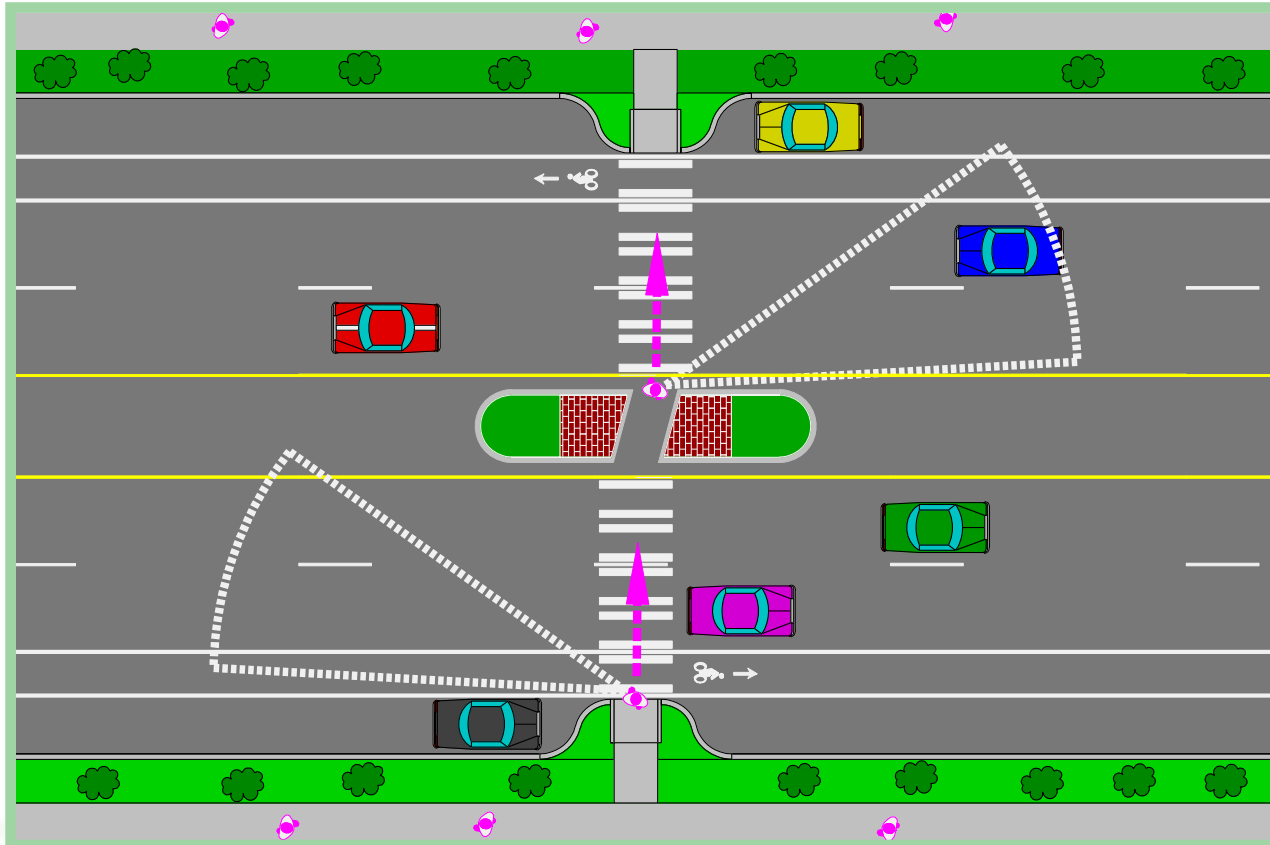
# A flush median is not a refuge



# Add a raised island



# Crossing island at marked crosswalk - same principle:



Breaks long complex crossing into two simpler crossings

# Option:



⇒ stagger or angle cut-through so pedestrians face oncoming traffic before 2nd crossing

# Pedestrian Signal

# Now easier to meet pedestrian volume warrant



# Provide a HOT response



Otherwise pedestrians won't wait for the light

# If wait is too long, pedestrians will seek gaps





# And then traffic waits for no reason



# Pedestrian Signal

**2-stage crossing increases effectiveness  
and disrupts traffic less**

# Stage 1: Pedestrian stops traffic in one direction



# Stage 1: Pedestrian crosses to median island



# Stage 1 over: Traffic in one direction resumes



# Stage 2: Pedestrian stops traffic in other direction



# Stage 2 over: Traffic resumes



# Detail 1: Requires pedestrian push button on island





# Detail 2:

Fences force pedestrians to walk against on-coming traffic



# Pedestrian Hybrid Beacon aka “HAWK” (High Intensity Activated Crosswalk)



# Drivers see Hybrid Beacon



**Peds see Pedhead**

# Hybrid Beacon Sequence



**1**  
Blank for  
drivers



**4**  
Steady red



**2**  
Flashing  
yellow



**5**  
Wig-Wag



**3**  
Steady  
yellow



Return  
to 1



# Over & Undercrossings

# In theory, grade separation = no conflicts



# In reality, pedestrians often ignore structures



Placing themselves in greater danger

# Sometimes fences are needed to direct users





# Grade separation

⇒ Grade separation is more useful for purposes beyond simply crossing from sidewalk to sidewalk



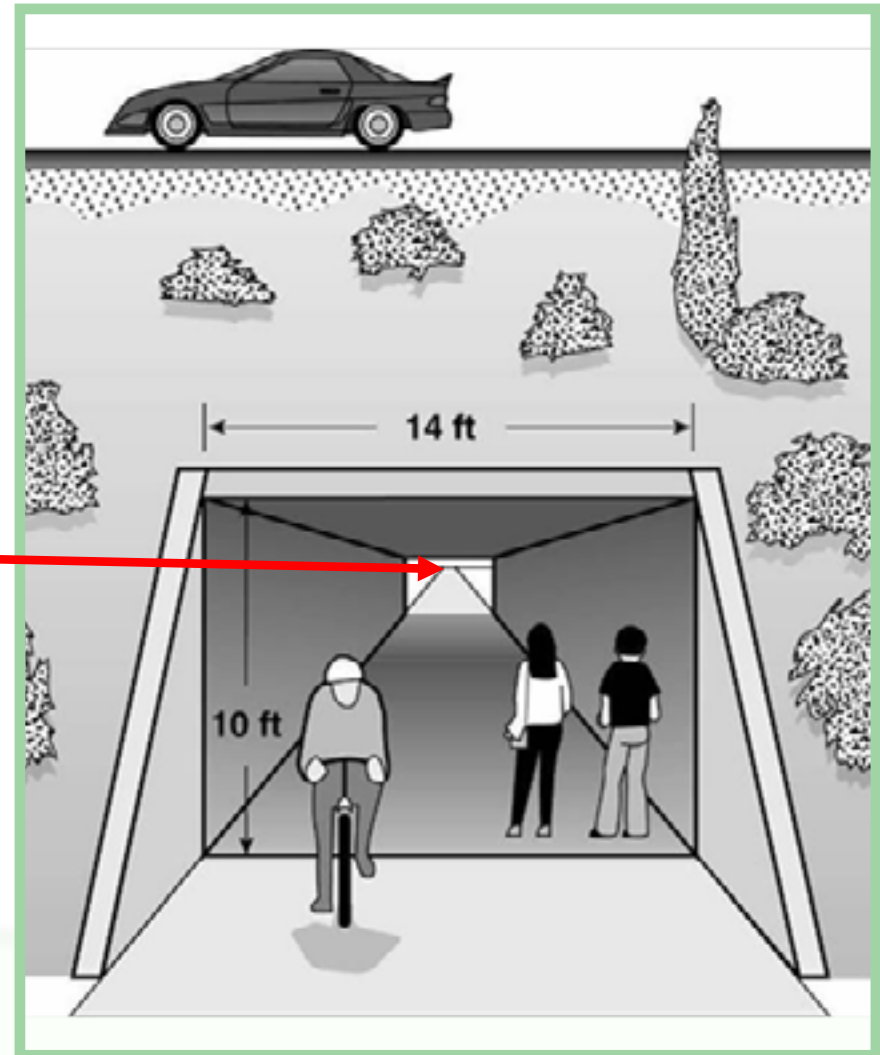
# Overcrossings



⇒ **Overcrossings are expensive because of their height, which requires long ramps**

# Undercrossings

- ⇒ Undercrossings require generous dimensions to be attractive: security is the main issue
- ⇒ Users must see light at the end of the tunnel



# Undercrossing must not intimidate potential user



# Elevated roadway allows open, airy undercrossing



# Undercrossings work best if well lit & attractive



# **Over/undercrossings should be a last resort**

## **⇒ Why are they not effective for street crossings?**

- They add out-of-direction travel

## **⇒ When are they useful?**

- To connect land uses separated by a major roadway

## **⇒ How can you increase their effectiveness?**

- By providing a direct route
- By providing security

# Crossing treatments cost comparison:

Treatment	Cost	Effectiveness
Signing	\$500 – 1,000	*
High visibility markings	\$2,000 – 15,000	**
Advance stop bars	\$1,000 – 2,000	****
Illumination	\$5,000 – 15,000	****
Median Islands	\$10,000 – 30,000	****
Signals	\$35,000 – 150,000	***
Over/undercrossings	\$500,000 – 2,000,000	*
Proper location	“Priceless”	*****

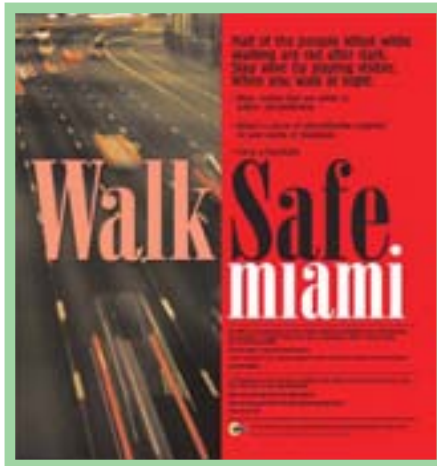


# “Right design invites right use”

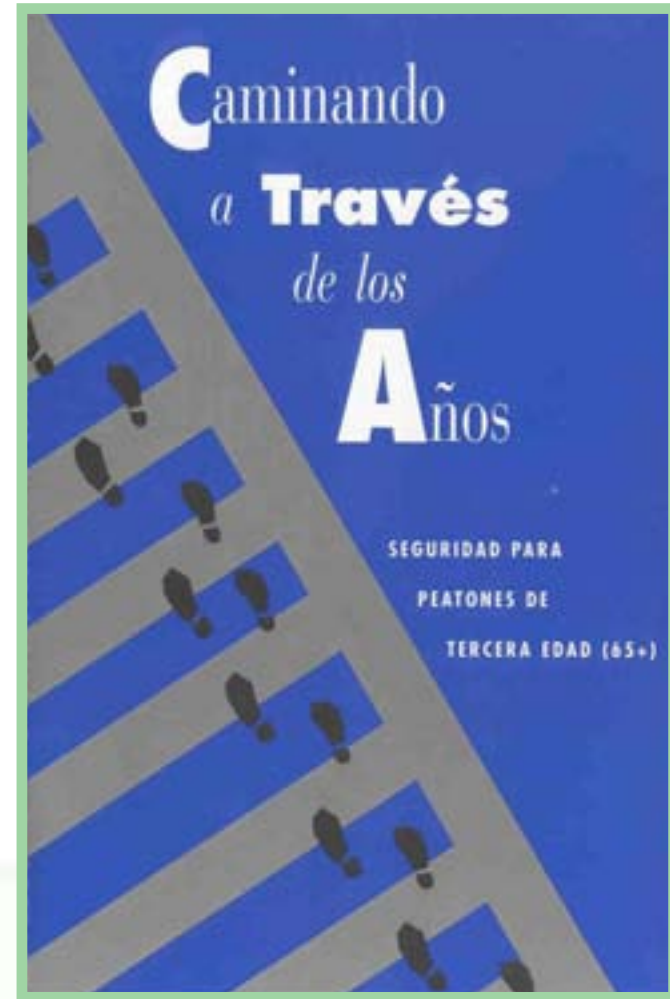
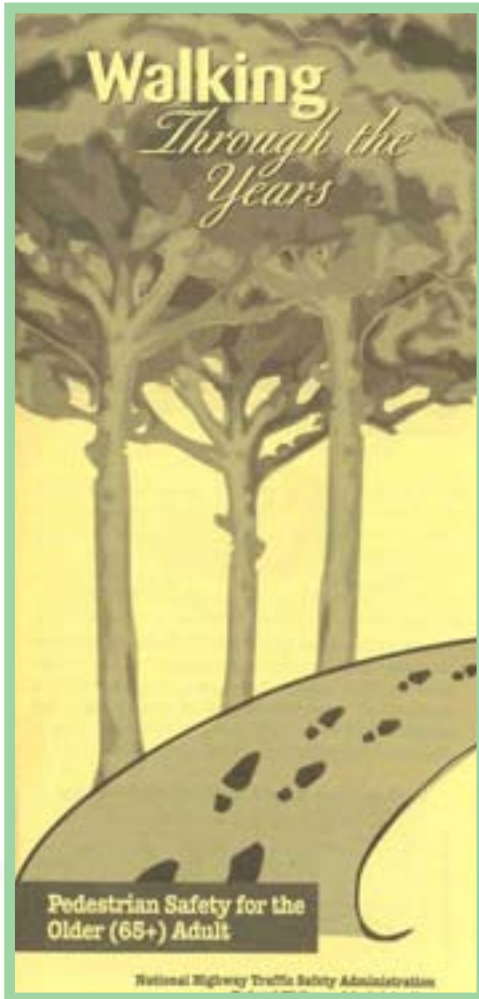




# Education: Transit Riders



# Education: The Elderly



# Driver Education & Enforcement



# Questions?

# Thank You!

## ⇒ Additional Resources

- Engineering solutions: <http://www.walkinginfo.org/engineering>
- FAQs: <http://www.walkinginfo.org/faqs>, subject heading “engineering”
- 2- and 3-day Training courses: “Designing and Planning for Pedestrian Safety”  
<http://www.walkinginfo.org/training>

## ⇒ Next PBIC Livable Communities Webinar:

- “Community Approaches to Pedestrian Safety Education”  
Thursday, March 18, 2-3:30pm ET  
Register at <http://www.walkinginfo.org/webinars>
- Archive at <http://www.walkinginfo.org/webinars>  
Downloadable and streaming recording, transcript, presentation slides

## ⇒ Questions?

- Call Jeremy Pinkham, UNC Highway Safety Research Center, 919-843-4859
- Write to [webinars@hsrc.unc.edu](mailto:webinars@hsrc.unc.edu)