PEDESTRIAN HYBRID BEACON (PHB)
Understand why, when and where to use PHB
  - Warrants
  - Data needs
  - PHB location/placement

Understand design and operation of PHB
  - MUTCD Standards and Guidance

Understand who to educate & what messages to deliver
  - Drivers
  - Pedestrians and bicyclists
  - Police

Describe unique PHB applications
  - Bike crossings/Roundabouts/two-stage PHBs
PHB (HAWK) HISTORY

■ **1st HAWK** Tucson, AZ
  - Year 2000
  - Pedestrian safety program “Watching over the Pedestrian Like a Hawk”

■ **2009 MUTCD**
  - adopted HAWK as Pedestrian Hybrid Beacon (PHB)

*(The Puffin Signal is addressed later in the presentation)*
REMINDER ON HOW IT WORKS

1. Blank for drivers
2. Flashing yellow
3. Steady yellow
4. Steady red
5. Wig-Wag

Return to 1

MUTCD Section 4F.02
WHY?

SAFETY!
Table 21. Summary of motorist yielding compliance from three sources for red signal or beacon and active when present.

<table>
<thead>
<tr>
<th>Crossing Treatment</th>
<th># of Sites</th>
<th>Range (%)</th>
<th>Average (%)</th>
<th># of Sites</th>
<th>Range (%)</th>
<th>Average (%)</th>
<th># of Sites</th>
<th>Range (%)</th>
<th>Average (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCRP D-08/NCHRP 3-71 Study</td>
<td>Compliance – Staged Pedestrian Crossing</td>
<td>2</td>
<td>97 to 100</td>
<td>99%</td>
<td>4</td>
<td>91 to 98</td>
<td>95%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compliance – General Population Pedestrian Crossing</td>
<td>6</td>
<td>94 to 100</td>
<td>97%</td>
<td>6</td>
<td>96 to 98</td>
<td>98%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Studies</td>
<td>Compliance – Literature Review (from Table L-1)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>99</td>
<td>99%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>In-Roadway Warning Lights</th>
<th>NA</th>
<th>NA</th>
<th>NA</th>
<th>11</th>
<th>8 to 100</th>
<th>66%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead Flashing Beacon (Pushbutton Activation)</td>
<td>3</td>
<td>29 to 73</td>
<td>47%</td>
<td>4</td>
<td>38 to 62</td>
<td>49%</td>
<td></td>
</tr>
<tr>
<td>Overhead Flashing Beacon (Passive Activation)</td>
<td>3</td>
<td>25 to 43</td>
<td>31%</td>
<td>3</td>
<td>61 to 73</td>
<td>67%</td>
<td></td>
</tr>
</tbody>
</table>
CMF (CRF)

- CRF 69% pedestrian crashes
- CRF 29% all crash types
- CRF 15% all serious injury & fatal crashes

Pedestrians want or need to cross the high speed multilane roadways.

Crossing location doesn’t meet signal warrants.

Crosswalk markings and signs just won’t do if there are any at all.

Pedestrians complain or crash data shows a problem.
Example:
- 35 mph
- 100 pph
- 750 vph
- 68 ft wide crossing

MEETS CRITERIA
Figure 4F-2. Guidelines for the Installation of Pedestrian Hybrid Beacons on High-Speed Roadways

TOTAL OF ALL PEDESTRIANS CROSSING THE MAJOR STREET - PEDESTRIANS PER HOUR (PPH)

MAJOR STREET — TOTAL OF BOTH APPROACHES — VEHICLES PER HOUR (VPH)

* Note: 20 pph applies as the lower threshold volume
If the posted or statutory speed limit or the 85th-percentile speed on major street exceeds 35 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, a 70% Factor can be used.
CAN PHBS BE USED ON HIGH SPEED ROADS?

FHWA and ADOT driver yielding studies

![Graph showing driver yielding percentage vs. posted speed limit and site.]
EB SAFETY – BEFORE/AFTER WITH COMPARISON SITES (SIGNAL AND NON-SIGNAL)

- 25% reduction in severe (fatal and injury) total crashes
  - (CMF of 0.75)
- 45% reduction in severe pedestrian-related crashes
  - (CMF of 0.55)
- 29% reduction in severe rear-end crashes
  - (CMF of 0.71)
Problem/Background

- Large percentage of residents 65 and older (retirement community)
- 6-lane divided arterial with transit lanes
- 40 mph speed limit
- More time needed to cross wide street
- Not appropriate for traffic signal

Source: Google Earth
Solution/ Details

- Installed PHB with PUFFIN detector logic
- PUFFIN able to detect if a pedestrian needs more time & lengthens the red signal
- Funded by sales tax focusing on elderly/pedestrian safety improvements

Example of PUFFIN detector logic (circled)
Results

- Increased yielding rates & pedestrian safety
- Positive reception of the crosswalk
- As of June 2012, Tucson has 114 PHBs and 2 PUFFIN beacons

Pedestrian Hybrid Beacon at East Broadway Blvd.
Standard:

- If used, PHBs shall be used in conjunction with signs and pavement markings to warn and control traffic.
- A PHB shall only be installed at a marked crosswalk.
Section 4F.02, paragraph 04

Guidance:

“When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then the PHB should be installed at least 100 feet from side streets or driveways controlled by STOP or YIELD signs.”

“Guidance” not a “Standard”

NCUTCD voted to remove that Guidance.

Standard recommended for the next MUTCD by the NCUTCD:

“If a pedestrian hybrid beacon is installed at or immediately adjacent to an intersection with a side road, vehicular traffic on the side road shall be controlled by STOP signs.”
“Guidance” not based on research from Tucson, AZ where PHB (HAWK) was developed
- (HAWKs in TTI study were at local street intersections)
- Some State supplements have eliminated the “Guidance” statement (Arizona)
- Ultimate decision for next MUTCD up to FHWA
ADOT PHB STUDY (2019)

- 186 PHB study locations
- Cross-sectional Evaluation
- Up to 10.75 years of crash data
- NO CRASH DIFFERENCES BETWEEN MIDBLOCK, 3 OR 4-LEG INTERSECTIONS
Prioritize warranted locations using a point system based on:

- Traffic volume during the peak pedestrian crossing time
- Peak hour pedestrian volume
- Pedestrian crashes
- Crossing width (number of lanes)
- Distance to nearest controlled crossing
- Posted speed
- Presence of a raised median
- Crossing is a designated trail, school crossing, or SRTS walking route
- Presence of elderly or disabled pedestrians
- Others (lighting, curved roads, other unusual road conditions, etc.)
SELECTION OF PHB LOCATIONS

- Requires extensive data collection
  - Pedestrian counts can be time consuming
- Point weights and factors may vary from city to city
- Point weights and factors may be adjusted from year to year to fine-tune the process
- Ultimate selection of location(s) should be based on Engineering Judgment, not merely on points alone
**ARIZONA DOT**

**TGP 640**  
**June 2015**

- Ped crashes (5 yrs)
- Ped volume
- Distance to nearest signal
- Posted speed
- AADT
- Raised median
- Path/sidewalk
- Ped generator
- Crossing width

---

<table>
<thead>
<tr>
<th>PEDESTRIAN HYBRID BEACON (PHB) EVALUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location: ____________</td>
</tr>
<tr>
<td>1. Motor vehicle crashes correctable by installation of PHB – Award 5 points for each crash (for the most recent 5 years of data) involving pedestrians, bicyclists, wheelchairs, skateboarders, motorized scooters, or golf carts crossing within 500 feet on either side of the proposed PHB locations, or half the distance to the nearest signal (whichever is less):</td>
</tr>
<tr>
<td>2. Peak hour pedestrian crossing volume – Award points if the average peak hour pedestrian crossing volume within 500 feet on either side of the proposed PHB location, or half the distance to the nearest traffic signal (whichever is less):</td>
</tr>
<tr>
<td>3. Location of nearest existing traffic signal or existing PHB – Award points:</td>
</tr>
<tr>
<td>4. Posted speed limit – Award points:</td>
</tr>
<tr>
<td>5. Roadway traffic volume (AADT) – Award points:</td>
</tr>
<tr>
<td>6. Raised median – Award 5 points if the roadway does not have a raised median with a minimum width of 6 feet.</td>
</tr>
<tr>
<td>7. Shared-use path or walkway – Award 5 points if a designated, maintained, and permitted shared-use path or walkway crosses the road at the proposed PHB location.</td>
</tr>
<tr>
<td>8. Pedestrian activity generator – Award 5 points if the proposed PHB location is within 500 feet of a senior center, medical facility, community center, school, or other pedestrian activity generator.</td>
</tr>
<tr>
<td>9. Roadway illumination – Award 5 points if the proposed PHB location does not have roadway illumination.</td>
</tr>
<tr>
<td>10. Crossing distance – Award 5 points if the crossing distance is greater than 36 feet. (If a raised median with a minimum width of 6 feet is present, the crossing distance is measured to the median).</td>
</tr>
</tbody>
</table>

**GRAND TOTAL**
How long of a count is needed?

- The peak crossing hour(s) must be counted.
  - Recommend 2- to 4-hour count over the peak crossing time
- Determine the peak crossings hours & day for each individual crossing. Crossings fluctuate daily and the peak hour(s)
  - May be different based on location (school vs. trail vs. CBD)
Video observations can be for longer durations and may be viewed at higher speeds to reduce data collection times

- Provide a record of the crossings and other behaviors
- Equipment security can be an issue

Some video equipment can do automated pedestrian counts (Miovision)
DESIGN CRITERIA
When an engineering study finds that installation of a PHB is justified, then:

A. Install at least two PHB faces for each major street approach

B. Install a stop line for each approach to the crosswalk
C. Install a pedestrian signal head at each end of the marked crosswalk, and

D. The PHB shall be pedestrian actuated
Standard:
A CROSSWALK STOP ON RED (symbolic circular red) (R10-23) sign shall be mounted adjacent to a PHB face on each major street approach.

Option:
State MUTCD’s may allow other appropriate MUTCD approved ped, bike or school crossing signs in addition to the standard R10-23 sign.
Except at roundabouts:

- Steady DON’T WALK shall be displayed:
  - During PHB Blank-out
  - Flashing or steady CIRCULAR yellow
- Solid WALK shall be displayed during steady CIRCULAR RED indications
- Flashing DON’T WALK shall be displayed during alternating flashing CIRCULAR RED
FHWA August 2011: It is our Official Interpretation that:

1. A steady RED clearance interval, in which the faces for the major street are steady RED and the pedestrian signal face are steady ORANGE UPRASED HAND, may be inserted in the sequence of a PHB between the end of the steady YELLOW change interval and the start of the WALK interval for the pedestrian crosswalk.

2. The alternating flashing RED display on the PHB faces for the major street may be extended beyond the end of the flashing ORANGE UPRASED HAND pedestrian change interval for a brief buffer interval before the major street faces return to the dark (non-illuminated) condition.

Recommend: Use this FHWA language.
If used at an intersection or driveway, the PHB crossing and signal equipment should only control one crossing.

- ITE Traffic Control Devices Handbook
Vehicle signal indications only face major street.

STOP signs face the minor road.

Side street indication is NOT recommended. Experience suggests that drivers will most likely abuse a dynamic signal’s indication (such as a signal or illuminated no turn sign) to push their way into the major street. (TCDH 2013)
RETROREFLECTIVE BORDERS ON BACKPLATES

- 2009 MUTCD - 4D.12, Paragraph 21 Option

- FHWA 9 proven countermeasures

- CRF 15%
Use Ladder or Continental crosswalk markings (more visible)

- Consider advance PED XING pavement stencils
- Consider advance Ped warning signs (W11-2 or W11-15)
- Consider advance solid lane line on approach to stop line (approx. 250 ft)
- Place advance stop lines 50 to 65 ft in advance of the PHB mast arms along with STOP HERE ON RED sign
- Remove broken lane lines between advance stop line & crosswalk
  - Improves conspicuity of stop line & crosswalk
Use APS buttons for universal accessibility (PROWAG-compliant)

- Make sure ramps exist and crossing is fully accessible

Click to play 3 sample locator tones

Click to play crossing message
Minimum desirable WALK - 7 seconds:
  - Consider longer WALK interval during school arrival & dismissal times if used at a school

Provide minimum vehicle “Go” time between PHB activations
  - Some agencies use 50 seconds of “blank-out” time between PHB activations (Background cycle)
  - 2013 ITE TCDH: recommends 15 to 45 seconds
  - Minimum “blank-out” time between activations can be shorter during peak crossing times
    - Example: school arrival & dismissal times
Consider multiple timing plans if used at schools or other facilities with unique crossing patterns and peaks.
- **PUFFIN** is a newer version of PHB.
- Flashing **RED** can be held longer to allow slower pedestrians to cross.
- Sensors connected into the system monitor pedestrian crossing movements in crosswalk.
- Pedestrian clearance time for PHB based on 3.5 fps walking speed. PUFFIN timing is set for 4.0 fps; but, controller can extend the clearance time up to 3.0 fps crossing time.

**PHB AS A PUFFIN: PEDESTRIAN USER FRIENDLY INTERSECTION**
Microwave sensors (or video detection) aimed at crosswalk to track pedestrians and extend crossing time if needed.
How to encourage drivers to proceed on flashing red after pedestrians have crossed:

- **Public education**
  - Media (newspapers, traffic PSAs)
  - Pamphlets distributed or posted on websites
  - Video (PSAs or posted on agency websites)

- **Special signs posted on PHB**

- **New Jersey’s First PHB**
  - Drivers don’t understand the flashing red
  - [Video credit: njbikeped](https://www.youtube.com/watch?v=bQdZqLDrhjc)
ENCOURAGING DRIVERS TO PROCEED

Phoenix Sign*

*No Longer Needed in Tucson after many years of Service
- Long delays for WALK signal may create pedestrian compliance issues
- Relatively quick WALK increases pedestrian compliance & encourages use of PHB
- If the pedestrian crosses “early”, the motorist will be stopped for no reason. This will diminish respect for PHB

Note: D.C. DOT syncs PHB with traffic signals
Motorists tend to run signals or beacons when not directly over the roadway.
AZDOT - HOW TO USE A PEDESTRIAN HYBRID BEACON - LIVE ACTION
SPECIAL PROVISIONS PRIOR TO ACTIVATING THE PHB

- Educate users
  - Pedestrians
    - Schools
    - Nearby senior centers & apartment complexes
  - Neighborhood associations and nearby HOAs
  - Community in general
- Motorists
Educate Police

- Most have never seen a PHB before & do not understand how they work
- Police must know what constitutes a violation and relevant ordinance/law
- Invite Police to activation for training
- Use Police to train other officers

SPECIAL PROVISIONS PRIOR TO ACTIVATING THE PHB CONT.
Use local media - reporters always love a good story or breaking issue

Videos played on agency websites or TV PSAs - mostly local cable

Engage students and community groups in education effort
  - School class project
## Cost (2013)

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>Description</th>
<th>Median</th>
<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Cost Unit</th>
<th>No. of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Hybrid Beacon</td>
<td>Pedestrian Hybrid Beacon</td>
<td>$51,460</td>
<td>$57,680</td>
<td>$21,440</td>
<td>$128,660</td>
<td>Each</td>
<td>9 (9)</td>
</tr>
</tbody>
</table>

**Source:** Costs for Pedestrian and Bicyclist Infrastructure Improvements: A Resource for Researchers, Engineers, Planners, and the General Public, October 2013
TWO-STAGE PHB

DOUBLE HAWK

PEDESTRIAN CROSSING

(AKA PTERODACTYL)
Two-stage PHB used to reduce overall stopped time for crossing a wide street.

Each crossing requires a far shorter clearance.

Can coordinate with two-direction traffic.

Requires fencing in the median to corral peds to both crossings.
Connects two retail developments across a very busy 6-lane median divided arterial
- 47,000 ADT
- 6 thru lanes, 2 Right turn lanes, median

Peak-hour “before” count was 23 crossings during time when “NO PEDESTRIAN CROSSING” signs were in place
DOUBLE HAWK PEDESTRIAN CROSSING (AKA PTERODACTYL)
## CASE STUDY:

"AFTER" COUNTS IN 2011 WITH PHBS

<table>
<thead>
<tr>
<th>Date</th>
<th>Hour</th>
<th>East to Scottsdale (Per Hour)</th>
<th>West to East Per Hour</th>
<th>Total Per Hour</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>East</td>
<td>West</td>
<td></td>
</tr>
<tr>
<td>Thursday, Dec. 8</td>
<td>9:00-10:00</td>
<td>11</td>
<td>13</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>10:00-11:00</td>
<td>15</td>
<td>22</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>11:00-12:00</td>
<td>28</td>
<td>34</td>
<td>62</td>
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<tr>
<td></td>
<td>12:00-1:00</td>
<td>72</td>
<td>75</td>
<td>147</td>
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<tr>
<td></td>
<td>1:00-2:00</td>
<td>82</td>
<td>68</td>
<td>150</td>
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<td>2:00-3:00</td>
<td>72</td>
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<td>128</td>
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<td>3:00-4:00</td>
<td>69</td>
<td>57</td>
<td>126</td>
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<tr>
<td></td>
<td>4:00-5:00</td>
<td>47</td>
<td>36</td>
<td>83</td>
</tr>
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<td></td>
<td>5:00-6:00</td>
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<td>6:00-7:00</td>
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<td>57</td>
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<td></td>
<td>9:00-10:00</td>
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<td>7</td>
<td>10</td>
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<tr>
<td></td>
<td>10:00-11:00</td>
<td>10</td>
<td>2</td>
<td>12</td>
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<td></td>
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<td>515</td>
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**Avg. = 76 Peds per/hr**

<table>
<thead>
<tr>
<th>Saturday, Dec. 10</th>
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<th>East to Scottsdale (Per Hour)</th>
<th>West to East Per Hour</th>
<th>Total Per Hour</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>East</td>
<td>West</td>
<td></td>
</tr>
<tr>
<td>11:00-12:00</td>
<td>72</td>
<td>79</td>
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</tr>
<tr>
<td>12:00-1:00</td>
<td>112</td>
<td>112</td>
<td></td>
<td>224</td>
</tr>
<tr>
<td>1:00-2:00</td>
<td>164</td>
<td>122</td>
<td></td>
<td>286</td>
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<tr>
<td>2:00-3:00</td>
<td>201</td>
<td>190</td>
<td></td>
<td>391</td>
</tr>
<tr>
<td>3:00-4:00</td>
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<td>187</td>
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<td>354</td>
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<tr>
<td>4:00-5:00</td>
<td>166</td>
<td>139</td>
<td></td>
<td>305</td>
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<tr>
<td>5:00-6:00</td>
<td>115</td>
<td>134</td>
<td></td>
<td>249</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>997</strong></td>
<td><strong>963</strong></td>
<td></td>
<td><strong>1960</strong></td>
</tr>
</tbody>
</table>

**Avg. = 280 Peds per/hr**
- **Option:**
  - If installed at a roundabout and an engineering study determines that pedestrians without visual disabilities can be allowed to cross the road without actuating the PHB, the pedestrian signal may be dark (not illuminated) when the PHB faces for motorists are dark.
PHB BIKE APPLICATION
EXPERIMENTAL
(BIKE HAWK)
Move bicycles to one side of the street for the crossing (if at an intersection)
Normal PHB with Bike Facilities and R9-5 for cyclists to use pedestrian signals
BIKEHAWK CROSSINGS

Provide actuation devices that are accessible to bicyclists with R9-5 sign

Compliance is in the 90% range & near 100% with families and children
BIKEHAWK CROSSINGS

Communicate to bicyclists with R9-5 sign
QUESTIONS