DEPARTMENTAL INFORMATION EXCHANGE

Summary Report 1153S
August 1993

IMPROVING THE TRAFFIC ASSIGNMENT PROCESS

PROBLEM STATEMENT

Constructing and maintaining our transportation systems involves the prediction of how much traffic will use various sections of the roadway in the future (typically 20 years). To develop these projections, a three- or four-step modeling process is used. Since project planning is so vital in making firm implementation decisions, those involved must have efficient access to a sound analytical base and useful data, particularly in the final step of this process—the area of traffic volume prediction (traffic assignment). The four-step models essentially address the following four questions:

1) How many trips will be made (the trip generation step)?
2) Where will they go (the trip distribution step)?
3) What mode of transportation will be used (the mode choice step)? and
4) Along what route(s) will the travel occur (the traffic assignment step)?

A number of concerns have been expressed regarding the traffic assignment process—such as the fact that no major modifications or improvements have been applied to the models for several years, and the perception that the traffic assignment process does not respond in a timely manner to the needs of the Texas Department of Transportation (TxDOT) districts. Additionally, as Environmental Protection Agency (EPA) regulations regarding mobile sources of pollution in non-attainment areas steadily increase, officials will likely depend upon the data from the traffic assignment process to estimate current and predict future levels of mobile source emissions. Thus, the traffic assignment models used in Texas must be as accurate and efficient as possible. Specifically, the capacity restraint models used in the Texas Travel Demand Package—the software used in TxDOT's mainframe computer—show a need for improvement in accuracy and efficiency to achieve the "state-of-the-practice" in traffic assignment.

OBJECTIVES

The Texas Transportation Institute (TTI) conducted study 1153, *Improving the Efficiency, Effectiveness, and Responsiveness of the Traffic Assignment Process*, for the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA) with two overall objectives in mind: 1) to improve the capacity restraint models used in the Texas Travel Demand Package for systems analyses, and 2) to investigate an automated, project-level traffic assignment process which reduces manual refinement of the assignment results for

TEXAS TRANSPORTATION INSTITUTE

In cooperation with
Texas Department of Transportation
and the FHWA

Summary Report

Office of Research and
Technology Transfer

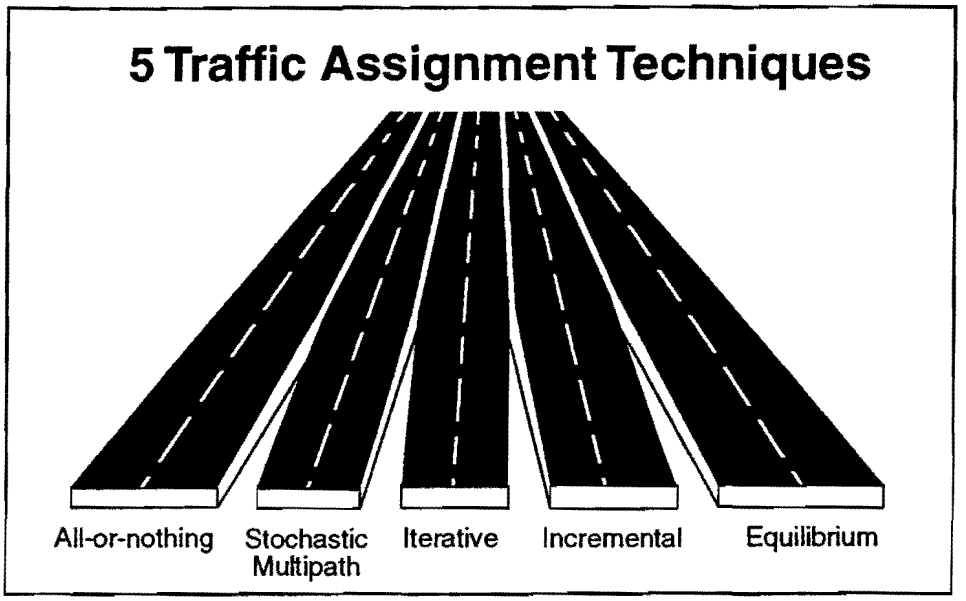
P.O. Box 5080 Austin, Texas 78763-5080

Phone 512-465-7644

FAX 512-465-7486

corridor analyses. A number of separate investigations were undertaken to address these objectives. The six resulting reports cover the following research activities:

- review multipath traffic assignment literature (1153-1),
- evaluate different assignment techniques (1153-3),
- develop a new capacity restraint assignment process that equalizes link volume/capacity ratios within a project study area (1153-2),
- test a new traffic assignment procedure in which capacity restraints are applied to nodes (intersections) instead of links (1153-4),
- compare two capacity restraint assignment models used in Texas—the Texas Capacity Restraint Procedure (Texas Model) and the Dallas-Fort Worth Joint Model Capacity Restraint Procedure (Joint Model)—to determine their ability to replicate observed counts and to recommend improvements to one or both models (1153-5), and
- detail the implementation of an equilibrium capacity restraint assignment procedure, the preferred "state-of-the-practice" with the EPA and the U.S. Department of Transportation, into the Texas Travel Demand Package (1153-6F). The documentation manual revisions for the ASSIGN SELF-BALANCING and PEAK CAPACITY RESTRAINT routines are also included in the final report.



FINDINGS

Improving Assignment Results for Project-Level Analysis

Traffic assignment data gathered for system-level applications must be refined and detailed to meet the more specific needs of project planning and design, especially in forecasting turning movements and link volumes. The refinement processes are usually performed manually based on the analyst's experience and judgment; and the procedures usually require considerable time and cost. In order to move toward automation and hopefully speed up the refinement processes, this study developed and evaluated two innovative capacity restraint procedures—one which incorporates computation of nodal (intersection) impedance, rather than just the conventional link data, and one which equalizes volume/capacity (v/c) ratios for competing roadways within a project study area.

Equalizing V/C Ratios

One promising approach used to manually adjust system-level assignments for project-level application is to equalize the link volume/capacity (v/c) ratios for the links on the competing routes. The rationale for developing such a process is that the competing links on parallel facilities in a corridor should have the same, or nearly the same, v/c ratios since traffic tends to be balanced among the competing facilities. Report 1153-2 investigated the potential of a computerized model using such a procedure.

A prototype capacity restraint assignment process which equalizes v/c ratios was developed by modifying an existing urban transportation planning computer package. It was tested and evaluated on the Tyler, Texas network. The prototype assignment procedure provided equalized v/c ratios for the links on the competing routes and produced better assigned link and turn volumes within the project area than the incremental assignment model which was selected as "best" of the existing assignment techniques. However, based on results in the cutline analysis, researchers recommended that the prototype model only be used with congested networks. And it did not appear that the procedure results would materially reduce the manual labor required by TxDOT, so develop-

ment and implementation of an operational model was not recommended.

A Nodal Restraint Assignment Procedure

The research then examined whether a nodal (based on intersections) restraint assignment could produce more accurate replications of traffic volumes, especially turning movements, than the conventional link-based capacity restraint assignments. This possibility makes sense because the capacity of an urban street system is constrained by the impedance (travel time) at the intersection (node) rather than between the intersection (link).

A prototype nodal restraint assignment procedure was successfully developed and applied to a test network (Preston Road Corridor in North Dallas). Evaluation compared the nodal restraint assignment results to the selected "best" available conventional capacity restraint assignments based upon traffic counts at major intersections along Preston Road. Results showed that the nodal assignment procedure was more responsive than the conventional capacity restraint assignments. Further development and implementation of an operational model was recommended following more expanded evaluation.

Improving Assignment Results for System Analyses

Researchers also explored alternative approaches to capacity restraint with the ultimate goal of improving capacity restraint in the Texas Travel Demand Package. They first undertook a thorough review of the literature in order to understand the historical development, theory, and effectiveness of the multipath (stochastic) assignment models when compared to or incorporated with capacity restraint procedures that use iterative or incremental assignment models. The review indicated that multiple path algorithms *can be* incorporated into the capacity restraint procedure, either iterative or incremental. Strictly speaking, no real "simultaneous-multipath" routing techniques exist in practice.

All five assignment techniques produced similar and acceptable assignment results, however, the three capacity restraint assignments, iterative, incremental, and equilibrium, were better able to replicate observed counts.

Comparing Five Microcomputer Traffic Assignment Techniques

Another phase of the research compared and evaluated results from five traffic assignment techniques available in the TRANPLAN software for microcomputers: all-or-nothing, stochastic multipath, iterative, incremental, and equilibrium. To determine if there were differences among the results, five different assignments of the existing Tyler, Texas network were compared to ground counts. In network-wide analyses, no significant differences were found; but using link-by-link comparisons, the volumes from the incremental assignment had the best results compared to ground counts. The incremental, iterative, and equilibrium assignments represented a slight improvement from the all-or-nothing and the stochastic multipath assignments. In general, all five assignment techniques produced similar and acceptable assignment results, however, the three capacity-restraint assignments, iterative, incremental, and equilibrium, were better able to replicate observed counts.

Comparing Two Mainframe Computer Traffic Assignment Techniques

As the study narrowed toward making specific changes in the Texas Package, researchers compared two capacity restraint assignment models currently used in Texas (report 1153-5):

- Texas Capacity Restraint Procedure (Texas Model), and
- Dallas-Fort Worth Joint Model Capacity Restraint Procedure (Joint Model).

The models represent two different approaches, one iterative and one incremental, for developing capacity restraint assignments; and although neither model was superior in matching observed counts, the comparative analysis did identify potential improvements to the Texas Package.

Since the Joint Model's use of minimum cost paths (as opposed to minimum time paths

currently used in the Texas Model) offers some advantages with highway networks containing toll facilities, it was recommended that the option of using minimum cost paths be provided in the Texas Package. The analysis also suggested that the initial network speed estimates have more impact on the assignment results than the capacity estimates. Thus both models would benefit from more refinement of the initial speed estimates during the model calibration process. Since it is expected that the EPA will continue to support equilibrium assignment models, it was recommended that an equilibrium option be implemented in the Texas Model's ASSIGN SELF-BALANCING and PEAK CAPACITY RESTRAINT routines (which will relieve the analyst from pre-specifying iteration weights). Such equilibrium techniques cannot be implemented in an incremental model like the Joint Model.

Implementation of an Equilibrium Assignment Procedure

Based on recommendations in preceding 1153 reports, the final work efforts focused on the implementation of an option for an equilibrium assignment procedure in the ASSIGN SELF-BALANCING and PEAK CAPACITY RESTRAINT routines of the Texas Large Network Assignment Package. From a user perspective, the basic difference is that the equilibrium assignment procedure will compute the iteration weights, and, hence, the user will not need to supply these weights. The user also has the option of specifying different travel time or speed adjustment functions by functional classification. Basically, the changes remove much of the subjectivity involved in assigning the iteration weights. New documentation and details on these routines can be found in Research Report 1153-6F.

CONCLUSIONS

For systems analyses, test results show that the implemented equilibrium assignment technique works well with congested networks; in view of the emerging EPA requirements, it is the recommended technique for the larger areas in Texas. The procedure should probably be tested for smaller areas. If the comparison shows the results are equivalent to those of the current Texas capacity restraint assignments, then the equilibrium assignment procedure is recommended for these areas as well. These changes should insure that TxDOT's traffic assignment process is in compliance with federal guidelines.

Future research in the improvement of traffic assignment at the project level should focus on extending the first objective of this study—increasing the cost-effectiveness of automated refinement techniques used in corridor analysis. Specifically, the development of an operational nodal capacity restraint procedure should be continued.

Prepared by Kelly West, Science & Technology Writer, Texas Transportation Institute.

The information in this summary is reported in detail in the following research reports:

1153-1, "Multipath Traffic Assignment: A Review of the Literature," Chen-Yuan Wang, Vergil G. Stover, George B. Dresser, Sept. 1990.

1153-2, "An Improved Traffic Assignment Process for Project-Level Analysis," Chun Soo Chung, Vergil G. Stover, George B. Dresser, Aug. 1990.

1153-3, "A Comparison of Traffic Assignment Techniques," Duk. M. Chang, George B. Dresser, Aug. 1990.

1153-4, "Development, Testing, and Evaluation of a Nodal Restraint Assignment Procedure," Chen-Yuan Wang, Jim D. Benson, George B. Dresser, June 1992.

1153-5, "A Comparative Analysis of Two Capacity Restraint Assignment Models Used in Texas," Jim. D. Benson, George B. Dresser, Nov. 1992.

1153-6F, "Implementation of an Equilibrium Capacity Restraint Model in the Texas Large Network Assignment Package," Jim D. Benson, George B. Dresser, Nov. 1992.

The contents of this summary do not necessarily reflect the official views or policies of the FHWA or TxDOT.