TIMING THE CLEARANCE INTERVAL

*Some ideas are so stupid that only intellectuals could believe them.*

- Michael Levine

So far, you have learned how to determine cycle length (that minimizes delay for stopping vehicles) and splits. Part of each split (or phase) is the clearance interval, and it has to be timed also. Considering a vehicle on the approach below, let's see how the logic works. Assume that we are given the following:

- Approach speed = $V$ (ft/sec)
- PIEV time = PIEV (sec)
- Deceleration rate = $a$ (ft/sec$^2$)
- Intersection width = $w$ (ft)
- Average vehicle length = $l$ (ft)

![Figure 1. Total Stopping Distance](image)

If, at *onset of yellow*, a vehicle is at or behind the vehicle location shown in Figure 1, it can stop by the time it reaches the intersection. If a vehicle is in front of this point at onset of yellow, it *cannot* stop and will enter the intersection. This critical point is located at the total stopping distance from the intersection. If we use the braking distance equation commonly found in physics and dynamics
courses, we get:

\[
Total \ Stopping \ Distance = P E V \times V + \frac{V^2}{2a}
\]

Now, let's consider Figure 2, below.

Figure 2. Maximum Distance to Clear on Yellow

In Figure 2, let X be the maximum distance that a vehicle can travel during the clearance interval, \((Y + AR)\), sec. (I'll explain later why we call it "\(Y + AR\)"). We calculate X for approach speed, V, by:

\[
X = V \times (Y + AR)
\]

If the vehicle is to clear the intersection before onset of red, he must reach the position shown on the far side of the intersection. We can determine distance D as:

\[
D = X - (w + l)
\]

A vehicle behind this location at onset of yellow cannot clear the intersection by onset of red. If we superimpose Figures 1 and 2, we get Figure 3 (shown on the following page), which reveals somewhat of a problem. A vehicle located in the shaded area at onset of yellow cannot stop before reaching the intersection. Nor can it clear the intersection before onset of red. This area is called the
**dilemma zone**, and we'd rather not have it. How can we get rid of it? We do it by "grabbing" the horizontal line marking "X" and "D" in Figure 3 and dragging it down until it is at the same point as total stopping distance, as shown in Figure 4. How can we do this? We can do it by lengthening the clearance interval such that the dilemma zone disappears.

![Figure 3. Dilemma Zone Geometry](image)

Using the geometry of Figure 4 (see next page), we can write an expression for D and total stopping distance:

\[ D = PIEV \text{ dist.} + \text{Braking dist.} \]

Substituting our earlier relationships for D and total stopping distance, we get:

\[ X - (w + l) = PIEV x V + \frac{V^2}{2a} \]

or

\[ X = PIEV x V + \frac{V^2}{2a} + (w + l) \]

But we had earlier that:
Substituting this, we get

$$V x (Y + AR) = PIEV x V + \frac{V^2}{2a} + (w + l)$$

If we divide both sides of the equation by $V$, we finally get Gazis' relationship for the change interval requirement.

$$\frac{(Y + AR)}{V} = PIEV + \frac{V}{2a} + \frac{(w + l)}{V}$$

⇐ THISIZZIT!!

**HOW TO USE IT:**

The following values are pretty much standard fare for timing the change interval.
PIEV = 1.0 sec
a = 10 ft/sec²
l = 20 ft
lane width = 12 ft
curb and gutter = 2.5 ft each side
Y and AR time- round up to nearest 0.5 sec.

**Example**

Given:

Approach speed = 35 mph
5-lane cross street
Y + AR = 4 sec

a. Is the existing clearance interval timing satisfactory?

b. If not, determine a suitable clearance interval, and show the location of the dilemma zone for the *existing timing* on a sketch.