Signal Timing Based on TRANSYT-7F

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In a climate of increasing concern over energy consumption in general, and fuel consumption by motor vehicles in particular, the Federal Highway Administration is promoting a number of actions that can be implemented to conserve energy and fuel. One area of emphasis that appears to have a high potential for reducing vehicular fuel consumption is the development of efficient timing plans for traffic signal systems.

The Federal Highway Administration used TRANSYT computerized optimization model to test this hypothesis in their National Signal Timing Optimization Project. Fort Wayne was fortunate to be one of only 11 cities in the nation to be chosen to participate in this endeavor.

The TRANSYT model was developed by Dennis I. Robertson of the United Kingdom in 1967. Since then, the Transport and Road Research Laboratory (TRRL) in the United Kingdom have made improvements so that there have been six versions since the original. The seventh version was used for this project and the University of Florida Transportation Research Center made modifications to this version to make the program easier to use.

TRANSYT is a very powerful signal timing tool. The computer used to run TRANSYT must have a 32-bit (or more) word length and a minimum core storage of 280 K bytes. It must also have a ANSI standard FORTRAN compiler and library functions. Because of this, it is suggested that use of the program be limited to use by agencies with two dimensional signal networks with greater than ten signals.

The two major functions of TRANSYT-7F are to simulate traffic flow and optimize the traffic signal timing plans. In order to do this the user must input the following data, so the traffic model may represent traffic flow within the network, accurately:

I. Network Data
   A. Intersections
   B. Block lengths
   C. Traffic regulations
      1. Parking
      2. Turn-only lanes
3. Turn restrictions

D. Bus Routes

II. Signal Timing Data
A. Signal sequence
B. Interval duration
C. Minimum phase duration
D. Cycle lengths
E. Offsets

III. Capacity Parameters
A. Saturation flow
B. Start-up lost time
C. Extension of effective green

IV. Speed Data

V. Volume Data
A. Link volumes
B. Turning movements
C. Classification - trucks
D. Major Mid-Block entry
E. Link-to-Link counts

Using this data the program optimizes phase lengths and offsets for a given cycle length by minimizing an objective function called the Performance Index (P.I.). The P.I. is a linear combination of delay and stops and is expressed as follows:

\[ P.I. = \sum_{i=1}^{n} (d_i + (k \times s_i)) \]

where \( d_i \) = delay on link \( i \) (of \( n \) links) in veh-hr
\( s_i \) = stops on link \( i \) in stops/sec
\( k \) = user input coefficient to express the importance of stops relative to delay

In order to minimize fuel consumption it was suggested to set \( k = 25 \).

As previously stated, the optimal phase lengths and offsets are generated for each computer run. In order to determine the "optimal" cycle length and the best phase sequence alternative, multiple computer runs are required.

Output from the TRANSYT-7F program includes the following:

I. Input Data
II. Performance Tables
A. Per link
B. Total node
C. System
   1. Delay (VEH-H/H)
      a. Uniform
      b. Random
   2. Stops (VEH-H/H)
   3. Maximum back of queue (VEH)
   4. Fuel Consumption (GAL/H)
   5. Speed
      a. Distance Traveled
      b. Time Spent
   6. Performance Index

III. Flow Profile Plots

IV. Controller Settings

V. Time-Space Diagrams

By analyzing this output the traffic Engineer can determine where
to expect problems within his signalized network and judge the quality
of progressive flow within his system. Output from various runs can
also be compared to determine the "optimal" cycle length and phase
sequence scheme.

In Fort Wayne, we optimized five separate timing plans involving
45 signals within our CBD computerized network. Approximately 20
separate optimization computer runs were required to come up with
the final results. The total cost of the project was $13,272.76. The total
estimated cost savings as a direct result of this project amounted to
$554,798 annually.

It can be seen from this that computer optimization programs are
very cost effective. The TRANSYT program, in particular, provides a
very powerful tool for the traffic engineer in analyzing his signal net­
work and timing it to its maximum efficiency.