HIGH SPEED MULTILANE ARTERIALS

Designing for Bicyclist and Pedestrian Safety
Characteristics of high speed multilane arterials
  - Defining high speed and multilane
  - Development and land use patterns
  - Complex intersections with long distance between crossings

Common problems on multilane arterials
  - Symptoms of high speed multilane arterials
  - Safety risk factors for pedestrians, bicyclists, and motorists

Design solutions and countermeasures
  - Access management and lane reduction
  - Enhancing crossings (Medians, RRFBs, PHBs, signals)
  - Lighting
  - Speed management
DEFINING “HIGH SPEED” AND “MULTILANE”

For the purposes of this module:

- **High Speed:** Posted or operating speeds exceeding 35 miles per hour
- **Multilane:** More than three lanes, but primarily:
  - Four lane undivided or divided (median)
  - Five lane (with two-way left turn lane)
  - Six lane (divided with median)
 IMPORTANCE OF DESIGNING FOR NONMOTORIZED ROAD USERS

- High speed, multilane arterials are traditionally auto-focused
- Decisions prioritize level of service and capacity, not safety or comfort of peds or bikes
- These corridors account for sizable share of crashes, but can be areas where pedestrians and bicyclists are dismissed as secondary road users
In Los Angeles, pedestrian crashes on arterials were seven times more deadly than those on non-arterials.

In Seattle, most crashes involving bikes and peds occur on arterials.

74.5% of bicycle crashes and nearly 80% of pedestrian crashes happen on arterial streets.

Taken from Seattle’s Bicycle and Pedestrian Safety Analysis.
Street design isn’t a one-size-fits-all approach

Land use, user needs and other factors should drive decision-making, and design approaches should be flexible

NCHRP 855 developed An Expanded Functional Classification System for Highways and Streets that builds upon existing AASHTO guidance, as well as other design guides from FHWA and NACTO
Expanded Functional Classification System (FCS) establishes a framework to consider all user needs based on roadway and context.
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**Figure 5.** Typical user priorities in the Expanded FCS.
PROBLEMS ON HIGH SPEED MULTILANE ARTERIALS
Destinations are further apart, and signals are spaced according to vehicle needs.

Resulting intersections handle more traffic and aren’t spaced for bikes/peds.

Decision to find a gap or walk/bike long distances to nearest intersection.
COMPLEX INTERSECTIONS

Reduced signal density increases signal complexity.

Longer cycle lengths, more delay.

Complex crossing maneuvers for bicyclists, pedestrians.
Platooning of vehicles across multiple lanes means that pedestrians and bicyclists have a more difficult time finding gaps.

Crossings are especially difficult if there is no median to break crossing into two parts.

FEW GAPS IN TRAFFIC
Development patterns lead to more driveways

Driveway designs de-emphasize sidewalk

Undivided roads with more driveways results in more opportunities for conflicts

CONFLICTS AT DRIVEWAYS
These corridors often do not have bicycle facilities.

Bicyclists are forced to ride far to the right or in the gutter pan.

Many may resort to riding on the sidewalk.

Not comfortable for most adults – LTS 4

Even bike lanes on these corridors are not comfortable – LTS 3
SOLUTIONS FOR HIGH SPEED MULTILANE ARTERIALS
<table>
<thead>
<tr>
<th>Solutions for High Speed Multilane Arterials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed Management</td>
</tr>
<tr>
<td>Bicycle Facilities</td>
</tr>
<tr>
<td>Crossing Enhancements</td>
</tr>
<tr>
<td>Lighting Improvements</td>
</tr>
<tr>
<td>Road Diets</td>
</tr>
<tr>
<td>Signal Improvements</td>
</tr>
</tbody>
</table>
SPEED MANAGEMENT

- Signal Timing
- Driver Speed feedback signs
- Automated Speed Enforcement (where permitted by State Law)
- Speed Feedback to Trigger Signals
- Roundabouts
- Other geometric improvements to reduce design speed
SPEED MANAGEMENT

- Coordinated signals can be timed to manage progression speed of traffic
- More challenging as signal density decreases
- San Francisco and Portland have both had success lowering speeds through signal timing changes
SPEED FEEDBACK SIGNS

- Dynamic speed feedback signs can provide reminders to drivers
- Los Angeles uses speed feedback signs to trigger downstream red lights for speeding drivers
AUTOMATED ENFORCEMENT

• Can be controversial, but effective in reducing speeds and crashes
• Scan of 90 studies found 20 to 25 percent reduction in injury crashes
• Be careful to roll programs out carefully and be transparent about where funding goes
ROUNDABOUTS

• Reduce speeds and conflicts at intersections using roundabouts
• Especially useful at transition zones, such as ramps from interstates where speeds change quickly
GEOMETRIC DESIGN

- A host of other geometric improvements have been shown to reduce speeds, such as:
  - Curb extensions and bulb-outs
  - Reduce curb radius
CROSSING ENHANCEMENTS

- Traffic signals & two-stage crossings
- PHBs & BikeHAWKs
- RRFBs
- Advance Stop/Yield Lines and Signs
- Medians and Refuge Islands
- Crossing Placement (Transit Stops)
MEDIANS AND REFUGE ISLANDS

• Medians and refuge islands are proven to reduce crashes
• Needed where volumes, speeds, and number of lanes make crossings difficult
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MEDIANS AND REFUGE ISLANDS

• Crossing islands can help shorten distances at intersections
• Proper design needed to manage slip lane traffic and move pedestrians safely from curb to island
TWO-STAGE CROSSINGS

- Where long distances exist between signals, incorporate two-stage crossings using median islands
- Allows for traffic to stop in one direction at a time to improve traffic flow
TWO-STAGE CROSSINGS

- Individual crossings enhanced w/ PHB or RRFB
- Example from Scottsdale, AZ:
RRFBs

• Improve yielding rates and reduce crashes
• Wide range of applications: trail crossings, uncontrolled midblock locations, uncontrolled intersections, roundabouts
RRFBs

- Two-stage crossing applications in Portland, OR
- Researchers found high rates of compliance with RRFB-equipped two-stage (“Z”) crossings in Portland
- 4 travel lanes; 40mph posted speed limit

Evaluating Driver and Pedestrian Behaviors at Enhanced Multi-lane Midblock Pedestrian Crossings: A Case Study in Portland, OR
ADVANCE STOP/YIELD LINES

- Improve visibility by pulling vehicles back from crosswalk
- Proven reduction in crashes
ADVANCE STOP/YIELD LINES

- Used in combination with other treatments already discussed
TRANSIT STOP PLACEMENT

• Transit stops are major generators of pedestrian trips
• High speed arterials are often transit corridors
• Use field observations to determine ideal placement
## TRANSIT STOP PLACEMENT

- Advantages and disadvantages for locating transit stops at:
  - Far-side of intersections
  - Near-side of intersections
  - Mid-block locations

<table>
<thead>
<tr>
<th>Stop Location</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Far-Side Stop</td>
<td>- Encourages peds to cross behind bus</td>
<td>- Sight distance issues for crossing vehicles and pedestrians</td>
</tr>
<tr>
<td></td>
<td>• Bus Stop</td>
<td></td>
</tr>
<tr>
<td>Near-side Stop</td>
<td>- Allows passengers to access bus closest to crosswalk</td>
<td>- Sight distance issues for veh to right of bus and crossing peds</td>
</tr>
<tr>
<td></td>
<td>• Bus Stop</td>
<td>- Obscures curb signals and peds</td>
</tr>
<tr>
<td>Mid-Block Stop</td>
<td>- Min sight distance problems for vehicles and pedestrians</td>
<td>- Encourages midblock crossing.</td>
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<tr>
<td></td>
<td>- May reduce congestion at passenger waiting areas</td>
<td>- Increases walking distance for peds crossing at intersections</td>
</tr>
<tr>
<td></td>
<td>• Bus Stop</td>
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SIGNAL IMPROVEMENTS

- Adding Traffic Signals
- Bicyclist Detection
- Bicyclist Clearance intervals
- Pedestrian countdown signals
- Leading Pedestrian Intervals
ADDING TRAFFIC SIGNALS

• Increasing signal density can help manage progression of traffic and create more opportunities for crossings
• Can be expensive and difficult to justify many new signals
SIGNAL TIMING STRATEGIES

Summarized from the NACTO Urban Street Design Guide:

- Coordinate signal timing to achieve desired progressions speeds
- Adjust peak and off-peak timing
- Fixed time is preferred over actuated signals
- Semi-actuated signals more common along major/minor intersections
- Shorten cycles and minimize phases to minimize wait times
PEDESTRIAN SIGNALS

- Belong at every signalized intersection
- Time signals to maximum 3.5 feet/second (can use slower speeds in areas with children or seniors)
LEADING PEDESTRIAN INTERVAL

- Gives pedestrians 5-7 second head start
- Provide in areas with turning conflicts
- Must restrict RTOR when used
ROAD DIETS

- Road Diets (lane reduction)
- Lane Diets (Narrowing)
- Use space for other purposes
- Minimize crossing distances and intersection size
ADT (Road Diet Candidate)
- 24,000 or less

Peak hourly volume (Road Diet Candidate)
- Below 875 vehicles per day in one direction

Case with higher ADT
- Lake Washington Blvd. Kirkland, WA
  - Initial volume of 23,000 vehicles per day
  - Increased nearly 26,000 after conversion
  - During one period about 30,000 vehicles per day

Summarized from FHWA Road Diet Informational Guide
EXAMPLE: EAST BOULEVARD, CHARLOTTE NC

- ADT ranged from 16,000 to 24,000
- Posted Speeds: 35 mph
- After project, 85th percentile speeds reduced from 43 to 40 mph
ROADWAY VS. PEDESTRIANWAY

- Roadway lighting typically 25 ft or higher
  - Overhead streetlights
  - Light source over roadway

- Road lighting may be sufficient for motorists to navigate & avoid obstacles
  - Often insufficient for specialized pedestrian needs
LIGHTING IMPROVEMENTS

- Along Corridors
- Lighting at Signals
- Lighting at Uncontrolled Crossings
- LED lighting
PEDESTRIAN LIGHTING ALONG CORRIDORS

• Help pedestrians safely navigate sidewalks & pathways
• Provide for visibility & security at all hours
• Extend hours a business district is active
• Encourage walking as part of an active lifestyle
• Improve access to transit & other services at night/early morning
LIGHTING ALONG CORRIDORS

• Consider roadway and pedestrian-way lighting
• Roadway: 25 ft or higher
  • Works for motorists but often insufficient for pedestrians
• Pedestrian: 20 ft or less from surface
POLE SPACING

Cross Street

Set Point for Spacing

Equal Spacing

(1)

Cross Street

Set Point for Spacing

(1)

Equal Spacing

Luminaire Pole (Typical)

Cross Street

Main Street
Consider:

• Land use
• Road width

Other Factors:

• Pole spacing and system layout
• Luminaire photometrics
• Wattage
• Road geometrics
• Power line conflicts
• Lighting levels and uniformity
• Aesthetics
• Obtrusive lighting issues
LIGHTING

CONSIDER TREE EFFECTS

TRR 2120 - Trees, Lighting, and Safety in Context-Sensitive Solutions
INTERSECTION LIGHTING

- No specific research done to address higher background luminance typically found at intersections
- 30 vertical lux considered conservative estimate
LED LIGHTING

• More agencies moving toward LED lighting due to:
  • Whiter light/better color recognition
  • Lower energy costs
  • Less maintenance

Advantages
- Lower energy use
- Longer lamp life
- No warm-up time
- Good light quality
- Directional (less light pollution)
- Environmentally friendly

Disadvantages
- High initial cost
- Sensitive to heat
- Long-term performance issues
Mixing Zone Treatments at Intersections
Protected Intersections
Separated or Buffered Bike Lanes
Use of Parallel Routes (Bicycle Boulevards)
OPTIONS FOR BIKE FACILITIES

- Shared-Use Paths
- Separated Bike Lanes
- Bike Lanes
- Shoulders
- Shared Roadway

Bike Facility Options

- Mixing Zone Treatments
- Protected Intersections
- Separated or Buffered Bike Lanes
- Parallel Routes
MIXING ZONES

- Mark conflict zones at and leading up to intersections to communicate desired movement.
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BIKE BOXES

- Allows bicyclists to queue at front of traffic when waiting for signal
- Improves visibility and reduces turning conflict
PROTECTED INTERSECTIONS

- Newer design to reduce conflict points at intersections

1. Corner refuge island
2. Forward bicycle queuing area
3. Motorist yield zone
4. Pedestrian crossing island
5. Pedestrian crossing of separated bike lane
6. Pedestrian curb ramp
PROTECTED INTERSECTIONS

• Example from Chicago:
BUCKETED BIKE LANES

- Added buffer between bike lane and travel lane
- Shy distance allows more comfortable travel and weaving space to avoid door zones
- No physical separation means more opportunity for conflicts
BUFFERED BIKE LANES

- The buffer shall be marked with 2 solid white lines. Minimum buffer width: 18 inches.

- The combined width of the buffer(s) and bike lane should be considered "bike lane width" with respect to other guidance.

- The buffer area shall have interior diagonal cross hatching or chevron markings 1/3 foot in width or wider.

- Desired minimum next to on street parking: 5 feet.

- Separation may also be provided between bike lane striping and the parking boundary to reduce door zone conflicts.

Bike Facility Options
Mixing Zone Treatments
Protected Intersections
Separated or Buffered Bike Lanes
Parallel Routes
BUFFERED BIKE LANES

Bike Facility Options

Mixing Zone Treatments

Protected Intersections

Separated or Buffered Bike Lanes

Parallel Routes
SEPARATED BIKE LANES

• Vertical barrier separating bike lane from traffic lane
• Can be one-way, two-way, or contraflow
• Raised to sidewalk level or on roadway
SEPARATED BIKE LINES

Advantages
- Very low stress midblock
- Encourages bike riding
- More conspicuous
- Crash rate reductions

Disadvantages
- Special intersection treatments
- Special driveway treatments
- Additional space needed
- More costly than bike lanes
- More to learn
SEPARATED BIKE LANES

Bike Facility Options
Mixing Zone Treatments
Protected Intersections
Separated or Buffered Bike Lanes
Parallel Routes
SEPARATED BIKE Lanes

Bike Facility Options

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Parallel Routes
QUESTIONS