TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM

Project Summary Report 4020-S
Project 0-4020: Improvements to Signal Timing Software

Authors: Nadeem A. Chaudhary, P.E., and Chi-Leung Chu

PROJECT SUMMARY REPORT

New PASSER Program for Timing Signalized Arterials

Engineers working with the Texas Department of Transportation (TxDOT) and Texas cities, as well as consultants, use Progression Analysis and Signal System Evaluation Routine (PASSER) II for developing bandwidth-based signal timings for their signalized arterials. PASSER II was originally developed with TxDOT support more than 30 years ago. The optimization technology used in PASSER II is simple but efficient. In addition, it has proven to produce high-quality timings for signalized arterials. Furthermore, bandwidth-based timings are easily recognized and appreciated by motorists in Texas and many other parts of the United States.

PASSER II development, however, has not kept up with enhancements in Windows-based operating systems for personal computers. As a result, its use has declined in the last decade. During the same time, an easy-to-use Windows-based program, known as Synchro, grew in popularity. However, most TxDOT staff do not feel comfortable implementing timings developed by Synchro because the quality of signal timings produced by this program is not known. Traffic Network Study Tool (TRANSYT), version 7F, is another signal timing optimization program. It is popular in many states, excluding Texas.

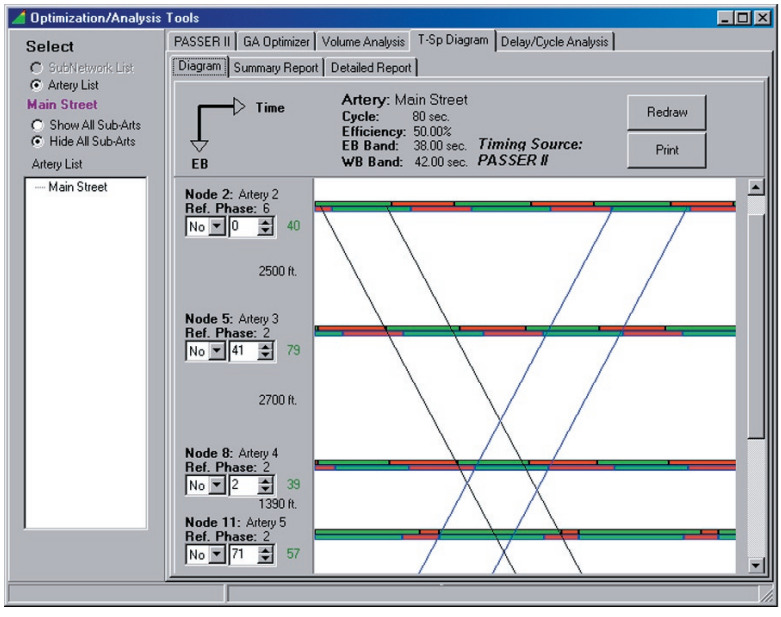

Figure 1. PASSER V Time-Space Diagram.

TxDOT funded this two-year project to achieve two objectives. The first objective was to compare Synchro, TRANSYT 7F, and PASSER II-90 and to develop guidelines for selecting the right software for use in signal timing projects. Synchro and TRANSYT 7F develop timings to minimize a delay-based objective function. PASSER II, on the other hand, optimizes timings to maximize arterial through progression. The second objective was to develop an enhanced version of PASSER II. These enhancements include a new Windows-based graphic user interface and improved optimization and analysis algorithms for arterials. Figures 1 and 2 show sample screens from the enhanced program.

What We Did...

We divided the research and development work into two major tasks matching the two objectives. The following is a description of work performed under these tasks.

Task 1: Software Comparisons

For comparing the three programs, we used data from eight real arterials obtained from several agencies. Five of these arterials had five to six intersections. For each of these, we received one real volume scenario. In addition, we applied one reduction factor and one growth factor to obtain two additional volume scenarios for these five arterials. The other three arterials had 10, 12, and 14 intersections, respectively. For two of these three arterials, we received real volume data for two peak periods.

This data collection approach resulted in a total of 20 different scenarios. Using all scenarios for the five small arterials, we conducted a total of 65 optimization runs using the three programs. In order to ensure unbiased comparison of the three programs, we simulated the timings developed by each program using Corridor Simulation Model (CORSIM), a program developed and supported by the Federal Highway Administration. For each timing plan, we conducted 20 replications of simulation using CORSIM and averaged these results for comparison. In all, we conducted a total of 1300 simulation runs using CORSIM.

These results identified the two best programs. Then, we used all five scenarios for the three large arterials to further analyze the performance of these two programs. During this stage of analysis, we performed more than 400 optimization and simulation runs.

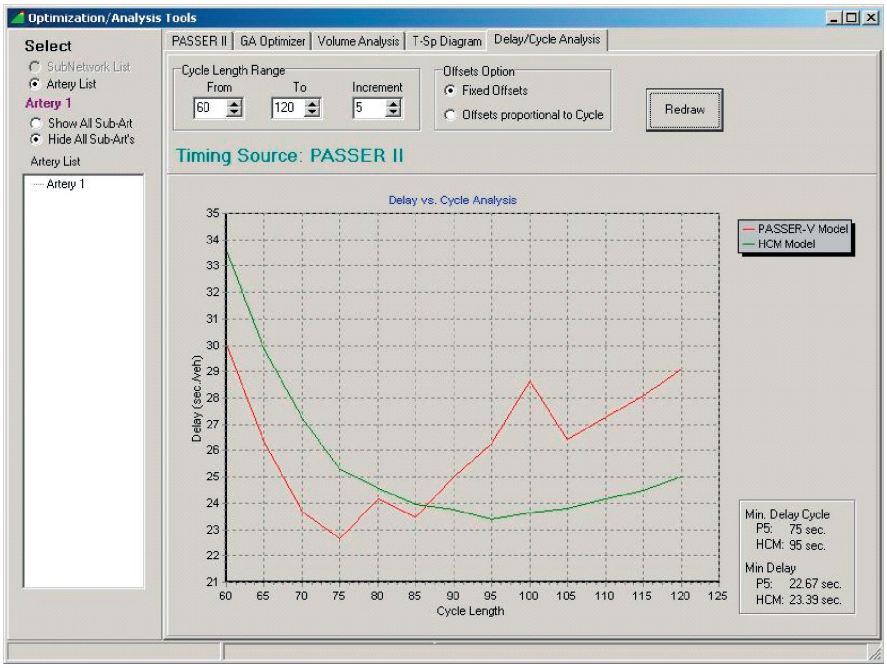

Figure 2. Sample Output from Delay Analysis Model.

Task 2: Enhancements to PASSER

In this task, we developed PASSER V, a new Windows-based program for timing signalized arterials. In PASSER V, we programmed the best features of the three programs analyzed in Task 1. These features include: a graphic user interface for easy data entry, bandwidth optimization algorithms, and a delay analysis and optimization algorithm that applies to all types of traffic conditions. We also compared the performance of this new PASSER program using 20 replications of CORSIM simulation for each case. In this comparison, we used all three programs used in Task 1. In addition, we used the base volume scenarios for all five small arterials.

What We Found ...

Task 1: Software Comparisons

For optimizing arterial operations, both Synchro 4 and PASSER II-90 outperformed TRANSYT 7F. Although TRANSYT 7F's traffic model was more accurate for simulating traffic than the other two programs, it failed to produce progression bands, and its delay was higher than that of other programs. We also found that Synchro produced timings with the least delay, and PASSER II produced timings with larger progression bands, fewer stops, and the ability to move more traffic through the system. In addition, we found that a judicious selection of cycle length results in PASSER II timings with delays comparable to or lower than those of Synchro. Further analysis of Synchro and PASSER II revealed that Synchro's ability to produce two-way arterial progression degrades for large arterials. We also found that Synchro has a tendency to estimate lower delays than PASSER II for the same timing plan.

Task 2: Enhancements to PASSER

Because of its Windows-based graphic user interface, PASSER V is more flexible and much easier to use than previous versions of PASSER programs. By comparing PASSER V optimization algorithms with other programs, we found that PASSER V produces:

- timings with better progression bands than PASSER II when the same green splits are used, as well as higher productivity than the other programs; and
- timings with delays similar to those of Synchro and lower delay than TRANSYT 7F.

In addition, PASSER V also provides a capability similar to PASSER III for timing signalized diamond interchanges, and a new planning/operations model to analyze the space issue for four-phase diamond interchanges. The other programs either do not have these features, or their capabilities to analyze/optimize diamond interchange operations are limited. Figures 1 and 2 provide screen shots from PASSER V to illustrate some program features.

The Researchers Recommend...

Among the existing programs compared in this project, both Synchro and PASSER II produced good timings. For timing arterials, PASSER V provides the best features of these two programs and TRANSYT 7F. Therefore, we recommend PASSER V for all future arterial signal timing projects. PASSER V is as easy to use as Synchro and provides additional features not provided by the other programs. These additional features include models for optimizing and analyzing Texas diamond operations. We recommend that the program be released to agencies outside TxDOT upon approval from the project panel.

For More Details . . .

The research is documented in the following report: Report 4020-1, *Software for Timing Signalized Arterials.*

Research Supervisor: Nadeem A. Chaudhary, Ph.D., P.E., Texas Transportation Institute, n-chaudhary@tamu.edu, (979) 845-9890

Research Co-Supervisor: Suleiman Ashur, Ph.D., The University of Texas at El Paso

Researchers: Chi-Leung Chu, Texas Transportation Institute, c-chu@tamu.edu, (979) 845-9892
Vijay G. Kovvali, Texas Transportation Institute
S. M. Mahabubul Alam, The University of Texas at El Paso

TxDOT Project Director: Rohit Parikh, P.E., rparikh@dot.state.tx.us (817) 370-6617.

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This research project involved the comparison of three well-known programs for optimizing arterial signal timings and development of guidelines for selecting software for use in signal timing projects. As a result, an enhanced version of the PASSER II program was developed for optimizing arterial signal timings. This new version was named the PASSER V program. Three products were required for this project:
1) draft guidelines for selecting software for use in signal timing projects,
2) guidelines for selecting software, and
3) enhanced PASSER II software.

TxDOT personnel may start using the guidelines and the new PASSER V program developed in this research. These products will improve their ability to time signalized arterials in a more efficient manner. Researchers from the Texas Transportation Institute have developed a training book and are conducting workshops to train TxDOT personnel in the effective use of PASSER V.

For more information, contact Mr. Wade Odell, P.E., RTI Research Engineer, (512) 302-2363, or e-mail wodell@dot.state.tx.us.

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