How to Create a Bicycle Safety Action Plan: Off-Road Bicycle Facilities

Christopher Douwes, Federal Highway Administration
Bill Schultheiss, Vice President, Toole Design
Peter Lagerwey, Regional Director, Toole Design

Oct. 30, 2014, 2 pm
Today’s Presentation

- Introduction and housekeeping
- Audio issues?
  Dial into the phone line instead of using “mic & speakers”
- PBIC Trainings and Webinars
  www.pedbikeinfo.org/training
- Registration and Archives at
  pedbikeinfo.org/webinars
- PBIC News and updates on Facebook
  www.facebook.com/pedbike
- Questions at the end

• Incorporate safe and convenient walking and bicycling facilities into transportation projects.
• Every transportation agency has the responsibility to improve conditions and opportunities for walking and bicycling and to integrate walking and bicycling into their transportation systems.
• Transportation agencies are encouraged to go beyond minimum standards to provide safe and convenient facilities for these modes.
Network Background and Context

- Networks will include a combination of facility types and should provide seamless travel through intersections and across bridges and other potential barriers.
- Connected pedestrian and bicycle networks will include both on and off-road facilities.
- Connected networks will include seamless transitions between different facilities.
Examples: Projects that Improve Networks

• A project adds bike lanes as part of a routine resurfacing process, linking other bike lanes and a shared use path.

• A community constructs a shared use path to connect a neighborhood to a school, shopping center, and health care facility.

• A community links together a combination of sidewalks and shared use paths to provide access between a school and a popular community park, allowing children to walk and bicycle safely.
Integrating Transportation and Recreation (It isn’t either/or)

- We can and should integrate transportation and recreation infrastructure.
- Trails often are bicycle and pedestrian through routes: spines for nonmotorized networks.
Bridges and Overpasses: Essential Links for Networks
Tunnels and Underpasses: Essential Links for Networks
Recreational Trails Used for Transportation

- Rail-trails and other shared use paths.
- No Federal law or regulation requires pavement, although accessibility requires “firm and stable”.
- No Federal law or regulation prohibits equestrian use.
Integrating Transportation and Recreation: Resources

- Shared Use Path presentation: www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design_guidance/design_nonmotor/shared/

- Recreational Trail presentation: www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design_guidance/design_nonmotor/recreation/
Off-Road Bicycle Facilities

Planning for Safety

Presented by:

Peter Lagerwey
Toole Design Group

and

Bill Schultheiss, P.E.
Toole Design Group

October 30, 2014
Instructors

Peter Lagerwey
Regional Office Director
Toole Design Group
Seattle, Washington
plagerwey@tooledesign.com
206-200-9535

Bill Schultheiss
Vice President
Toole Design Group
Silver Spring, MD
wschultheiss@tooledesign.com
301-927-1900
Outcomes

At the end of this series, you will be able to...

- Recognize a bicycle-friendly network of roads and trails will increase cyclists’ safety.
- Describe how planners and engineers develop bicycle plans that directly address safety.
- Recognize bicyclists are a diverse subset of travelers with wide ranging skill and tolerance of traffic stress.
- Identify good practices and effective Countermeasures to enhance bicycle safety and accessibility.
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Planning for Bicycle Safety</td>
</tr>
<tr>
<td>2</td>
<td>On-Road Bicycle Facilities</td>
</tr>
<tr>
<td>3</td>
<td>Off-Road Facilities</td>
</tr>
</tbody>
</table>

**PBIC Webinar**

[www.pedbikeinfo.org](http://www.pedbikeinfo.org)
Section 1

Resources & Safety Analyses
Approaches
National Design Resources
National Design Resources

http://www.access-board.gov/guidelines-and-standards/streets-sidewalks
Local Design Resources
Crash Context

Section 2
Overview of Bicycle Safety Problem

In 2012:

- 726 killed
- 49,000 injured
- Cyclist account for over 2% of all traffic deaths and injuries

...but are only 1% of all traffic
Common Crash Types

**Mid-path**
- Collisions with other users
- Collisions with fixed objects
- Falls
  - Inattention/user error
  - Surface defects

...mid-path collisions are typically not reported unless injury between users requires hospital treatment.

**Intersections**
- Collisions with left or right turning vehicles
- Broadside collisions with through vehicles
  - Multiple threat
  - Single lane
Pre-crash Maneuvers

Most Common Motorist Pre-crash Maneuvers

- Going Straight: 585
- Making Right Turn: 271
- Making Left Turn: 239
- Entering/exiting alley/driveway: 119

Most Common Bicyclist Pre-crash Maneuvers

- Going Straight: 622
- Riding in crosswalk/SW: 455
- Drove Wrong Way: 43
- Entering/exiting alley/driveway: 42

Source: City of Denver Bicycle Crash Study
Right Hook into “wrong way” bicyclists on sidepath

Broadside into “wrong way” bicyclists on sidepath
Shared Use Path Users

- **Bicyclists**
  - Upright adults, children
  - Recumbent bicyclists
  - Bicyclists pulling trailer/bikes
  - Tandem bicyclists

- **Pedestrians**
  - Walkers, Runners
  - People with disabilities
  - People with strollers
  - People walking dogs

- Inline/roller skaters
- Kick scooter users
## Shared Use Path Users

### Table 2: One-way Observations of Path Users by Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Farmington River 1</th>
<th>Heritage Canal Greenway</th>
<th>Farmington River 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walkers</td>
<td>44.9%</td>
<td>25.0%</td>
<td>22.7%</td>
</tr>
<tr>
<td>Walkers with Strollers</td>
<td>3.2%</td>
<td>1.8%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Runners</td>
<td>6.7%</td>
<td>3.2%</td>
<td>4.9%</td>
</tr>
<tr>
<td>Wheelchairs</td>
<td>0%</td>
<td>0%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Skaters</td>
<td>6.0%</td>
<td>23.7%</td>
<td>9.8%</td>
</tr>
<tr>
<td>Scooters</td>
<td>1.3%</td>
<td>0.1%</td>
<td>0%</td>
</tr>
<tr>
<td>Skateboarders</td>
<td>0.4%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Cyclists</td>
<td>37.6%</td>
<td>45.5%</td>
<td>55.2%</td>
</tr>
<tr>
<td>Horse riding</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Dogs</td>
<td>N/A</td>
<td>0.6%</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

Source: UCONN Trail Safety Study
http://www.cti.uconn.edu/pdfs/jhr04-297_02-2.pdf
Users

• Motorized vehicles not recommended
  – Exceptions: wheelchair users, maintenance vehicles, snowmobiles

• Can accommodate horses with an adjacent bridle trail
Diagram 2 - Speeds of various modes on paths at Westerfolds Park, Melbourne (Shepherd 1994)

Speeds in mph:
- Cyclists: 3, 6, 9, 12, 15, 18, 21, 24
- Rollerskiing
- Rollerbladers
- Joggers
- Walkers

Lower quantile, Median, Upper quantile

Minimum data point within a specified range

Maximum data point within a specified range

PBIC Webinar - www.pedbikeinfo.org
User Design Implications

- **Approach** speeds determined by **fastest:**
  - Bicyclists (12-30mph)
  - Motorists (15-80mph)

- **Departure** speed determined by **slowest:**
  - Pedestrians 3.0 – 3.5 feet/second
AASHTO Guide: Recommends Marked Crosswalks for all Path Crossings

- Legal Crossings
  - Mid-block: marked crosswalks required to create a legal crossing
  - Sidepath: crosswalks exists regardless of marking

- Consider state laws
  - How are bicyclists treated? (bicyclist = pedestrian in x-walk?)
Path Safety Audits – Potential Prompt Questions

Observations
• Path volumes, user mix?
• User speeds?
• Path width?
• User behaviors?
• Obstacles?
• Surface conditions?
• Sign inventory

Design Checks
• Sight Distance
• Curve radius
• Intersection controls
• Sign conformance with MUTCD
• Custom sign design
Crash Countermeasure Resources

http://www.pedbikesafe.org/PEDSAFE/
Crash Countermeasure CMF

- Crash Modification Factors (CMF) are limited for bikes
  - Limited before/after data
  - Insufficient bike counts
- Use CMF’s for pedestrians
- Countermeasure research available on PEDSAFE
Off-Road Bicycling Infrastructure Crash Reduction Countermeasures Mid-Path

Section 4
Crashes Due to User Conflicts
Countermeasure: Widen Shared Use Path

- Use Shared Use Path LOS Calculator to design width for volume:
  - Pedestrians
  - Bicyclists
- AASHTO Guide:
  10 ft = minimum width
  11 ft is needed for passing
  10-14 ft width is typical
  8 ft = constrained minimum
Countermeasure: Separate Bikes/Peds Horizontally

- Striping, color differentiation, or barriers
- Bi-directional walking lane for pedestrians
  - 5 ft min width for pedestrians
- Uni-directional lanes for cyclists
  - At least 5 feet for bicyclists
Requires Higher Volume of Bikes than Peds
Countermeasure:
Separate Bikes/Peds Vertically
Countermeasure: Separate Bikes/Peds Barriers
Countermeasure: Provide clear sight lines at path intersections with other paths
Countermeasure: Lighting

- Where nighttime use is permitted
- Pedestrian scale fixtures
- Consider 0.5 to 2 foot candles
- Higher illumination at crossings
Crashes Due to Maintenance
Countermeasure:
Proactive Maintenance – Sweeping/Plowing
Countermeasure:
Proactive Maintenance – Spot Repair
“Barriers such as bollards, fences, or other similar devices create permanent obstacles...and can cause serious injury.” - AASHTO
Countermeasure: Restricting motor vehicle access
Countermeasure: Bollard considerations

If bollards must be used:

- Retroreflectorized
- Bikes can pass w/o dismounting
- Provide adequate sight distance
- Stripe an envelope at approach
- Use flexible delineators
- Vehicles should not be able to pass
- Use an odd number of bollards
- Set back min, 30 ft from road
- Flush hardware in ground
Countermeasure: Provide Shy Distance

Provide clearance to fences, guard rails, railings, walls

- 2 ft desirable
- 1 ft minimum if “smooth”
Crashes Due to Curves/Speed
Countermeasure: Horizontal Curve Design/Widening

Follow AASHTO Guidance:
- Actual user speeds?
- Design speed?
- Stopping sight distance?

\[
H_SO = R \left[ 1 - \cos \left( \frac{28.65S}{R} \right) \right]
\]

\[
S = \frac{R}{28.65} \left[ \cos^{-1} \left( \frac{R - H_SO}{R} \right) \right]
\]

where:
- \( S \) = stopping sight distance (ft)
- \( R \) = radius of centerline of lane (ft)
- \( H_SO \) = horizontal sightline offset, distance from centerline of lane to obstruction (ft)

Note:
- Angle is expressed in degrees
- Line of sight is 2.3 ft above centerline of inside lane at point of obstruction
Countermeasure: Superelevation of Unpaved Paths

\[ R = \frac{V^2}{15 \left( \frac{e}{100} + f \right)} \]

| where: |
| --- | --- |
| \( R \) | minimum radius of curvature (ft) |
| \( V \) | design speed (mph) |
| \( e \) | rate of bikeway superelevation (percent) |
| \( f \) | coefficient of friction |

PBIC Webinar www.pedbikeinfo.org
Off-Road Bicycling Infrastructure Crash Reduction Countermeasures Path - Roadway Intersections

Section 5
Understand the Path Crossing Types

1. Mid-block roadway crossings
   – Outside the functional area of an adjacent intersection
   – Can be considered a four-leg intersection

2. Sidepath roadway crossings
   – Within functional area of intersection

3. Grade-separated
Midblock Crossings

Outside functional area of adjacent intersection
Side Path Crossing Types

Within functional area of adjacent intersection
Shared Use Path – Motorist Conflict Types

**Straight-on**

**Turning and Straight-on**
Traffic Control Non-Compliance

“Apply the least restriction that is effective.” - AASHTO
Countermeasure: Choose the least restrictive – but effective – control

- Unwarranted controls will be ignored by users
- Consider relative volumes, speeds, and system hierarchy
  - Local street vs. regional trail
  - Low volume road vs. high volume trail
Countermeasure: Integrate Sidepath Crossings Controls at Signalized Intersections

Conveying clear message?...
Countermeasure: Integrate Sidepath Crossings Controls at Signalized Intersections

Integrate path with street traffic controls...
Countermeasure: Integrate Sidepath Crossings Controls at Signalized Intersections

- Bicycle signals issued interim approval by FHWA
- Research shows increased bike compliance
- Next edition of MUTCD will add guidance for use
Crashes Due to Poor Sight Lines
Provide Adequate Sight Lines

• Approach speeds determined by fastest users:
  – Bicyclists (12-30mph)
  – Motorists (15-80mph)

• Departure speed determined by slowest users (typically pedestrian):
  – 3.0 – 3.5 feet/second
Multiple Threat Crashes

First car stops for pedestrian, too close to crosswalk, blocking visibility to second lane

Pedestrian steps out, doesn’t see second car not stopping
Countermeasure: Crossing islands

- Lower crash rates
- Beneficial at:
  - High roadway volumes
  - Wide crossings
  - Crossing 3 or more lanes
- Widths
  - Minimum width: 6 feet
  - Preferred width: 10 feet
    - consider platoons
Countermeasure:
Advance stop or yield lines

Photo: Bill Cowern
Countermeasure: Advance warning signs and markings

Should not use where roadway is stop, signal, or yield controlled
Countermeasure: Rectangular Rapid Flashing Beacons
Countermeasure Takeaways

• Shared use path countermeasures require pedestrian countermeasures
• Comfort and safety have a relationship
• Land use, terrain, and traffic character influence use and safety
• Education & Enforcement strategies are also very important
• Our industry needs more count data for CMF’s
Questions?
Thank You!

⇒ Archive at www.pedbikeinfo.org/webinars
  - Downloadable and streaming recording, transcript, presentation slides

⇒ Questions?
  - Christopher Douwes  
    chrisopher.douwes@dot.gov
  - William Schultheiss  
    wschultheiss@tooledesign.com
  - Peter Lagerwey  
    plagerwey@tooledesign.com