Discussion of the paper by Feng-Bor Lin
"Timing Design of Signal Change Intervals"

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In "Timing Design of Signal Change Intervals," Feng-Bor Lin presented data on the clearance time requirements of a limited number of vehicles at 11 sites, which were compared with the clearance time requirements as calculated by the formula recommended by ITE, and with the actual signal change intervals. Alternatives to the ITE timing formula were derived from analyses of traffic flow and intersection characteristics. From these analyses, the author claimed that the first two terms of the ITE formula (t + V/2a) can be combined into a constant term that is a much more "logical form" than the ITE formula and that will result in more accurate estimates of timing requirements. Closer examination of this study reveals that, in fact, the clearance time data presented by the author are not inconsistent with the ITE formula and that the ITE formula and procedures are adequate for most intersections.

In arguing for alternative equations, the author has disregarded the statistical variation associated with their estimated parameters. Detailed comparison of the ITE formula and Equations 7 and 9 from Lin's analysis shows that they are not statistically different (see accompanying table). Comparing the ITE parameters with Equation 7, the estimates for the coefficients for A, B, and C are all within the 95 percent of confidence interval of the comparable parameters in the ITE equation. If the average of the 85th percentile vehicle speeds at all the sites (51.4 ft/s) is substituted as a constant for V in the first term of the ITE formula (t + V/2a), it becomes

$$T = 3.57 + \frac{W + L}{V} .$$

The first term (3.57) of this equation is within the statistical variability of Equation 9, but the coefficient for the second term is not (1.0 compared with 0.95). Overall, these alternative equations are not meaningfully different from the ITE formula.

Lin's data generally confirm the validity of the ITE formula and procedures. Although a timing equation with a constant term, such as provided by Lin may be simple, the ITE formula is preferable because it provides adequate timing that is based on specific combinations of traffic flow and intersection characteristics. In general, the alternative formulas derived by Lin will result in longer change intervals except for approach streets with slow traffic that must cross a wide cross street. Two recent studies have found that this scenario tends to have less than adequate change intervals and higher rear-end and right-angle crash rates.[18,19]

Finally, the author has misinterpreted the first two terms of the ITE equation ($t + V/2a$) as "representing the time required for a driver to come to a stop after the yellow interval begins." On the contrary, this expression represents the time it takes vehicles to travel the distance within which most drivers would reject stopping. The actual time it takes to stop a vehicle is $t + V/a$, which is longer than the previous expression. Time is not a constraining factor for stopping but distance is.

The data provided by Lin in Table 4 show that the ITE formula typically provides sufficient signal change interval time for 95 percent of vehicles at most sites. The author has failed to demonstrate that

either of the proposed alternative formulas are superior or significantly different from the ITE formula in terms of underlying theory or performance. There were, however, some sites for which the ITE formula, as well as Lin's equations, would have accommodated less than 90 percent of the clearing vehicles. It would be of interest to examine these intersections for specific characteristics that may contribute to this failure.

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(18) Zador, P., Stein, H., Shapiro, S. and Tarnoff, P. The effect of clearance interval timing on traffic flow and crashes at signalized intersections, ITE Journal, November 1985.

(19) Taghipour-Z,A. Relationship between accident experience and timing of the clearance interval at signalized intersections (unpublished thesis). Atlanta, GA: Georgia Institute of Technology, School of Civil Engineering, March 1985.

TABLE

Comparison Of Timing Equations

Equation	Parameter	Estimate	Standard Error
ITE Formula: $T = t + \frac{V}{2a} + \frac{C(W + L)}{V}$ (t = 1.0 sec, a = 10 ft/sec^2)			
	t	1.0	-
	1/2a	0.05	-
	C	1.0	-
Equation 7: $T = A + BV + C\frac{(W + L)}{V}$			
	A	3.38	1.36
	B	0.017	0.022
	C	0.63	0.22
Equation 9: $T = A + B\frac{(W + L)}{V}$			
	A	4.36	0.57
	B	0.56	0.20