Signalized Intersections

Learning Outcomes

At the end of this module, you will be able to:

1. Explain why traffic signals don’t “guarantee” safety: *they assign the right of way*
2. Identify major conflicts: *concurrent turn movements*
3. Select *protected turns* to improve ped safety
4. Identify signal timing techniques that *favor ped crossings*
Traffic signals assign the right of way, regulate the flow of traffic and create gaps.

Traffic signals do not guarantee safety - in fact, signalized intersections have more crashes than non-signalized.

Signalized Intersections May Be Improved For Pedestrians By:

1. *Using good geometric design*
2. *Placing islands to break up complex crossings*
3. *Placing crosswalks in logical locations*
4. Providing pedestrian signal heads
5. Placing push-buttons in convenient locations
6. Timing signals to minimize ped delay & conflicts
   - 1, 2 & 3 addressed in earlier module
Turn movements often result in conflicts

Traffic signals don’t insure protection

Peds routinely ignore the light *(usually quite safely)*
Traffic signals don’t insure protection

Pedestrians will cross where it’s convenient

Philadelphia PA

Traffic signals don’t insure protection

Red-light running

Concurrent left turns on Green

Pedestrians are at risk *when crossing with the light*
Pedestrian signals at Signalized Intersections
*(Aka ped heads/pedestrian indicators)*

**Need and placement**

Pedestrian signals should be provided, otherwise pedestrians don’t know when to cross.

*Fredericksburg VA*
Lack of ped signals on one way street: The pedestrian may not notice the signal

Ped head placement: close to crosswalk, visible to pedestrians, especially with long crosswalk

Place ped head here, not here

Ped head should be placed here:

Height: 7’ – 10’
Two-step signals: ensure pedestrians don’t see conflicting signals.

These pedestrians kept walking, against light.

Are ped heads always needed?

In general, YES

Possible exceptions:

- Narrow street
- High ped use
- Simple intersections/simple signal phasing
- Appropriate Vehicular signal heads is readily visible to both directions
- Calculated Ped clearance time can be accommodated by vehicular yellow plus all-red (Having time to cross when light turns yellow)
Current System

1. WALK
2. Flashing DON’T WALK *
3. Steady DON’T WALK

1/2 of Americans don’t understand it;
➢ Is there a better system?

- Flashing orange hand/don’t walk is ped clearance interval: very counterintuitive

Problem with current system:
People not sure if they can start during flashing DON’T WALK
Pedestrian count-down signal tells pedestrians how much crossing time is left

Reno NV

Pedestrian count-down signal research results:
- Pedestrians understand how it works
- More pedestrians start to cross during clearance phase, but...
- Fewer pedestrians initiate walk late in clearance phase
- No pedestrians left in crosswalk in steady DON'T|WALK
- Drivers don’t take a cue and accelerate to beat the light

Honolulu HI
What about crash reduction?
Results from San Francisco study are promising: CRF = 25% after countdown signals installed

2009 MUTCD – New meaning of Flashing upraised hand when pedestrian countdown signals are present

Ped may enter the intersection on the flashing upraised hand when a countdown pedestrian signal indication is present if able to travel to the far side of the traveled way by the time conflicting traffic receives a green signal
2009 MUTCD - Countdown displays required for all new pedestrian signals

Significant reductions in pedestrian-vehicle crashes, as well as all types of crashes.

Discussion:
What are your policies & practices regarding the provision of pedestrian indicators and countdown signals?
Placing Push-buttons In Convenient Locations

Preferred push-button placement: 2 separate buttons

Always next to landing at top of ramp, in line with crosswalk.
Alternate push-button placement: 2 on single pole

Always next to landing at top of ramp, in line with crosswalk.

Poor Push-button Placement

Inconspicuous  Too Far From Ramp
Poor Push-button Placement

Behind Guardrail

Behind Vegetation

At Back Of Pole

In Front Of Pole
Proper Push-button Placement

On side of pole

On pedestal at top of ramp

Use MUTCD accessible signal (APS) standard so pedestrians will understand which button to push.
Communicate With Pedestrians

LED tells peds the signal has received the call after pushing button *(like an elevator)*

Embossed arrow gives direction to blind and sighted pedestrians

2009 MUTCD - Positioning of pedestrian pushbuttons and legends on pushbutton signs shall clearly indicate which crosswalk signal is activated by which pushbutton
At high-use crosswalks, pedestrians should get a signal at every cycle.

Signal Timing & Walking Speeds
Pedestrian Walking Speeds

Current requirements:

- 7 sec steady walk (peds may enter crosswalk); 4 sec min
- Flashing don't walk (ped clearance phase) calculated at 4'/sec curb-to-curb (was curb to middle of last travel lane).
- 60' crosswalk requires 15 sec
- $15 + 4 = 19$ sec absolute min

2009 MUTCD:

- 7 sec steady walk minimum
- Ped clearance phase calculated at 3.5'/sec curb-to-curb.
- 60' crosswalk requires 17 sec
  - $7 + 17 = 24$ sec total
- Time from push button (or 6' feet back from top of ramp to curb at the other side to equal 3'/sec including steady walk phase
  - $60' + 6' = 66'$
  - 66' requires 22 sec
  - $24$ sec $> 22$ sec; passes test.
Future requirement: Total time from pushbutton (or 6' back from top of ramp) to curb at the other side to equal 3'/sec INCLUDING steady walk phase

60' xwalk + 6' ramp = 66' total; @ 3'/sec = 22 sec including steady walk

Note: top of ramp is considered departure point for older pedestrians and people in wheelchairs.

Reducing Pedestrian & Left-Turning Vehicle Conflicts

Pedestrians often conflict with left-turn movements
Use ITE Clearance Interval Policy for Change Intervals

ITE Traffic Engineering Handbook

Yellow = t + V/2a + V/20*64.4*g  
All-Red = ( W + L) / V

CRF = 12% for reduction in Total Crashes

AMF = 37% for reduction in Pedestrian Bike Crashes

Protected Vs. Permissive Left Turns

At signals, turning movements account for most of ped crashes;  
Left/right turn ratio is roughly 2:1

* CRF 70% (all crashes) converting permissive left turns to protected only left turns
Permissive left turns

Pedestrians cross at the same time as left-turning car; Drivers turning left on a green ball don’t look for pedestrians.

Protected left turns

Pedestrians cross after left-turning car, with thru-traffic; Pedestrian and car not in conflict.
Protected/permissive left turns

Pedestrians cross after LT-turning car (protected phase); Pedestrian and 2\textsuperscript{nd} car are in conflict (permissive phase)

Protected/permissive left turns: Alternative

Flashing left yellow arrow during steady green ball warns drivers: yield to pedestrians and oncoming traffic

Future MUTCD provision
Discussion

- What are your traffic signal timing policies?
- Do you use protected left turns to protect pedestrians from turning vehicles?
- Do you use protected/permissive phasing?
- If so, have you considered flashing left yellow arrow during the steady green ball?
Signal Timing To Minimize Pedestrian Delay & Conflicts

Chinatown, NYC

Use Short Signal Cycle Length

Portland OR

Long wait causes stacking: pedestrians wait in street, or don’t wait and cross against the signal
Peds shouldn't be required to push a button when major street is set to recall to green.

LPI = Lead Pedestrian Interval

*LPI gives pedestrians a head start*

Looks like a regular signal to drivers.
Looks like a regular signal to drivers: *green-yellow-red*

LPI: WALK comes on 2 to 5 seconds prior to the vehicular green; pedestrians enter crosswalk before turning vehicles arrive there.
LPI Sequence - without:
Pedestrian starts crossing at same time as RT-turning car;
Pedestrian and car on collision course

LPI Sequence - with:
Pedestrian starts crossing before RT-turning car;
Pedestrian gets head start and driver sees ped before entering crosswalk
Where do the extra 3-5 seconds come from?

Peds need 30 seconds to cross

Major Street

Vehicle queue needs less time to clear

Minor Street

These peds waited 3 cycles before turning drivers let them cross as legally required. LPI would give them a head start.
Simple & Innovative Ideas To Minimize Pedestrian Conflicts

Signs: inform turning drivers they must to yield to peds

MUTCD R10-15

Local variations, using MUTCD-approved lettering and symbols:

New York

Alaska
Restricting RTOR:
1. When kids are present

Difficult to enforce

Restricting RTOR:
2. By time of day

Limits most RTOR
Restricting RTOR:
3. When ped pushes button or as set by controller

Note: An on-demand NTOR sign can be used to improve the effectiveness of a Lead Pedestrian Interval

Restricting RTOR:
4. At all times
Pedestrian Scramble (Barnes Dance)

Popular because all traffic stops and pedestrians cross in any direction (No RTOR)

Pedestrians pay a price in delay:
- Pedestrians wait for traffic in one direction

Pasadena CA
Pedestrians wait for traffic in other direction

Pasadena CA

Pedestrian scramble increases safety but decreases efficiency of intersection
Use where there are high ped volumes and many turning vehicles

Reward: pedestrians can cross in any direction

Pasadena CA
Using ITS to Help Pedestrians

- High-tech signal used to help slower pedestrians cross the street with minimal delay to traffic.
- A slower crossing speed would delay traffic significantly.
Microwave Sensors Are Aimed At The Crosswalks To Track Peds

Signal is timed @ 4 ft/sec when ped pushes the button

Sensor tracks peds as they cross
The controller adds 4 seconds crossing time if ped hasn’t finished crossing.

The sensor tracks ped and adds more time if necessary.

In this case, the walk phase was prolonged in 20% of crossings, reducing unnecessary traffic delay the other 80% of crossings.

Learning Outcomes

You should now be able to:

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4. Identify signal timing techniques that favor pedestrian crossing
Questions?