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ADJUSTING THE RESPONSIVENESS OF A FULLY ACTUATED TRAFFIC SIGNAL

One of the primary advantages of a properly timed fully-actuated traffic signal is that it provides each movement with just enough green time to serve all of the waiting vehicles. Once the vehicles for a particular movement have been served, the green is then transferred to the next movement (or set of movements) where vehicles are waiting. This type of operation usually results in an efficient allocation of green time amongst competing movements and also tends to minimize the delay incurred by waiting motorists.

However, there are some drawbacks to timing a signal so that the green "pinballs" back and forth between conflicting movements:

1. Every time the green is transferred a certain amount of non-productive "dead time" is incurred. This dead time is associated with the yellow and all-red change intervals as well as vehicle start-up delay. Research has shown that about one-third of the yellow and all-red change interval is dead time (which means that motorists keep going through 2/3 of the change interval!) while another 2 or 3 seconds of dead time is experienced as waiting vehicles begin moving. In total, about 4 seconds of time is lost every time a phase change occurs.

2. For a fully-actuated signal, if there is a big enough gap in main street traffic then just a single vehicle on the side street or in the main street left turn lane will transfer the green away from the main street. This transfer of green away from the main street can happen even if a large main street platoon is about to arrive at the intersection, forcing the platoon to abruptly stop.

3. For some movements to be made, there is little or no need to transfer the green from the main street. For example, unless traffic volumes are heavy, right turns from the side street can usually be made on the red indication. Likewise, protected/permissive left turns from the main street can usually be made on the ball green if volumes are not too high. Quickly transferring the green to service these movements can be wasteful.

4. The public is accustomed to main street motorists receiving more green time than side street motorists and often express frustration if the main street traffic stream is interrupted too frequently in order to let side street motorists in. Likewise, side street motorists are accustomed to having to wait a bit before receiving the green indication.

So we see that there are reasons and circumstances under which it may be of interest to time an actuated signal so as to favor main street traffic flow at the expense of side street traffic. Probably the most popular way of doing this is to place the signal into coordinated operation so that the green is "held" on the main street, allowing the side street phases and main street left turn phases to be serviced only once per cycle. If a 120 second cycle is used, then these minor phases are serviced only once every 2 minutes.

However, if the signal in question is not in coordination (it may be too far away from other signals for coordinated operation to be of any benefit, or the signal may not be coordinated late at night when main street platoons are small), one will have to turn to other means to favor the main street motorist. The following actions can be taken, either individually or in combination, to accomplish this end:

A. **Increase the Initial Interval for the Main Street Thru Phases:** This change will increase the guarantee minimum green time for the main street. It has the most effect during low volume traffic conditions since the green is routinely extended well beyond the initial interval during high volume conditions.

B. **Increase the Passage Interval for the Main Street Thru Phases:** This change will result in more main street green time. With a longer passage interval, the main street green will be extended a higher percentage of the time since it will take a larger gap between vehicles to terminate the green.

C. **Increase the Maximum Interval for the Main Street Thru Phases:** This change increases the maximum amount of green time that can be given to the main street. It has the greatest effect during high volume traffic conditions since the maximum green is seldom reached during low volume conditions.

Under low volume traffic conditions, increasing the maximum interval has essentially no effect on the amount of green time which the main street will receive. In this case, if it is desired to increase the amount of green time going to the main street, one is better-off to increase the extension and initial intervals. However, the opposite is true under high volume traffic conditions. In this case, increasing the initial interval has no effect and one is better off to raise the extension interval and maximum intervals.

D. **Do Opposite of the Above for Side Street Phases and Main Street Left Turn Phases:** By reducing the initial, extension, and maximum intervals, minor movement phases will be shortened, resulting in more green time for the main street.

E. **Activate Simultaneous Gap Out for Main Street Thru Phases:** By activating the simultaneous gap out function, both main street phases will have to gap out at the same time for the green indication to transfer to the side street. The end result is that the green remains on the main street for a longer period of time.

F. **Activate Non-Locking Operation for Side Street Phases and Main Street Left Turn Phases:** By activating non-locking operation (memory off) for these phases, vehicles which pass thru the detection area will not lock a call into the controller, allowing the green to remain with the main street. Locking operation for a phase is active whenever the signal indication for that phase is not green, including during the yellow interval. Under locking operation, if a vehicle traverses the detection area when the signal turns yellow, and then continues through the intersection on the yellow, the vehicle will be remembered. This usually causes the green to be falsely displayed to an empty approach the next time the phase is serviced. Activating non-locking operation prevents this from happening.

G. **Activate Delay Detection for Side Street Right Turn Lanes and Main Street Protected/Permissive Left Turn Lanes:** By using delay detection for these movements, the green will not be transferred from the main street unless vehicles are detected for a period longer than the delay interval. In other words, vehicles that promptly turn right on red, or promptly turn left on a green ball, will not take the green away from the main street.

H. **Omit Main Street Left Turn Phase:** Time can be taken-away from certain minor phases by omitting these phases altogether. For example, by omitting the protected portion of a protected/permissive left turn (forcing motorists to turn left on the green ball), more time is made available for other phases, including the main street thru movements. Phase omits can be done on a time-of-day basis so that the movement is only omitted when it is not needed, such as when turning volumes are low.

I. **Activate Maximum Recall for the Main Street Thru Phases:** This essentially converts the signal from fully-actuated operation to semi-actuated operation, with the main street thru phases receiving their maximum green time every cycle. This is a drastic solution that heavily favors the main street.

The most powerful effect is achieved when these actions are combined.

For example, using a long extension interval (7 seconds) and a high maximum interval (90 seconds) on the main street, combined with a short extension interval (3 seconds) and low maximum interval (20 seconds) on the side street, one will cause the green indication to remain with the main street for a very high percentage of the time. If simultaneous gap is activated for the main street phases and non-locking operation with delay detection is used for the side street, then the overall percentage of green time provided to the main street will be even greater.

By modifying the above settings, one can adjust signal responsiveness from very lethargic (slow to leave the main street) to very snappy (pinball-wizard).