

May 22, 2001

AVOIDING WASTED GREEN TIME

One of the primary objectives in designing and operating traffic signals is to eliminate, or minimize, wasted green time. The primary function of an intersection traffic signal is to assign the right-of-way to competing traffic streams in a safe, orderly and efficient manner. This is done by displaying the green indication to one set of non-conflicting movements at a time, and continuing to do so as long as a reasonable level of demand for the movements is present, and as long as conflicting motorists are not forced to wait too long.

In general, it is not considered good traffic operations when motorists are forced to wait at a signal even though there is little or no conflicting traffic. Green time is wasted when this occurs and wasting green time both increases vehicular delay and heightens motorist frustration.

Unfortunately, there are many items that can cause green time to be wasted. Here are a few of the more common ones:

1. **Malfunctioning Vehicular Detection** - Most vehicle detectors used for traffic signal control are designed to fail "on" when the detection device (inductance loop, microwave unit, video camera, etc.) malfunctions. This will cause the green time for the movement in question to extend until the maximum interval is reached or, if the signal is in coordination, until the force-off point is reached. Since maximum intervals and force-off points are usually set high to accommodate peak-period traffic flows, during most of the day there will be more green time given to the movement than is needed. Consequently, the malfunctioning detection will result in a considerable amount of wasted green time. The negative effect will be particularly evident late at night when the green indication for the movement associated with the malfunctioning detection comes up every cycle (even if there is no demand) and stays on for what seems like an eternity.
2. **Malfunctioning Pedestrian Detection** - If a pedestrian push-button shorts to the "on" position then the pedestrian WALK and flashing DON'T WALK intervals for that movement will be displayed every cycle. This will cause the green time for the associated vehicular movement in question to extend until the pedestrian intervals have timed out - which can be an extensive period of time for a wide intersection. Consequently, malfunctioning pedestrian detection usually results in a considerable amount of wasted green time. The negative effect will, once again, be particularly evident late at night when the green indication for the movement associated with the malfunctioning pedestrian detection comes up every cycle (even if there is no pedestrian or vehicular demand) and stays on for what seems like half-an-eternity.
3. **Inappropriate Use of Recall** - Recall is typically used to return the green indication to the highest volume movement at an intersection (usually the major street thru movement) when demand on other conflicting movements has ceased. However, sometimes recall becomes

inadvertently activated for one of the minor movements, causing this movement to receive the green indication even when there is no demand. This improper use of a recall setting can result in wasted green time. The negative effect will, once again, be particularly evident late at night when traffic volumes are low and the green indication for the recall phase comes up every cycle, even when there is no vehicular demand.

4. **Excessive Coordination** - When signals are kept in coordinated operation even though main street traffic volumes are low and platooning is weak (such as occurs late at night), wasted green time results. Side street motorists are forced to wait unnecessarily and motorist frustration skyrockets. The same effect can occur when unreasonably long cycle lengths are used during coordination, cycle lengths that produce long intervals of time when there is no traffic on the main street yet side street motorists are being forced to wait.
5. **Unwarranted Use of Restrictive Left Turn Phasing** - If protected-only left turn phasing is used at locations where protected/permissive phasing would work fine, then unnecessary delay results and green time is wasted. Not allowing motorists to turn permissively when it is safe to do so forces these motorists to make turns during the protected left turn phase, which steals green time away from other movements at the intersection. The same is true, but to a lesser degree, when protected/permissive left turn phasing is used at locations where permissive phasing would suffice. Consequently, restrictive left turn phasing should only be used at locations that, for safety reasons, warrant it.
6. **Use of High Initial Intervals** - When higher-than-needed initial intervals are used, especially for minor movements, a substantial amount of green time is wasted during cycles when only one or two minor movement vehicles are waiting for the green (such as occurs during low volume periods).
7. **Use of Long Passage Intervals** - When longer-than-needed passage intervals are used, green time is wasted in two ways:
 - A. The green continues to extend for a phase even though a large gap exists between successive vehicles, and
 - B. The green is inefficiently extended for a longer-than-necessary time after the last vehicle clears the detection zone."Snappy" transfer of the right-of-way is lost and lethargic signal operation results.
8. **Use of Locking Operation** - When a phase is set to locking operation then a call will remain on the phase even if the vehicle leaves the detection zone before the next green is displayed. This can happen in one of three ways:
 - A. The vehicle proceeds thru the intersection on the yellow (since locking operation becomes active during any non-green period, including the yellow), or
 - B. The vehicle turns right on red, or

- C. If locking operation is set for a protected/permmissive left turn then the call will remain for the protected phase even though the vehicle turned left during the permmissive period.

Consequently, locking operation wastes green time and should not be used unless absolutely necessary. The negative effect of locking operation will be particularly evident late at night when traffic volumes are low and the probability is greatest that the green indication for the locked phase will come up when there is no vehicular demand.

- 9. **Non-Use of Delay Detection** - The appropriate use of delay detection helps reduce wasted green time. The following three situations benefit from the use of delay detection:
 - A. Side Street Exclusive Right Turn Lanes - Using delay detection here gives the side street motorist a chance to turn right-on-red before forcing main street traffic to stop. A typical delay setting for this situation would be about 10 seconds. Delay detection can also be beneficially used for shared thru/right lanes on the side street. However, the level of benefit obtained is less since only some of the motorists using this shared lane will be turning right. A typical delay setting for this situation would be about 6 seconds.
 - B. Main Street Protected/Permmissive Left Turn Lanes - Using delay detection here prevents the left turn arrow from coming up during low volume periods when the signal is resting in green on the main street. Without delay detection, the right-of-way will transfer to the protected left turn movement even though the motorists already turned left during the permmissive period. The end result will be the display of the green to an empty approach. A typical delay setting for this situation would be about 4 seconds.
 - C. Side Street Inside Lanes that are not Protected by a Median - If the main street thru movement is resting in green and vehicles making a permmissive left turn from the main street "cut across" a side street loop, the loop will be activated and the green could be transferred to an empty approach. To avoid this problem, delay detection should be used for innermost side street lanes that are not protected by a median. A few seconds of delay is all that is needed.

The negative effect of not using delay detection will, once again, be most evident late at night when traffic volumes are low and the signal is resting in main street green. During this time, any momentary demand will immediately transfer the green from the main street even though the green is not needed.

As you might have deduced from the above discussion, a very good way to spot operational problems that waste green time is to observe intersections late at night since the negative effects of most operational problems are most noticeable when traffic volumes are low. However, it still takes a trained eye to spot these problems and to come up with the appropriate solution. Rotating an experience signal technician or signal timing engineer onto the night-owl shift once in a while, and forcing him or her to "ride the circuit" around town, could pay significant dividends in spotting these problems in your community.

Another important realization that can be made based on the above discussion is that low volume flashing operation is very useful in reducing the negative effects of many of these problems. Malfunction detection, inappropriate recalls, missing delay settings, and the like are all of no consequence when the signal is in flash. The associated reduction in motorist delay and frustration is an often overlooked benefit of low volume flashing operation.