

## Traffic Monitoring and Data Collection

# Pedestrian Performance Measures at Signalized Intersections



The image shows a 'Report Card' for the National Traffic Signal program in 2007. It lists several categories with their corresponding grades. A callout bubble from the main title points to the 'Traffic Monitoring and Data Collection' category, which has an 'F' grade. The overall grade for the program is 'D'.

Category	Grade
Management	D-
Signal Operation at Individual Intersections	C
Signal Operation in Coordinated Systems	D
Signal Timing Practices	C-
Traffic Monitoring and Data Collection	F
Maintenance	C-
<b>OVERALL</b>	<b>D</b>

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# **Pedestrian Performance Measures at Signalized Intersections**

- Paul Olson's poll on Traffic Signal Operations (the why for this PPT)
- How do pedestrian cross the street?
- What are the relevant pedestrian performance measures?
- We want 24/7 observations
  - Issues are not necessary 8-5 M-F
- We need to remember to look to the literature, not “email me the PPT!”

In 25 words or less please tell us your definition of "Traffic Signal Operations". / PRO&EC

Bullock's stab (22min reply disclaimer)

- Safe, efficient management of traffic signal infrastructure. Prioritization of competing objectives, spanning multiple modes, are subject to budgetary constraints and local stakeholder input.

...so remainder of talk is going to talk about possible performance measures associate with objective of pedestrian mode crossing the street.

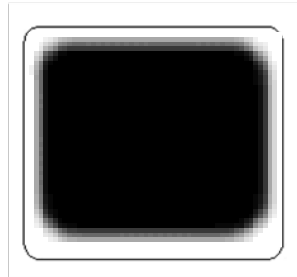
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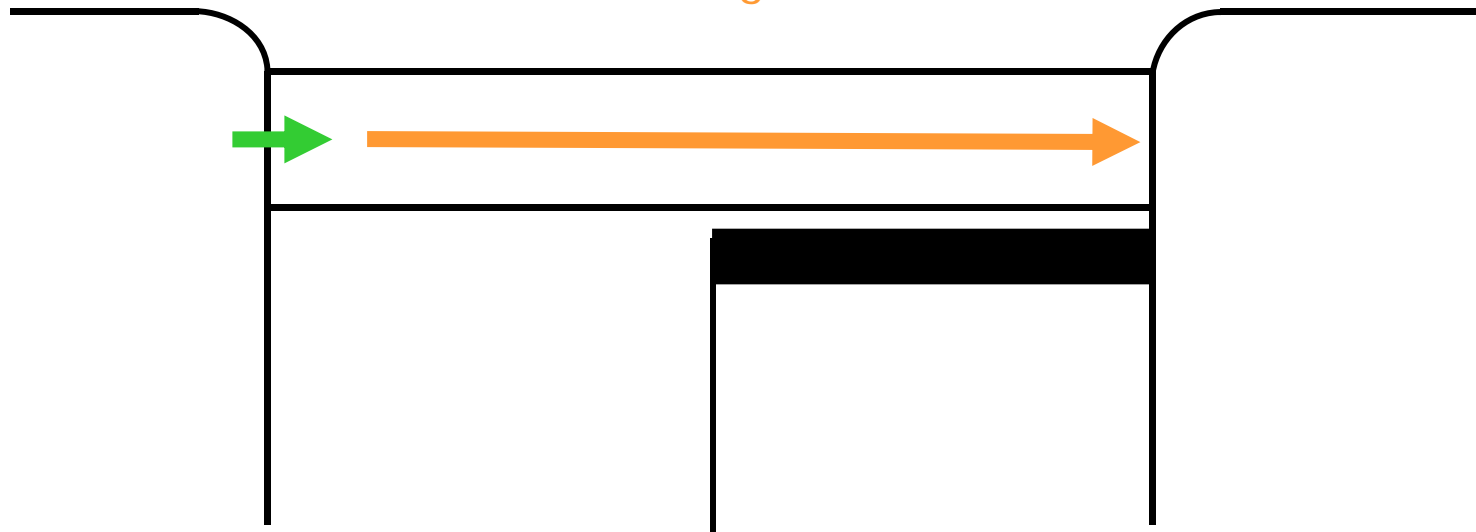
# How do Peds Cross the Street: Concurrent Service



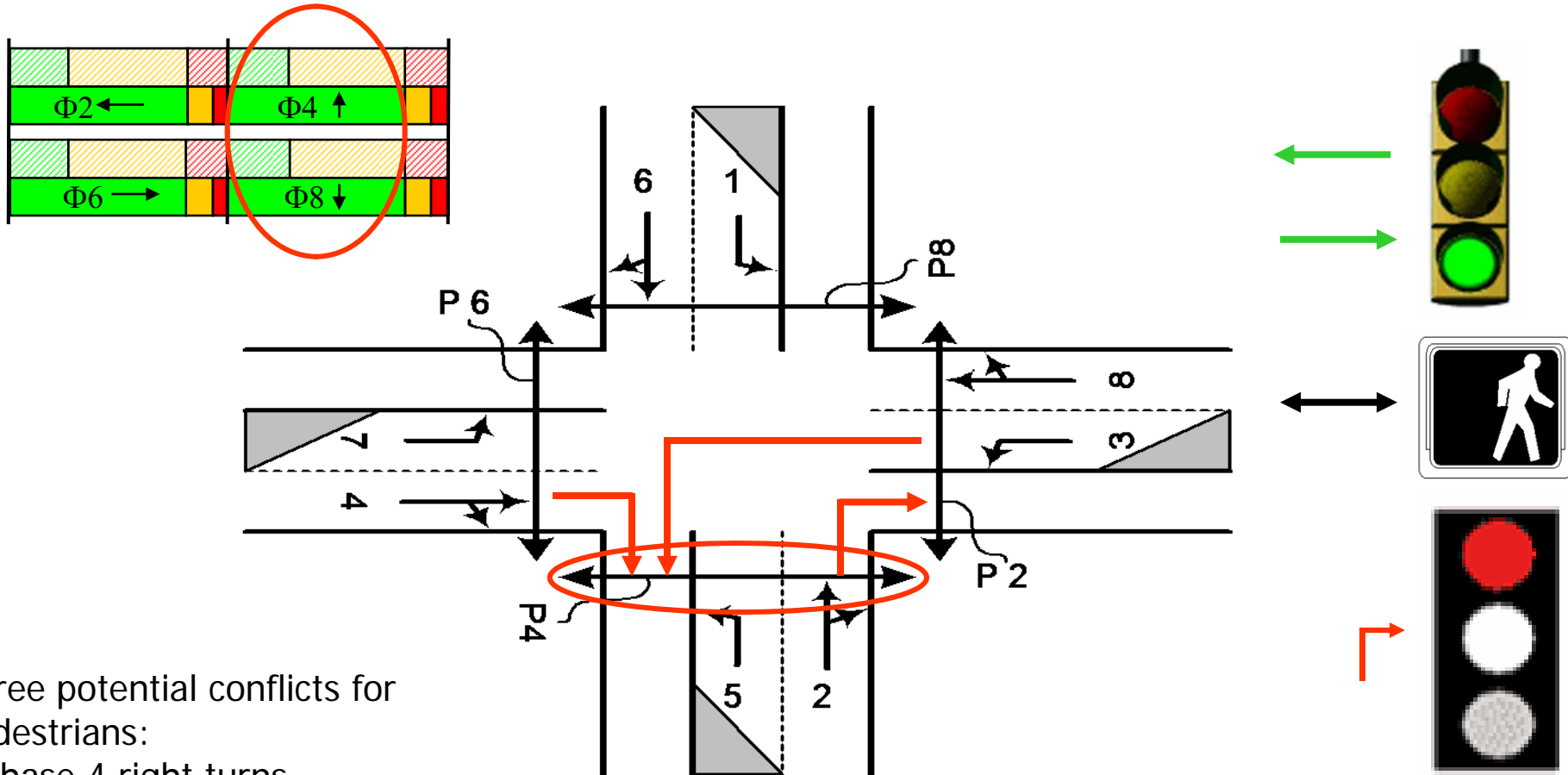
Walk Phase  
4 to 7 sec



Pedestrian Clearance Phase  
Flashing Don't Walk



# Potential Conflicts between Turning Vehicles and Pedestrians



Three potential conflicts for pedestrians:

- Phase 4 right turns
- Phase 3 left turns
- Phase 2 RTOR

RT tends to be very challenging

# Concurrent Pedestrian Service, Mid 1900s



“ A downtown shopper needed a four-leaf clover, a voodoo charm, and a St. Christopher's medal to make it in one piece from one curbstone to the other. As far as I was concerned--a traffic engineer with Methodist leanings--I didn't think that the Almighty should be bothered with problems which we, ourselves, were capable of solving.”

-Henry A. Barnes, traffic commissioner in Denver, Baltimore, and New York City, as referenced in Barnes' autobiography, *The Man With the Red and Green Eyes* (E. P. Dutton and Company, 1965)

**This is not a new problem!**

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# Pedestrian LOS Models for Signalized Intersections in the HCM

## HCM Delay (Eqn 18-5)

- Pedestrian Delay =  $0.5 (C - g)^2 / C$

Dominated by C



## HCM Time-Space Capacity (Eqn 18-16)

- Based on space per pedestrian  
Number of pedestrians, crosswalk length and width, number of turning vehicles, duration of walk and pedestrian clearance intervals

Relevant to Times Square



# HCM Pedestrian Space (Eqn 18-16)

$$\text{Space} = \frac{LW_E [(WALK + FDW) - L/(2S_P)] - 40N_{tv} W_E}{N_{Ped} [3.2 + (L/S_P) + (0.27N_{Ped})]}$$



# Pedestrians' Perceived LOS by Petritsch, Landis et al

- $LOS = 0.005689 * (RTOR + PermLefts) + 0.0001274 * (PerpTrafVol * PerpTrafSpeed) + 0.6810 * (LanesCrossed^{0.514}) + 0.04011 * \ln(PedDelay) + 0.5997$
- Equation dominated by number of lanes crossed
- **Right turn volume not a variable in equation unless there is a right turn channelized island**

# Hubbard Logit Modeling

- Demonstrated following parameters are statistically significant
  - Right turn flow rate (t-stats 4.00, 6.73)
  - Direction of pedestrian travel (t-stat -3.96)
  - CBD (t-stat -3.29)
  - Pedestrian compliance (t-stat 2.53)
  - Number of pedestrians (t-stat -3.98)
  - One-way street (width of conflict zone, t-stat 1.93)

Hubbard, S.M.L., D. M. Bullock, and F.L. Mannering, "Right-Turns on Green and Pedestrian Level of Service: A Statistical Assessment," ASCE Journal of Transportation Engineering, in press (Spring 09)..or

<http://docs.lib.purdue.edu/dissertations/AAl3307451/>

# Uncompromised vs. Compromised Pedestrian Crossing



Delay on curb



Delay in crosswalk



Evasive Action  
(Sideways or back)



Evasive Action  
Accelerate/Trot/Run

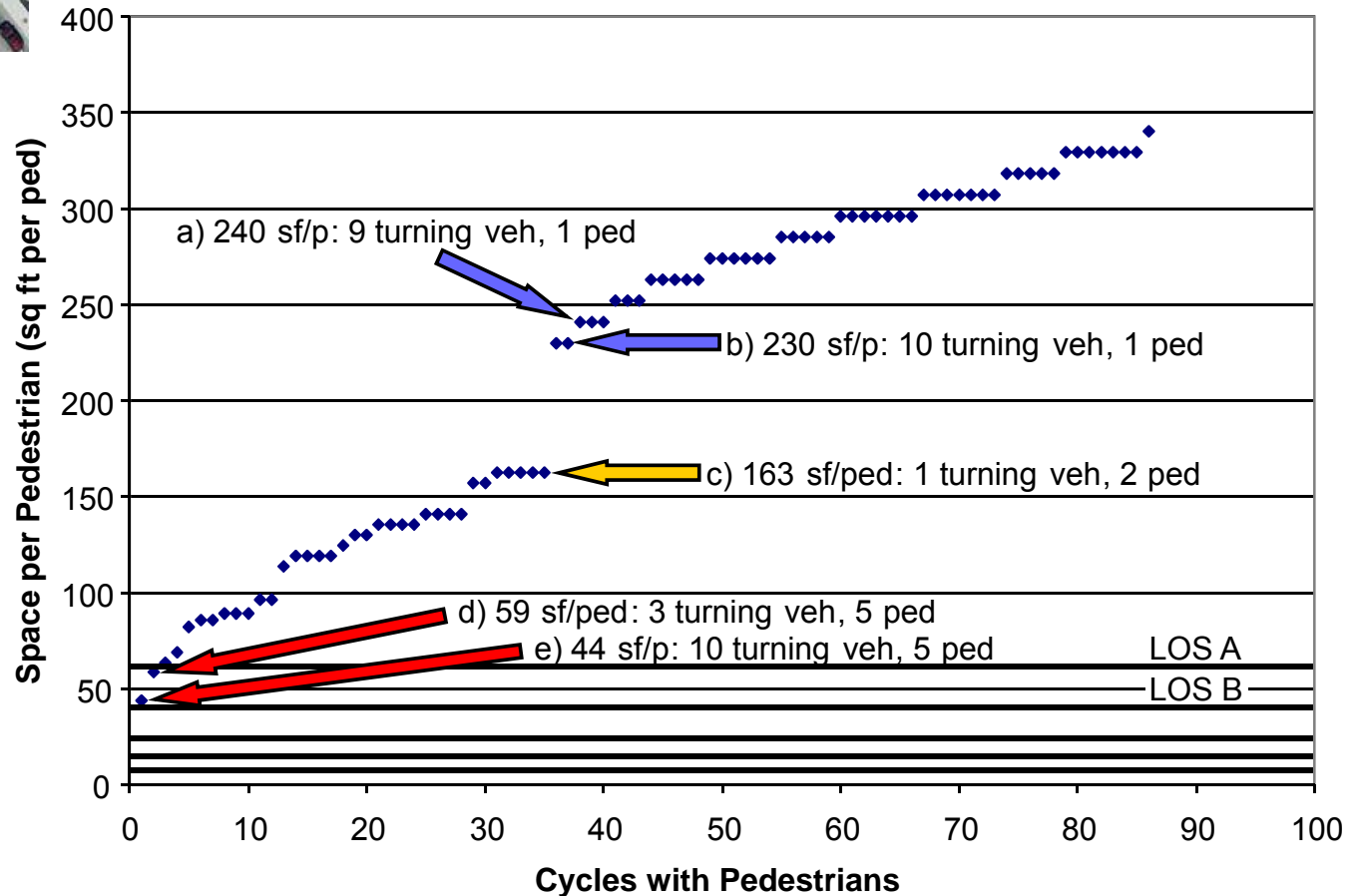
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# HCM: Ped Space

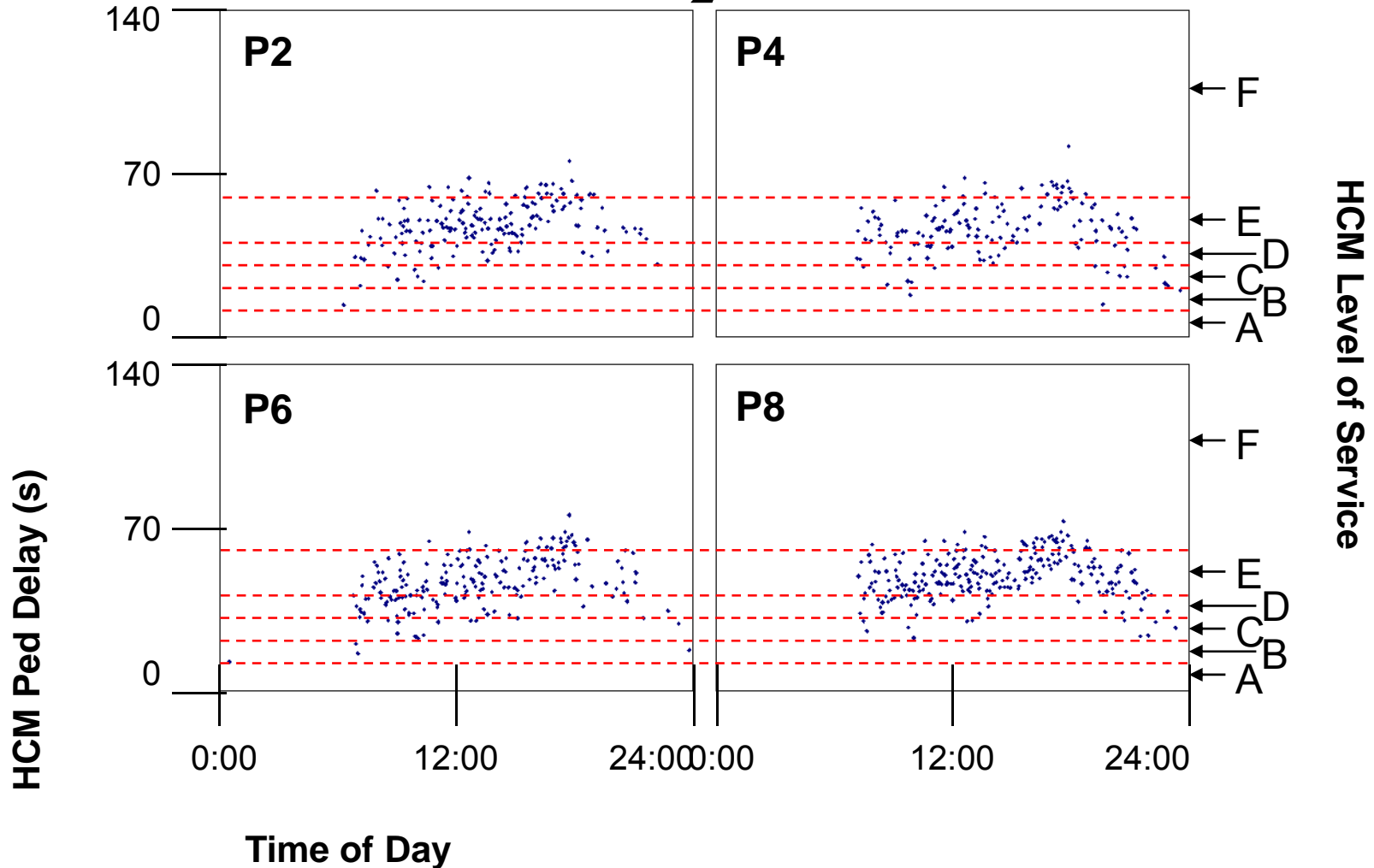


$$\text{Space} = \frac{LW_E [(WALK + FDW) - L/(2S_P)] - 40N_{tv} W_E}{N_{Ped} [3.2 + (L/S_P) + (0.27N_{Ped})]}$$



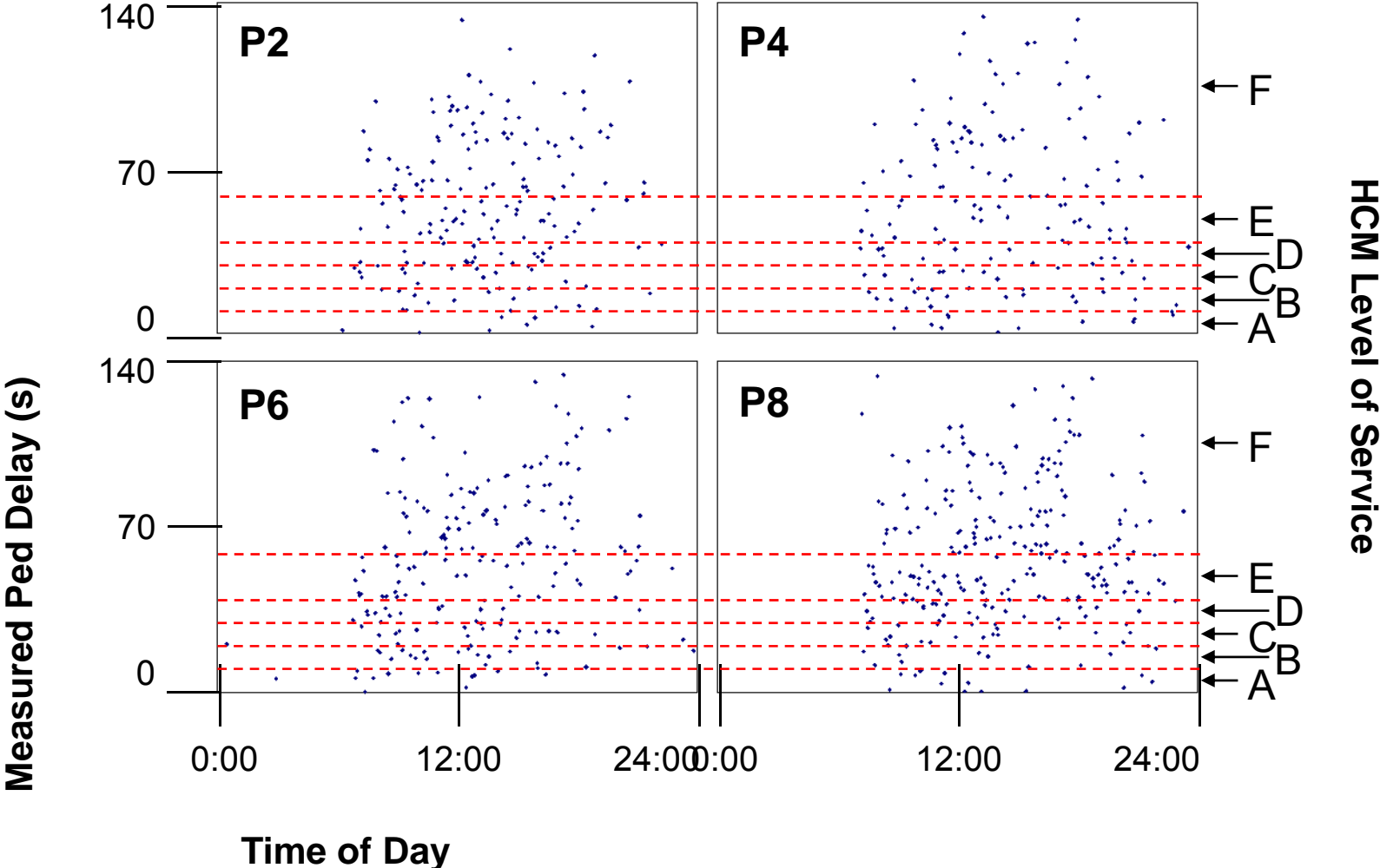
# HCM Modeled Pedestrian Delay

$$\text{Ped Delay} = \frac{1}{2} [C - (W + 4)]^2$$

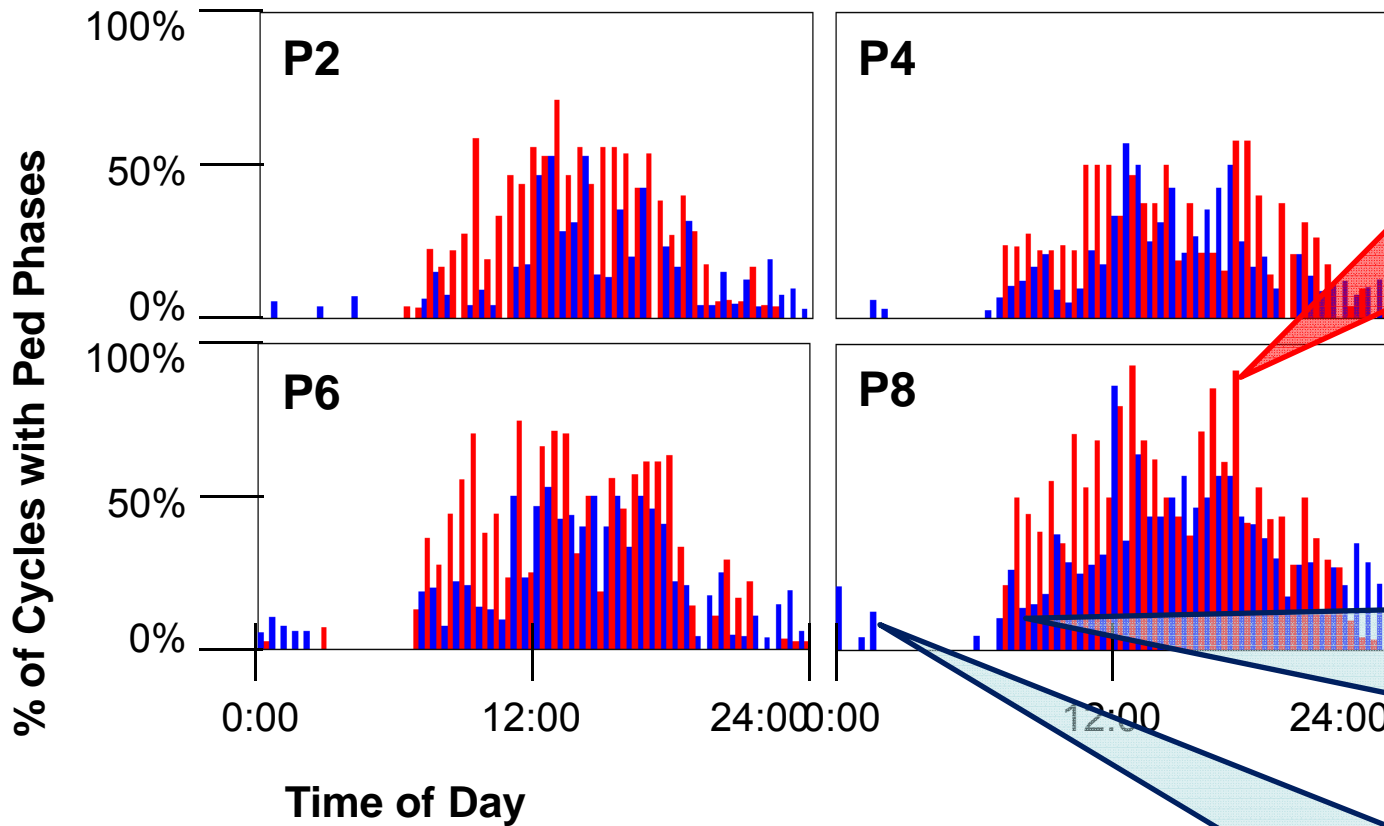




# But why model what you can directly measure (Pushbutton to start of phase)



# Percentage of Cycles with Pedestrian Phases



During semester PM cycle length must accommodate w+pc

Maybe during semester break cycle could be shorter in AM

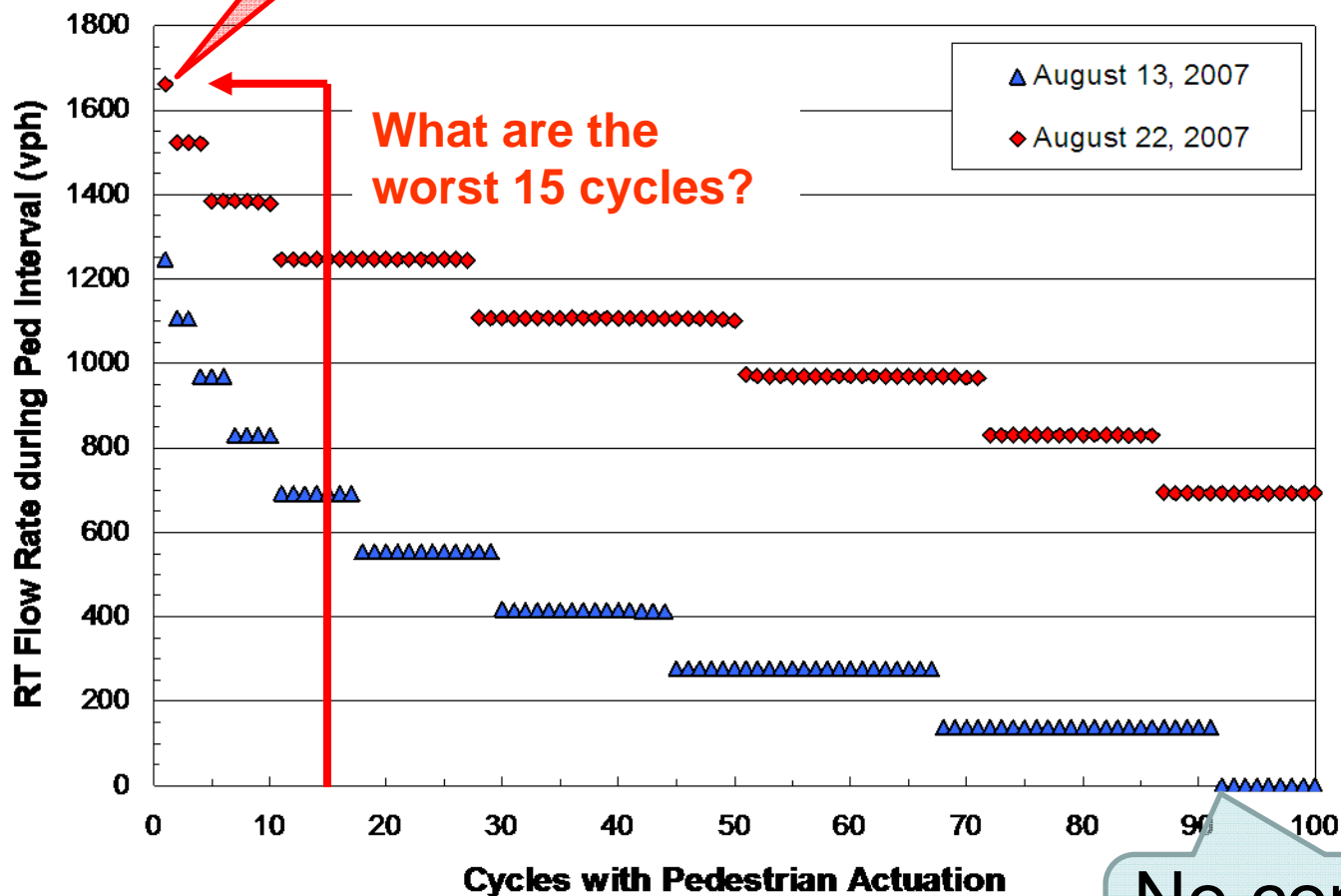
Perhaps students getting back from pre-semester studying at library?

Week Before Fall Semester (8/15/08)  
1st Week of Fall Semester (8/22/08)



Vehicle every  
~2.1s

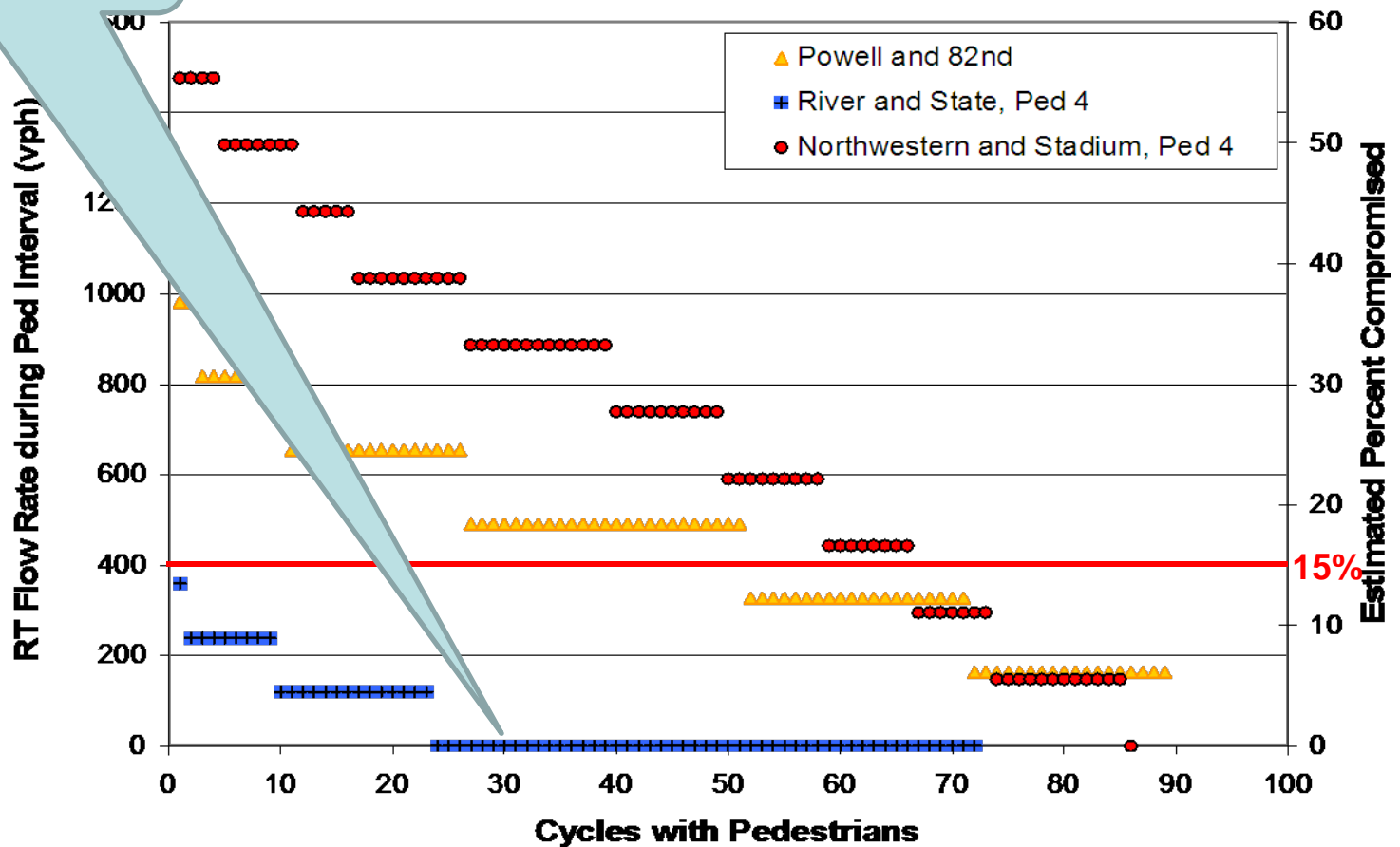
# Right Turn Volumes during Ped Phase 4



No concurrent vehicles

# Longitudinal comparison among intersection to identify priorities

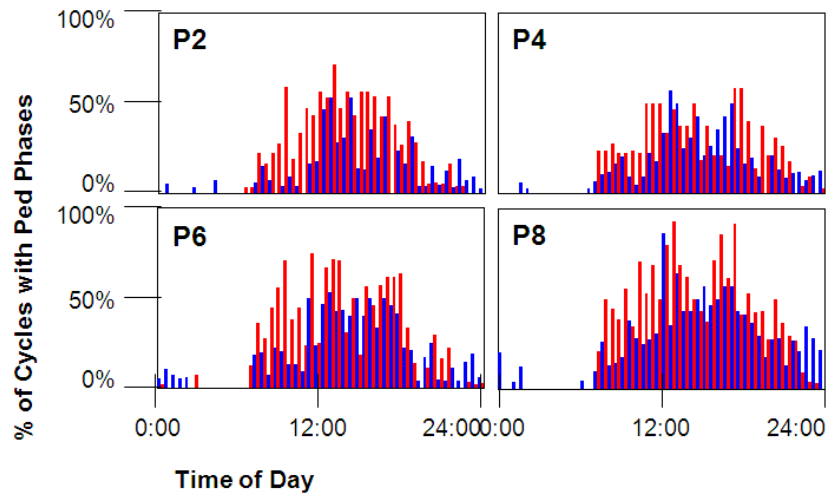
Most ped phases have no conflicting vehicles



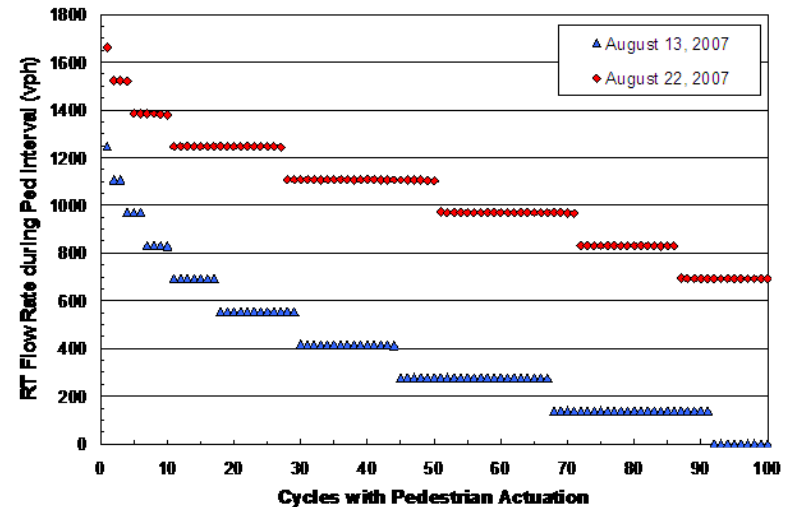
# Concluding Comments

- Several opportunities for infrastructure tabulated performance measures
  - HCM Delay (Eqn 18-5)
  - HCM Time-Space Capacity (Eqn 18-16)
  - Hubbard et.al. [Paper ID: 08-1392] in press
    - % of phase with ped actuation over 24hrs
    - Inferred compromised crossing based upon conflicting turning movement volume

# Proportion of phases that service peds



# Count of cycles with unacceptably high conflicting vehicle volumes



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# References

- Hubbard, S.M.L., R. Awwad, and D.M. Bullock, “A New Perspective on Assessing Impact of Turning Vehicles on Pedestrian Level of Service at Signalized Intersections,” *Transportation Research Record*, #2027, TRB, National Research Council, Washington, DC, pp. 27-36, 2007.
- Hubbard, S.M.L., D.M. Bullock, J. Thai, “Trial Implementation of a Leading Pedestrian Interval: Lessons Learned,” *Institute of Transportation Engineers Journal*, ITE, Vol. 78, No. 10, pp. 32-41, October 2008.
- Hubbard, S.M.L., D.M. Bullock, and C. Day “Opportunities to Leverage Existing Infrastructure To Integrate Real-Time Pedestrian Performance Measures Into Traffic Signal System Infrastructure,” Paper ID: 08-1392, submitted July 2007, revised October 2007, in press.
- Hubbard, S.M.L., D. M. Bullock, and F.L. Mannering, “Right-Turns on Green and Pedestrian Level of Service: A Statistical Assessment,” *ASCE Journal of Transportation Engineering*, in press.
- Hubbard, S.M.L., “A new perspective on pedestrian level of service at signalized intersections,” Doctoral Dissertation, Purdue University 2008.”

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