Assessing the benefit of improved traveler information: a pseudo-dynamic modeling approach

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Assessing the benefit of improved traveler information:
A pseudo-dynamic modeling approach

by

Michael David Anderson

A dissertation submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of
DOCTOR OF PHILOSOPHY

Major: Civil Engineering (Transportation Engineering)
Major Professor: Reginald Souleyrette

Iowa State University
Ames, Iowa
1998

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ABSTRACT

This research develops an assessment methodology to estimate traveler information benefits using regional travel demand and microscopic simulation approaches in combination. This method uses the strengths of the two conventional approaches in an innovative way, providing essentially a pseudo-dynamic model capability that uses readily available data and is easy to understand and implement. The pseudo-dynamic model provides measures of delay that are more reasonable than those available through either of the model sub-components individually.

While attempts have been made to develop dynamic regional planning models, regional model "simulation" is not yet available. Therefore, the approach addresses several gaps in capabilities left by the use of simulation or regional models alone. For example, existing simulation models can not alter individual destination choices because origin-destination flows are assumed fixed. Further, as current methods assume that travelers have immediate and complete knowledge of the transportation system operation for making route choice decisions, a mix of knowledge levels is difficult to assess. The proposed approach also allows for a mix of optimal and sub-optimal (but perceived optimal) user choices, promulgated by various levels of traveler information which can be modeled to assess benefits of various strategies.

The principal contribution of this research is the development of a pseudo-dynamic modeling environment suitable for assessing traveler information or other ITS services. The identification and combination of optimal and "perceived-optimal" paths in a regional
network simulation is original to this work. The system allows region-wide assessment of pre-trip and en-route traveler information services and incorporates travel time feedback into the trip making and route selection processes. Specifically, the work provides a practical approach to assessing ITS improvements. In general, the work shows that conventional transportation modeling environments can be integrated to perform analyses of new transportation systems.
CHAPTER 1. INTRODUCTION

In recent decades, roadway traffic volumes have outpaced highway construction and resulted in significant urban congestion. The cost of this congestion is estimated to exceed 60 billion dollars annually (1). This trend is expected to continue (1). During this period, the standard approach to meeting increased demand was to build more lane miles. Clearly, increased environmental and land-use constraints limit the efficacy of this approach.

In the last thirty years, transportation managers have attempted to meet travel demands with travel demand management (TDM) and transportation system management (TSM) techniques. Although potentially effective in the short run, TDM and TSM solutions typically provide only marginal improvements to roadway congestion problems (2.3).

Recently, the proliferation of high technology (computers, controls and communications systems) has motivated the application of these techniques to enhance transportation efficiency and safety. Collectively known as Intelligent Transportation Systems (ITS), these technologies can provide services such as Advanced Traffic Management Systems, Advanced Public Transit Systems, In Vehicle Navigation and (potentially) Control/Guidance, and Advanced Rural Transportation Systems. Another service, Advanced Traveler Information Systems (ATIS), is the focus of this work. ATIS provides information to travelers to promote more system and user-efficient decisions, ultimately reducing energy use, environmental impacts, and lost productivity.

Traveler information can be provided either en-route or pre-trip. Technologies for providing traveler information include: variable message signs, highway advisory radio,
cable television and Internet applications, and commercial radio stations. Variable message signs (VMS) display information reflecting current or anticipated traffic conditions (4). In use since the early 70s, more modern signs are capable of displaying increasing amounts of information. Highway advisory radio (HAR) uses a low-output radio transmitter to provide traveler information (5). VMS and HAR serve similar functions - to provide timely information to drivers, enabling them to make route diversions upstream of incidents or other lane restrictions. At a minimum, they increase safety by reducing surprises. Decisions are limited, because destinations are typically known and fixed for most drivers, and there are generally a very limited number of rerouting alternatives. Sometimes, no information is provided to drivers on alternative routes. Pre-trip information systems, on the other hand, enable more options for travelers as travel conditions are known a priori. Assuming travel conditions are accurately reported (and more importantly forecast), and that the travelers trust this information, options include a wider array of route choices, mode changes, trip destination changes or even the decisions to forego the trip altogether.

An accurate assessment of benefits is key to the efficient deployment of these and other ITS technologies. Several tools are available to estimate benefits of improved traffic management (chiefly reductions in travel time or delay). However, these methods are limited in their ability to evaluate traveler information benefits as they "either lack sensitivity to variables or are not sufficiently sensitive to the impacts of user services" (6).

Conventional travel demand forecasting methods (i.e., regional models) provide daily traffic forecasts, and are used to evaluate major infrastructure improvements (7). They are
mainly strategic models. Most regional models are not capable of providing accurate
time-of-day traffic estimates, and output measures are limited (8,9). Their application in
tactical situations is often suspect. For example, regional models do not estimate queue
lengths or give accurate estimates of travel speed or delay on a local, time-dependent scale.
Although peak hour models and other hourly models are available, these are typically based
on factors of 24-hour volumes.

On the other hand, microscopic simulation modeling methods provide more detailed
measures of effectiveness, although their complexity generally limits their size to something
significantly less than an entire urbanized area, at least in microcomputer applications. There
have been efforts to simulate traffic in large scale urban areas using super-computers (10).
however, like their microcomputer counterparts, the models lack the ability to predict
dynamic destination changes. In addition, although a microsimulation model can be
developed for a small to medium sized urban areas, data intensiveness presents a serious
strain on staff resources (10,11).

The dynamic model, based on dynamic traffic assignment (DTA) methodologies,
promises to forecast time dependent network travel. However, although first proposed in the
late 1980's, data intensiveness and analytical complexity have precluded the introduction of
DTA into commercial products.

1.1 Research overview

This research develops an assessment methodology to estimate traveler information
benefits using regional travel demand and microscopic simulation approaches in
combination. This method uses the strengths of the two conventional approaches in an innovative way, providing essentially a pseudo-dynamic model capability that uses readily available data and is easy to understand and implement. The pseudo-dynamic model provides measures of delay that are more reasonable than those available through either of the model sub-components individually.

In this approach, a regional travel demand model is used to distribute trips and develop network travel patterns. An interface between the regional model and a GIS package (written as part of this research) is used to effectively store, manage and present model data. A FORTRAN program (was written to convert network geometry and traffic patterns from the regional model into the format required by a microscopic traffic simulation model. The simulation model incorporates intersection control effects and calculates improved estimates of link travel times, which can then be fed back into the regional model via the GIS interface. Figure 1-1 outlines this process.

This "combined" approach is superior to the regional model alone, in that it can assess the impact of time-dependent incidents. It is superior to using the simulation model alone in that it can estimate feedback effects on regional traffic flow patterns. The approach also has the advantages of being readily available to current users, and has nominal data and computational requirements.

1.2 Contribution to the state-of-the-art

While attempts have been made to develop dynamic regional planning models, regional model "simulation" is not yet available. Therefore, the chief contribution of this
work is to provide a practical approach to dynamic modeling of regional systems that allows assessment of ITS and other traffic improvements. The approach addresses several gaps in capabilities left by the use of simulation or regional models alone. For example, existing simulation models can not alter individual destination choices because origin-destination flows are assumed fixed. Further, as current methods assume that travelers have immediate and complete knowledge of the transportation system operation for making route choice decisions, a mix of knowledge levels is difficult to assess. All conventional assignment methodologies assume some sort of user or system optimal equilibrium. Actual systems exhibit non-optimal characteristics (although they are perceived by users as optimal) which are more effectively modeled by the proposed approach. To re-state, the proposed approach allows for a mix of optimal and sub-optimal (but perceived optimal) user choices.
promulgated by various levels of traveler information which can be modeled to assess benefits of various strategies.

1.3 Document organization

This dissertation contains five chapters. The first chapter presents the motivation for the research and provides an overview of the research. This chapter provides insight into the contributions of the research.

Chapter 2 presents a review of the current literature related to existing traffic assessment tools. A review of the capabilities, application, and limitations of existing tools (sequential model, dynamic models, and simulation packages) is provided.

The third chapter defines the new methodology employed to assess the benefits of traveler information. This chapter presents the required logic to perform the assessment and provides detail into the operation of the combined travel demand and microscopic simulation method.

Chapter 4 presents the case study and evaluation. The selected city was Des Moines, Iowa. The new assessment methodology and combined method are employed within the case study and the benefit of providing improved traveler information, using different technologies, is calculated. The evaluation section provides an assessment of the methodology and the supporting evaluation methods.

The final chapter draws conclusions about the benefit of providing improved traveler information systems and identifies limitations of the integrated travel demand and simulation
model approach for performing dynamic traffic assessments. This chapter also contains direction and recommendations for future efforts as well as provides concluding remarks.

Several appendices are included with this dissertation. The first contains a sample Tranplan control file to generate a peak period origin-destination table. Two methods for traffic assignment are contained in the second appendix. The third appendix contains all program code required to operate the integrated system. The final appendix provides a user's manual for incorporating an existing regional model into GIS.
CHAPTER 2. LITERATURE REVIEW

Individually, conventional regional and simulation models are limited in their ability to assess the benefit of improved time-specific traveler information. Further, due to steep data and methodological requirements, dynamic assignment methodologies are not yet available in commercial implementations. This chapter reviews each class of models, paying particular attention to these limitations. The review concludes that while each approach is limited when used individually, a methodology that combines regional and microscopic simulation models is promising. Essentially, this combination would approximate a dynamic traffic assignment and would be available now to practitioners.

The literature review contains four sections. First, a brief overview of traffic modeling is provided. The remaining three sections examine sequential, simulation, and dynamic modeling. Each methodology is defined, example applications are presented, and limitations are identified. The chapter concludes by summarizing limitations of existing assessment methodologies and motivating the "pseudo-dynamic" modeling environment.

2.1 Model background

Providing travelers with information is certainly not a novel concept. Static information has been provided in the form of road signs and maps before the advent of the automobile. However, with the introduction of the digital computer in the 1950's, it became possible to handle vast amounts of data required for transportation planning and forecasting. Early transportation planning efforts assumed that travel behavior was fixed (3). These early planning efforts were expanded in the sixties by legislation requiring cities with populations...
exceeding 50,000 to develop "continuous, comprehensive, and cooperative" plans (7). The planning efforts performed in this decade were systems-oriented, had long horizon times, and were region-wide in scope. Transportation models developed follow what is now commonly referred to as the four step planning process or the Urban Transportation Planning Process (UTPP). This process is a series of sequential planning steps incorporating estimates of regional socio-economic and roadway data to forecast roadway volumes.

In the 1970's, transportation planning shifted to shorter-time horizons and focused on corridor analysis (7). With the change in focus, many tools to assist planners developed, the most important being Quick Response Modeling Techniques and computer implementation of UTPP-type models. The decade also saw the development of simultaneous modeling methodologies as an alternative to the sequential process. However, computer capabilities limited the application of the simultaneous models (12). The eighties focused on shorter-term transportation planning in urbanized areas, especially with respect to transportation system management schemes. The eighties also experienced continued improvements in computer tools and capabilities supporting UTPP-type models as well as simultaneous models (7). For example, several personal computer applications of the UTPP were written (7) and Safwat and Magnanti developed a model that combined all four steps of the UTPP into a single program (13). In the late 1980's, analysts incorporated time dependent vehicle location in dynamic models. However, as the newer methods require difficult-to-obtain data and are methodologically challenging, travel forecasting at planning agencies continues to rely on the sequential modeling methodology.
During the 1990s, the direction of transportation planning has been guided by two major pieces of legislation: the Clean Air Act Amendments of 1990 (CAAA) and the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). CAAA directed metropolitan planning organizations in non-attainment areas to develop transportation strategies and use travel models to verify that plans would assure attainment levels within specified time frames (14). The goal of air pollution attainment prompted many governmental agencies and researchers to re-examine transportation models. The models were examined with increased attention to accuracy of results - travel speeds, in particular (15).

ISTEA provided funding to initiate the Travel Model Improvement Program (TMIP) which has three main goals:

1) to increase the policy sensitivity of existing travel forecasting procedures and their ability to respond to emerging issues including environmental concerns, growth management, and changes in personal and household activities patterns, along with the traditional transportation issues.
2) to redesign the travel forecasting process to reflect today's traveler behavior, to respond to greater information needs placed on the forecasting process, and to take advantage of changes in data collection technology.
3) to make travel forecasting model results more useful for decision makers (16).

One of the most visible aspects of the TMIP program is the development of the TRANSIMS model for travel forecasting.

The TRANSIMS procedures deal with individual behavioral units and proceed through several steps to estimate travel. TRANSIMS forecasts travel for
individual households, residents and vehicles rather than for zonal aggregations of households. TRANSIMS also forecasts the movement of individual loads of freight. The TRANSIMS process forecasts information related to trip generation and trip distribution in an "activity planner" and for mode and route assignment in a "trip planner." The trip planner is then iterated to modify trip destinations and/or mode choice in response to congestion on chosen modes or routes. In this way TRANSIMS performs the functions of the traditional four-step travel forecasting process, but it does so in a different manner and exceeds the capabilities of the existing process (17).

The TRANSIMS model takes a disaggregate approach to the transportation modeling process and is quite different from the current models used at most planning agencies. While the TMIP program promises improvement in the travel model process, the TRANSIMS model is still several years away from practical implementation. When available, the model is likely to be complex and will surely be data intensive.

In addition to the TMIP program, the Federal Highway Administration (FHWA) also supports computer-based simulation packages for evaluating transportation system alternatives. Supported simulation packages include TRAF-NETSIM, FRESIM, and CORSIM. TRAF-NETSIM is an urban transportation micro-simulation model for arterial streets, FRESIM is a micro-simulation model for freeway operations, and CORSIM is a micro-simulation program to evaluate integrated freeway and surface streets incorporating both TRAF-NETSIM and FRESIM (18). Several other commercially available simulation packages exist, however, the programs listed above include vehicle operational characteristics, such as car following and lane changing algorithms, which are not included in
all packages. However, like all simulation programs, they require significant training and extensive data collection.

ISTEA fostered the "efficient" use of existing facilities to meet increasing traffic demands. In part, Intelligent Transportation System (ITS) approaches are being developed to respond to ISTEA challenges. ITS goals include increasing the operational efficiency and capacity of roadways through the deployment of technology. In promoting ITS, the USDOT maintains that ITS can directly impact the operational efficiency of the transportation system by reducing disruptions due to incidents and improving the level of service and convenience provided to travelers (19).

Traffic modeling and simulation can effectively support two ITS initiatives, advanced traffic management systems (ATMS) and advanced traveler information systems (ATIS) (19). Interest in ITS technologies and its potential to improve local transportation system operations has prompted many agencies to develop strategic plans and/or conduct ITS deployment studies. While technology cost estimates are often provided in these studies, rigorous assessment of ITS benefits is often lacking. This work is dedicated to improving these assessment capabilities.

2.2 Sequential models

The modeling typically performed in local transportation agencies uses the four step UTPP process, or sequential model. Regarding traveler information technology deployment assessments, these models are the only available tools at most planning agencies. Sequential models perform: trip generation, trip distribution, modal split, and trip assignment. The
model inputs are network characteristics, consisting of roadway geometry, speeds and capacities; and socioeconomic characteristics, usually represented as zonal productions and attractions. In addition, most sequential modeling packages require control files to specify operational requirements and outside files or data sets (e.g., external trip tables, friction factors, and signal timings). The outputs from these models are usually peak period or daily traffic volumes and roadway travel times and/or operating speeds. These outputs provide planners, engineers and policy makers both current and future year forecasts to evaluate transportation decisions. The information is rarely, if ever, disseminated to motorists, for obvious reasons.

Travel demand models attempt to balance two competing mechanisms: the desire of travelers to proceed from their respective origin to destination while minimizing their individual travel time and the disutility associated with users of the transportation network (20). The sequential model's operational characteristics incorporate these competing mechanisms by initially determining the traffic generated and travel desired between origin/destination pairs, then assigning the trips to a network using a pre-defined assignment methodology. Key operational limitations are that travelers are assumed to know a priori their destination regardless of congestion, and no differentiation is made concerning when the trip occurs, e.g., peak period versus off-peak periods.

To improve the forecasted traffic volumes, several feedback techniques as well as the explicit incorporation of intersection delay penalties have been proposed. The feedback techniques perform multiple sequential model iterations, modifying roadway travel times and
origin/destination flows during each iteration. Modifying the origin/destination matrix is the key to implementing feedback within the model. Sequential modeling packages can modify roadway travel times during individual traffic assignment iterations, they are constrained to assign the same origin/destination matrix, illustrated in Figure 2-1. The static origin/destination matrix forces pre-defined trip flows, independent of network operation characteristics, a behavioral assumption that can be avoided with feedback loops. The explicit incorporation of intersection traffic control is intended to add realism to the transportation network. Because individuals base route decisions, in part, on traffic signal locations, improved traffic assignments could result from explicitly incorporating intersection delay. Both feedback and intersection delay attempt to add realism into the sequential planning process and these have been implemented in some commercial packages.

2.2.1 Examples of sequential models

As sequential models are commonly used, several studies have examined methods to improve the accuracy of the outputs.

2.2.1.1 Feedback techniques

One improvement uses feedback of network information within the four step process. Boyce, et al. and Loudon, et al. performed independent studies evaluating several travel time feedback schemes. Boyce, et al. concluded that all of the feedback algorithms used arrived at a nearly equilibrium solution, all with differing levels of statistical accuracy and computation times (22), whereas Loudon, et al. concluded that direct feedback methods did not necessarily reach convergence and took considerably longer (23). Loudon, et al. also
identified drawbacks to including feedback to be increased storage requirements, increased time for model runs and difficulty understanding the relationship between the improvements and forecasted volumes.

A study by Walker and Peng examined using Tranplan, a commercially available travel demand software package, iteratively to model traffic for the Delaware Valley (24).
They incorporated travel time feedback using three weighting procedures to assure convergence and compared the accuracy of assigned model volumes and speeds to collected data. They concluded that the development of feedback through different iterative convergence procedures were not simple tasks and iterating the model required days to complete for a single alternative. The authors further concluded that all iterative approaches significantly degraded the accuracy of the traffic assignment, making validation difficult on a daily basis.

2.2.1.2 Intersection control

Intersection control is another method used to increase the accuracy of output from sequential models. Intersection traffic control penalties were examined by Allen using MINUTP, another commercial regional model, to incorporate delay effects in a sub-area model (25). Allen concluded that in sub-areas, small sections of the regional network, the network detail can use intersection effects to improve the assigned traffic validity. Allen further concluded, however, that complete regional networks lacked sufficient detail to warrant the inclusion of intersection control.

Koutsopoulos and Habbal examined the effects of four network development levels (26). They concluded that the HCM intersection delay equations can successfully incorporate intersection delays in traffic models and that improved forecast accuracy could be attained with enhanced intersection modeling. They also concluded that incorporating link interactions, through the Bureau of Public Roads (BPR) equation where new travel times are a non-linear function of existing travel times and volume/capacity ratios, was more important
than detailed intersection movement representations and that the accompanying computational requirements for intersection delay could be prohibitive.

In two papers by Horowitz, a modified version of QRSII (AJH and Associates, Milwaukee, WI) was used to incorporate actuated signal control in a sample network and test the use of the HCM 1994 revisions (27, 28). Horowitz concluded that actuated signals added realism to the network. However, the delay relationships and model needed to be sensitive to traffic control. He concluded that actuated networks do not require much more computational effort, computer memory, or user expertise (for small networks) (27). Regarding the HCM 1994 revisions, based on the premise that good traffic theory should be compatible with region-wide traffic assignment, he recommended including the explicit intersection delay equations (28). As Horowitz conducted tests on sample networks, the results could not be validated.

A paper by Kurth, et al. examined the use of HCM equations in the Albuquerque regional model to improve speed and volume forecasts for input to an air quality model (16). Their initial validation results showed that accurate estimates of travel speeds can be obtained simultaneously with accurate traffic assignment using HCM procedures. They stated that incorporating HCM equations has been completed for EMME/2, another commercially available program, with a simplified version completed for MINUTP.

A paper by Levinson and Kumar discusses a structure for incorporating travel time feedback and performs a case study following the structure (29). They state that not incorporating elastic demand or responsive intersection control in the theoretical framework
will cause an incorrect representation of network flow (29). Their work concluded that the implementation of route assignment with travel time feedback and intersection control was suitable for practical application on a realistic, large-scale network (29). However, they commented that their work was computationally intensive and did not consider non-signalized intersections and analyzed each signal as operating in isolation.

2.2.1.3 Peak period modeling

Regarding peak period modeling, most communities use a daily sequential forecasting model with factors applied to generate peak period volumes. These peak period factor methods involve schemes where validated daily traffic volumes are multiplied by a percentage or other factor. A common example is that peak period flows are often taken to be 10 percent of the daily volume.

A complete factorization table was developed by Gunawardena, et al. which included peak hour and directional factors based on roadway functional classifications (30). Their methodology used several count locations and linear regression to determine hourly utilization factors. This approach is limited, however, because confidence is reduced when transferring the factor to new communities.

Under the auspices of the Travel Model Improvement Program (TMIP), Cambridge Systematics, Inc. developed a report on time-of-day modeling procedures reviewing some traditionally used factor methods. They concluded trip factors are applied throughout the four step process: after traffic assignment, between mode split and traffic assignment, between trip distribution and mode split, and between trip generation and mode split (21).
The use of the methods presented in the TMIP report reflect the work of Gunawardena, et al. in that they apply peaking factors into the modeling process.

Model alterations produce peak hour estimates of traffic as a direct output from the travel models. An example of altering a travel model to produce peak hour estimates using the Tranplan modeling software was developed by Crevo and Virkud (31). Their required model adaptations included: peak period estimates for each trip purpose, the ability to separate truck and non-truck travel, peak period volume-captability ratios, time dependent speed data, and directional splits. Results indicated that to validate the effort, an agency needs detailed hourly traffic count data. Validated peak period model estimates for any hourly period could be developed with this information.

Some innovative approaches to time-of-day modeling include; link-based peak spreading, trip-based peak spreading, and system-wide peak spreading. Link-based peak spreading accounts for congestion at the link level and diverts trips to the "shoulder" hours on either side of the peak based on congestion level defined by volume to capacity ratios. A case study of link-based spreading in the Phoenix, Arizona area resulted in significantly more realistic estimates of traffic volumes and speeds on congested highways, as well as more realistic estimates of regional measures such as vehicle-miles of travel versus using a factor method (21). An alternative to the link-based peak spreading approach is a trip-based approach that spreads the number of trips for an origin-destination interchange that occur in the peak period or peak hour (21).
The third method, system-wide peak spreading, has been implemented by the Volpe National Transportation System Center within a travel demand modeling framework to evaluate Intelligent Transportation Systems (ITS). This peak spreading approach considers the system-wide excess travel demand and delay and distributes excess travel demand between the individual travel hours that comprise the peak period (21).

2.2.2 Limitations of sequential models

Sequential models can provide daily and peak period traffic estimates vital for corridor analysis and project planning. Limitations of the sequential modeling process are that an explicit decision-making process is imposed on drivers (20), inconsistencies developed in early model steps are carried and compounded through the modeling process (32), and the output is insufficient for identifying time dependent congestion or incident locations and evaluating real-time improvements offered by ITS technologies (33).

To respond to the explicit decision making process and inconsistencies being carried throughout the process, several assignment methodologies adjust route choice (i.e., capacity-restraint, incremental and equilibrium) as well as destination and mode decisions, which may change based on the condition of the network (29, 32, 34). These improvements have been made by using feedback loops and by incorporating intersection delay, even to the point of being included in some commercial packages, (i.e., QRSII). However, the main limitation of the sequential modeling process is the inability to model time-dependent congestion or incident locations necessary for evaluating traveler information deployment scenarios.
2.3 Microscopic simulation packages

Simulation is defined as "the process of designing a model of a real system and conducting experiments with this model for the purpose of understanding the behavior of the system and/or evaluating various strategies for the operation of the system (35, p. 1)."

Microscopic simulation can identify and collect statistics on individual elements within a simulation. Therefore, simulation can model time-dependent problems, such as roadway incidents collecting individual vehicle delay data.

2.3.1 Examples of microscopic simulation packages

The following provides a review of some commonly used microscopic simulation packages. The review focuses on application, network size limitations, cost, and computer resource requirements.

- INTEGRATION was developed to model the interactions of freeway and surface streets, simulation and traffic assignment, static and dynamic controls and routings, and ATIS and ATMS in an integrated fashion. The model uses a time-step procedure based on user specified speed-flow relationships for each link, and uses multi-path vehicle routes which may be dynamically re-selected en-route in response to any traffic congestion that may develop during the course of a simulation run. The integrated logic of the model can perform HCM level of analysis for stop signs, permissive and protective signal phasing and coordination. The model provides real-time visualization through animation of individual vehicles and signal settings. The interface allows individual vehicles to be queried. Statistics are collected on: travel time, distance, number of stops, queue sizes, fuel consumption and vehicle emissions. The small version of the model, costing $395, is capable of 25,000 vehicles, 250 links, 250 nodes and 25 zones on a 486 DX personal computer
with 8 megabytes of RAM. Larger versions of the program capable of handling several thousand links. 500 zones and 500,000 vehicles are available at an increased price (36).

- The TEXAS model for intersection traffic can evaluate various traffic demands, types of control and/or geometric features at an individual intersection. It can be used to evaluate existing or proposed roadway geometry, driver and vehicle characteristics, flow conditions, intersection control, lane control and signal timing plans. It is also capable of analyzing diamond interchanges and actuated control. It includes animated graphics with color coded vehicle types moving through the intersection. The TEXAS model requires an IBM personal computer of 386 or greater and cost $250 for version 3.11 (36).

- FRESIM was designed for microscopic freeway simulation. FRESIM is an enhancement of a previous model and includes improvements in geometric and operational capabilities. Geometric conditions include: 1-5 through lanes, 1-3 lane ramps, grades, curves, superelevation, lane additions, land drops, incidents, work zones, and auxiliary lanes. Operational conditions include: lane-changing, ramp metering, surveillance system, different vehicle types, heavy vehicle restrictions, driver habits, warning signs, incidents, and off-ramps. The current size limitation for FRESIM is 600 links, 350 nodes and 10,000 vehicles with a purchase price of $250. Operation of the FRESIM model requires Windows95 or WindowsNT running on a 486 (33 megahertz) personal computer with 8 megabytes of RAM (36).

- TRAF-NETSIM is a simulation model that allows the traffic engineer to evaluate complex strategies on a real-time basis for a given network. TRAF-NETSIM is a microscopic stochastic simulation model. It is used for
evaluating urban roadway networks. It is designed to evaluate alternative network control and management strategies and is particularly appropriate for the analysis of dynamically controlled traffic signal systems based on real-time surveillance of network traffic movements. However, it may also be used to address a variety of other problems, including the effectiveness of conventional traffic engineering measures, bus priority systems, and a full range of standard fixed-time and vehicle-actuated signal control strategies (37). A graphics package accompanying NETSIM provides color display of both input and output data. Displays include detailed intersection geometrics, highlighting of potential problem areas, and animation of simulation traffic flows. TRAF-NETSIM is limited to 250 nodes, 500 links and 10,000 vehicles with a purchase price of $200. Operation of the TRAF-NETSIM model requires Windows95 or WindowsNT running on a 486 (33 megahertz) personal computer with 8 megabytes of RAM (36).

• CORSIM is a package that contains both FRESIM and TRAF-NETSIM allowing the user to simulate a combined freeway and arterial street system with one program called Traffic Software Integrated System (TSIS). The current version of CORSIM has the same size limitations and personal computer requirements as both the FRESIM and TRAF-NETSIM modules. The purchase price for CORSIM is $500 which includes an animation program called TRAF-VU allowing users to visualize network traffic conditions during specified time intervals or traffic incidents (36).

• TRANSIMS is a new micro-simulation package being developed as one track of the Travel Model Improvement Program (TMIP) sponsored by the USDOT, Environmental protection agency, and Department of Energy. TRANSIMS is a set of integrated analytical and simulation models and supporting databases. TRANSIMS methods deal with individual behavioral
units (households, residents, and vehicles) as opposed to zonal aggregations of households (18).

At this time the TRANSIMS network limitations, cost and hardware requirements are unknown. The TRANSIMS model was originally expected to be available in 2001. however, there is uncertainty regarding the actual release date.

2.3.2 Limitations of microscopic simulation packages

Microscopic simulation package can identify individual vehicle locations and model time-dependent traffic flows which can not be modeled using sequential models. In addition, some packages can perform dynamic vehicle routing.

A limitation of existing microscopic simulation packages is that dynamic vehicle routing, if available, is performed instantaneously and automatically with all vehicles using complete information to select the optimal route. When evaluating traveler information system deployment, the assumption that all vehicles have complete and instantaneous information is not valid. Traveler information schemes require users to positively respond to information, which not all traveler will do. Therefore, travelers within the system will follow "perceived" optimal routes. In addition, knowledge of an incident, or other traffic problem, is not known instantaneously. Time is required to verify a problem or incident before information can be provided.

Another limitation of the existing packages is the limitations on available traveler decisions. Provided with information, travelers might choose alternate modes of travel, or new destinations, or question the necessity of the trip. The current models do not allow for these driver decisions.
2.4 Dynamic models

Dynamic modeling incorporates time at which travel occurs and individual vehicle location into transportation modeling. Incorporating time and location allows trips to be assigned to a dynamic, changing, traffic network. De Romph, et al. identified several limitations with static models including: produce erroneous results when congestion occurs because a vehicle can contribute to congestion on more than one link at a given time, can not show variable traffic demand or temporal disturbances, and can not predict queue length (38).

Dynamic modeling can be defined as a temporal generalization of the static modeling problem of which the static model uses one long period (8). Dynamic modeling can also be classified into three approaches: (a) simulation-based approach, (b) optimal control theory approach, and (c) optimization approach (9). Differences between the approaches are identified:

The simulation based dynamic assignment uses the simulation for performance prediction within an iterative assignment framework. Most research into the optimal control-based models have produced continuous-time formulations, which are solved using discrete-time algorithms. As for the optimization approach, Merchant and Nemhauser formulated the DTA problem with a nonlinear and non-convex mathematical program and Carey reformulated the model as a convex, nonlinear program. Both models try to capture congestion effects using link exit functions that are non-decreasing and concave (9, p. 51-52).

While this research focuses on the development of a "psuedo-dynamic" modeling environment using simulation, other studies of dynamic modeling will be reviewed.
Dynamic modeling has been described in a Travel Model Improvement Program document which states:

- generally uses an analysis period divided into several intervals of equal lengths,
- the trip table is divided into subsets corresponding to the time slices,
- each trip assigned to the network during each time slice is allowed to traverse the network only as far as it could during the time period. Trips which do not reach their destination continue during the next time interval.
- capacities can be treated as limits on flow rates that cannot be exceeded. Demand on links that exceed capacity create a queue that spills back onto upstream links,
- intersection dynamics could also be simulated using node performance functions.
- congestion that remains on the network after the peak period spills over to the subsequent period. (39, p. 4-2).

The TMIP document identifies the need for real-time traffic information in a dynamic modeling system to provide for the implementation of selected IVHS (now ITS) strategies (39). Janson stated dynamic traffic assignment procedures "are needed to evaluate the impacts of alternative travel demand management strategies during peak periods in urban areas and will play a key role in the development of real-time traffic management and in-vehicle route guidance systems" (8, p. 69).

2.4.1 Examples of dynamic models

Several recent studies, documenting the development of dynamic models have been reviewed. A paper presented by Ran, et al. describes an analytical path-based multi-class dynamic traffic assignment model. They used driver classifications of knowledge about the
network (either fixed route, stochastic choice, or dynamic choice). They demonstrated that, on a simple network with various percentages of drivers in each classification, knowledge of the network and ability to modify route choice decisions could be used to evaluate network infrastructure decisions (40). Recommendations for future work, although not being tested to date, include adding a travel time function that considers intersection signal control effects, adding distribution functions for classes of drivers, and incorporating dynamic departure time choice.

Janson developed a dynamic traffic assignment solution, called DTA, based on a heuristic (8). Janson defined dynamic user equilibrium when "all paths between a given pair of zones used by trips departing in a given interval must have equal travel impedances and all paths between a given pair of zones not used by trips departing in a given time interval cannot have lower travel impedance" (8, p. 69). While the DTA methodology provides an accurate prediction of travel volumes, the heuristic does not necessarily converge to a dynamic equilibrium solution. Not necessarily converging to an equilibrium solution seemed acceptable to Janson as the model results were validated to ground counts, however, the operation of this model requires extensive data collection and training to operate the program (information provided by Janson via e-mail).

Wie presented a dynamic traffic assignment model for one origin, one destination, and $N$ parallel paths between the two nodes (41). The model formulation was never tested, although extensions were identified for using the methodology for more complex networks.
Drissi-Kaitouni and Hamada-Benchekroun presented a dynamic traffic assignment solution using artificial space-time links to represent vehicle delays. Travel time was defined as the time spent traveling on a link plus the time spent waiting to access the next link of the trip (42). Numerical results show that this model may be used to simulate the flows of large real networks and the model provides the planner the flows and queues on the network for each period of time, which helps to analyze the moves of congestion in space and in time. This model was extremely computationally intensive.

Lasdon and Luo studied the dynamic traffic assignment problem using a linear program with concave link exit functions (43). Two problems identified in their approach are that even small networks yield very large optimization problems and the optimization technique applies smaller delay times when attempting to validate the program with a micro-simulation package. The authors recommend future research focusing both on improved exit functions and devising additional constraints to model congestion.

Jayakrishinan, et. al. present the dynamic traffic assignment problem using a two part iterative method, incorporating traffic engineering principles (9). The authors' formulation is distinct from other models in that the traffic flow relationships are explicitly incorporated into the model. By using short time intervals, they claim the ability to better capture traffic dynamics. They expressed a need to investigate the possibility of relaxing the strict definition of dynamic equilibrium in which the integer variables are defined in terms of time windows.
Another paper by Janson describes the development of a dynamic traffic assignment model with scheduled trip arrivals (44). Janson identified that either the departure or arrival times need to be fixed within dynamic models. Janson also identified that decisions affecting supply changes such as road widening and ramp metering cannot be considered independent of policies affecting peak-period spreading of the commuting trips. Some future issues identified for using dynamic models include the need to incorporate departure time and route choice information to motorists to aid their trip scheduling decisions, to implement of real-time traffic modeling and route guidance systems in traffic operation centers, and to incorporate reductions in link capacities due to accidents and spillback queuing in time intervals when these events occur (44).

2.4.2 Limitations of dynamic models

Dynamic models represent a promising new modeling methodology where time and vehicle locations are included. The dynamic models possess the capability to perform assessments of incidents and other ITS technology deployment scenarios. However, as the examples of dynamic models indicate, these packages do not represent feasible solutions for today's practitioner. This is based on the uncertain nature of the models and several studies concluding that these models will be complex and data intensive, when available.

2.5 Summary and conclusions

The capabilities of the existing assessment tools are limited for different reasons. Sequential methods, even with feedback and intersection penalties, lack the ability to identify individual vehicle locations and provide time-dependent measures of effectiveness. Although
they are sufficient to provide daily, or even hourly, traffic forecasts by calculating origin-destination tables and using pre-defined assignment methodologies. They can not model time slices small enough to respond to traveler information policy decisions.

Microscopic simulation packages can model actual vehicle locations at a given time. This alone represents an improvement over sequential models. Further, many microscopic simulation packages can dynamically assign origin-destination pairs through the network. However, these packages are incapable of supporting dynamic destination choice and scenarios where traveler information is delayed and received by only a select number of simulated travelers.

Dynamic models, although promising, are still in the developmental phase and are not yet ready for commercial usage. These models incorporate time dependent characteristics into a regional travel model, which could perform an assessment of traveler information. However, these data intensive and computationally intensive models are currently unavailable.

By combining sequential and microscopic simulation models, the strengths of each model can be pooled to approximate the operation of a dynamic model. This "pseudo-dynamic" modeling environment can then be applied to assess the benefits of deploying traveler information technology.
CHAPTER 3. METHODOLOGY

The need for improved methods to evaluate the benefit of traveler information systems was discussed in Chapter 2. This chapter presents an integrated traffic modeling approach that capitalizes on the strengths of several widely used methods. Essentially, a regional travel demand model is used to distribute and assign traffic to a transportation network. A customized geographic information system is then used to export volumes to a traffic simulation model, where explicit representation of intersection control and microsimulation of vehicle movements improves estimates of travel time. The travel times are then returned to the regional model for re-assignment until travel times reach a pre-defined equilibrium. The whole process is then repeated under assumed conditions of driver awareness of travel incidents. Finally, travel patterns from both situations (some drivers with information, others without) are combined and fed into the simulation model which provides detailed system measures of effectiveness, chiefly travel time and delay. The entire process approximates a truly dynamic traffic model but uses readily available data and implementation is straightforward. The technique is, therefore, referred to as a pseudo-dynamic modeling approach.

This chapter presents three assessment scenarios of interest to ITS planners. The first scenario is comprised of long duration incidents or road construction, expected to occur during the entire simulation period. To address this scenario, two assignments are combined, one with and one without traveler information, based on a specified percentage of travelers
with pre-trip information. The model incorporates feedback of travel times and allows adjustment of origin-destination patterns.

The second scenario is one where specification of greater roadway detail may be required than in a typical regional model. As in the first scenario, the approach combines two assignments. As will be seen, a limitation of this approach, imposed by the regional model, is the inability to modify origin-destination patterns.

A third scenario provides en-route information to travelers during their trip. This scenario represents short duration incidents, occurring for less than an entire simulation period, which was one hour for this study. For this scenario, the approach calls for two steps. First, travel patterns are assessed prior to the incident in a "pre-awareness" period. During the "post-awareness" period, two groups of drivers are modeled and the results are combined as in the previous two scenarios. If time remains during the simulation period and if the effects of the incident have dissipated, all remaining time is modeled as in the "pre-awareness" period. Figure 3-1 demonstrates the different approaches used for the pre-trip and en-route traveler information scenarios. Pre-trip applies to scenarios one and two.

The chapter concludes with brief sections describing model validation procedures, benefit cost analysis process, and a closure. For this research, Tranplan was selected as the regional model, CORSIM as the traffic micro-simulation program and MapInfo as the GIS platform (used for data formatting, maintenance and effective display of results). While this
Figure 3-1. Difference between pre-trip and en-route systems.

Chapter is written to be as generic as possible. Certain procedures, where noted, are specific to the software platforms chosen.

3.1 Scenario 1, Pre-trip information systems with feedback
(sub-area approach)

In the first scenario presented, traveler information provided prior to long duration incidents or road construction is assessed using an approach where travel time feedback can affect trip distribution/origin-destination patterns. A sub-area network, extracted from an
existing regional model is used for the analysis. The sub-area network selected from the regional model retains the regional model's roadway, intersection and zone structure. Figure 3-2 outlines the sub-area modeling approach. The steps used to address this scenario include:

- Step 1, Obtain/develop network for regional model
- Step 2, Generate Trips
- Step 3, Distribute Trips for Internal Zones
- Step 4, Add External Trips
- Step 5, Adjust Demand for Peak Hour (or hour of interest)
- Step 6, Assign Traffic
- Step 7, Export Data into Geographic Information System (GIS)
- Step 8, Extract sub-area network
- Step 9, Test for Convergence
- Step 10, Export Data to Microsimulation Model
- Step 11, Run Simulation and Compute Revised Travel Times
- Step 12, Export data into GIS
- Step 13, Use New Travel Times in Regional Model
- Step 14, Repeat steps 1-13 for various levels of traveler information
- Step 15, Assess the combined travel pattern

3.1.1 Step 1, Obtain/develop network for regional model

The sub-area approach to assessing the benefit of pre-trip information begins with a calibrated regional network model which forecasts daily traffic volumes. The regional model must contain roadway links, intersections, and traffic analysis zones and include travel time, speed, length and capacity. Tranplan requires network data in an ASCII format. These data are processed by the Tranplan module BUILD HIGHWAY NETWORK to create a binary highway network. Tranplan control files tell Tranplan which module to execute and specify
Figure 3-2. Sub-area modeling approach.
parameters, options and location of input data. Minimum time paths through the network are computed using Tranplan's HIGHWAY SELECTED SUMMATION and BUILD INTRAZONAL IMPEDANCES modules (see Appendix A for Tranplan control and sample data files).

3.1.2 Step 2, Generate trips

At a minimum, the pseudo-dynamic assessment methodology requires daily estimates of travel demand (productions and attractions). These are typically produced using regression equations, trip rates, or cross classification tables which generally are computed outside of Tranplan in a spreadsheet or FORTRAN program. For this methodology, daily travel demand for each TAZ (productions and attractions) are provided a priori in the form of a Tranplan data input file (see Appendix A). If peak hour, or any hour of interest, travel demand estimates are available, development of these estimates (step 5) may be skipped.

3.1.3 Step 3, Distribute trips for internal zones

Although any method of trip distribution will do, a gravity model is used to determine initial trip distribution using either free flow, or other initial travel times (Tranplan's GRAVITY MODEL module). For all subsequent iterations, new roadway travel times reflecting roadway congestion and intersection delay (obtained from the simulation), will be used to determine new impedance (friction) values for links of the regional model network. Trip distribution produces trip tables for each of a number of trip purposes, containing all internal-internal and internal-external trips for the regional network. (The number and type of trip tables is dependent upon the original structure of the regional model. At least one
Appendix A provides the Tranplan control file for trip distribution.

3.1.4 Step 4, Add external trips

After developing trip tables, external-external trips should be combined with the existing trip tables. Development of the external-external trip table is taken as exogenous to the methodology (the table is provided in Tranplan binary format and was originally created using a Fratar model). See Appendix A for the Tranplan control file.

3.1.5 Step 5, Adjust demand for peak hour (or hour of interest)

To estimate the impact of traveler information on travel time and delay, the modeling process must be sensitive to short duration incidents (incidents lasting less than 24 hours). A daily regional model cannot be sensitive to such incidents. Further, as traffic volumes input to microsimulation models will be uniformly distributed over the entire simulation period, 24 hour volumes would greatly overestimate night-time volumes and underestimate peak hour flows. Therefore, the 24 hour regional model demand estimates must be converted into hourly (or less, say, 5 minute) volumes. Usually, the peak hour of traffic flow is of greatest interest, although the methodology applies to any hour of the day.

Three modifications are required to convert daily trip tables (by purpose) into a single, peak hour trip table. The first is to alter the daily flow values into peak period flows by applying hourly distribution factors. The second adjustment is to remove directionality for all trip purposes, except for the home-to-work trip purpose where directionality is warranted. After completing the first two modifications, the trip tables are aggregated into a single, peak
period trip table for the entire regional network. See Appendix A for the Tranplan control
file that is used to develop the peak hour trip table.

3.1.6 Step 6, Assign traffic

Traffic assignment loads vehicle trips from the single, peak period trip table using
minimum time paths. The specific traffic assignment method used during the initial
assignment is not critical, except to provide a good estimate of final travel patterns which
will considerable reduce the number of iterations needed by the pseudo-dynamic approach. It
is important to note that an all-or-nothing or stochastic traffic assignment methodology
should be used in subsequent iterations. This ensures that individual roadway travel times
are not modified by the regional model during the traffic assignment step, new travel times
reflect congestion and intersection traffic control effects as will be modeled by the micro
simulation package. Two control files are provided in Appendix B, one for the initial
assignment and one for successive iterations.

3.1.7 Step 7, Export data into geographic information system (GIS)

After trip assignment, a GIS is used to import data from the regional model. The
process uses a FORTRAN program and a MapBasic (MapInfo's programming language)
program which were developed as part of this study. (See Appendix C for FORTRAN code,
TP_MI.FOR and MapBasic, MODEL.MB code and a user's guide which provides detailed
instructions for exporting the regional model data into the GIS format.) In addition to
managing the network data, the GIS allows spatial queries and improved network attribute
updating capabilities - an important feature for performing feedback of travel time
information, as will be seen. A GIS depiction of a medium sized (800 zones, 600,000 population) regional network is shown in Figure 3-3.

3.1.8 Step 8, Extract sub-area network

With the regional network in GIS format, the user can readily define the sub-area network. A MapBasic program (SUBAREA.MB - see Appendix C) was written to automatically generate sub-area network coordinates and spatial queries help to identify and renumber centroids and external stations (in CORSIM format). Figure 3-4 shows an example sub-area selection. After selecting the sub-area, i.e., selecting the links and nodes to be included in the sub-area model and storing them into two selections, the MapBasic program assimilates turning movement volumes for each of the selected intersections and renumbers centroids and external stations.

3.1.9 Step 9, Test for convergence

During this step, a convergence test is applied to the assigned traffic volumes of the sub-area, except after the first regional assignment (proceed to step 10 on first time through). Convergence is attained when the assigned traffic volume differs from ground counts be less than a certain percentage, or if data are unavailable, when the traffic volume difference calculated between successive iterations falls below a specified amount. The convergence test is applied to each link of the sub-area network, by graphing differences in assigned volumes between iterations in the GIS. Differences are compared to a predefined maximum by visual inspection (the user may define their own convergence criterion). If any link volumes fail the convergence test, the sub-area network is exported to the simulation model.
Figure 3-3. A regional model with a GIS environment.
Figure 3-4. An example of a sub-area.

to calculate new roadway travel times (step 10). If convergence attained, the user proceeds to step 14 or 15 (see descriptions to determine appropriate step).

3.1.10 Step 10, Export data to microsimulation model

This section describes the procedure for exporting the sub-area network from GIS into the microscopic simulation model. While specific to MapInfo, Tranplan and CORSIM, the procedures are generalized to apply to other software platforms.

CORSIM requires a space-delimited control file containing entries for link geometry, turning movement percentages, intersection control, zonal production rates, and intersection coordinate data. In addition, the control file requires run-specific information defining simulation time duration and various output characteristics. A MapBasic program.
SUBAREA.MB extracts the sub-area network. A FORTRAN program, NETWORK.FOR, formats the data and provides run time control information for the simulation model. (See Appendix C for code.) The following subsections describe how the FORTRAN program converts data from Tranplan native format into CORSIM format.

3.1.10.1 Link characteristics

Link data required by the CORSIM control file include beginning and ending node numbers, the length, number of lanes, allowable movements, and downstream node numbers (specifies network connectivity). Default values are provided for all additional data elements, such as grade.

CORSIM requires that centroids be numbered starting at 8001, while remaining nodes must be numbered less than 750. The FORTRAN program renumbers nodes to comply with these requirements. The FORTRAN program also calculates the number of lanes for a link based on its Tranplan capacity (number of lanes is optional in Tranplan). While number of lanes can be entered manually, default values are provided as such:

- capacity less than 7200 vehicles = one lane per direction
- capacity between 7200 and 14400 = two lanes per direction, and
- capacities greater than 14400 = three lanes

Default values for allowable movements depend on the number of lanes in each direction. One lane approaches allow any turning movement, whereas two lane approaches constrain left turn movements to the left lane and right turns to the right lane (straight through movements are allowed in either lane). For three lane approaches, the middle lane is constrained to straight through movements only. Link values may be manually adjusted from
their default values, and must be adjusted for nodes which do not represent intersections (e.g., nodes that are placed simply to provide shape).

To determine downstream node numbers for each intersection approach, the FORTRAN program performs a nested search of the Tranplan link data. The program then uses coordinate geometry and a dummy node to calculate a direction for each movement (see Figure 3-5). A through movement is calculated if the angle between the beginning, ending, and downstream nodes form an angle between 160 and 200 degrees. A left or right turning movement is determined by placing a dummy node to the right of the ending node. The movement is considered a right-turn if the distance from the beginning to downstream node through the dummy node is less than the distance from the beginning to downstream node through the ending node (see again, Figure 3-5). Manual adjustment must be performed for intersections with highly acute angles or more-than-four legs.

3.1.10.2 Turning movement percentages

Turning movement volumes are provided by the regional model. As this file contains multiple records for each intersection, link beginning-and-ending node numbers are matched to all entries to assign turning volumes for each movement at a given intersection. Intersection approach volumes are then summed and the total used to compute turning movement percentage rates (required by CORSIM).

3.1.10.3 Intersection control

Although some regional models allow for explicit representation of intersection control, Tranplan does not. In this case, we add significant realism to the modeling
environment and improve estimates of travel time and delay by including control parameters during this stage of the methodology. The FORTRAN program allocates 100 percent green time to each intersection approach, by default. Signals and stop signs must be manually input to the CORSIM control file. This information need only be entered once, as the timing information can be saved for subsequent iterations. A useful extension to this methodology would be to allow dynamic assignment of actuated signal control parameters based on demand.

Figure 3-5. Determining downstream node number.

If \( xh + xa < x_1 + x + xa \), then the node represents a right turn. Otherwise, the node represents a left turn.
3.1.10.4 Zonal production and coordinate information

The final simulation control file data elements required are hourly zonal productions and intersection coordinate data (coordinates are needed only if the user wishes to display the results of the simulation in TRAFVU, CORSIM's visualization program). Productions are taken from the sub-area of the regional model peak period trip table. Node coordinates are taken from the GIS output file, created by the MapBasic program in step 8.

3.1.11 Step 11, Run simulation to compute revised travel times

After the FORTRAN program creates the control file, CORSIM is run using the assignment from the sub-area model. After running the simulation model, revised estimates of roadway travel times are developed. These travel times reflect traffic congestion and intersection traffic control effects within the sub-area network. At this point, the results of the simulation can be displayed in TRAFVU. Example screens from TRAFVU are shown as Figure 3-6 and Figure 3-7.

3.1.12 Step 12, Export data into GIS

The new travel times developed by the simulation are returned to GIS where the original regional model is stored. GIS data manipulation capabilities help the analyst update the sub-area travel times in the regional model. A damping factor was used during each update to minimize oscillations in trip assignments and ensure convergence. Two damping techniques are used: 1) a modified capacity restraint and 2) the method of successive averages.
Figure 3-6. Entire network in the animation program.

Figure 3-7. Isolated intersection in the animation program.
The modified capacity restrain approach is used to force the model into an equilibrium state (20). This method averages the original and new roadway travel times using a 75 percent weighting factor for the original travel times and 25 percent for the newly obtained travel time. Although other weighting factors can be selected, 25 percent was recommended by Sheffi (20). In the modified capacity restraint method, the following steps are performed:

Step 1. Initialization. In the regional model, perform the assignment based on the original travel times \( t_o \) to get the original assignment \( \{X_0\} \). Set \( n=1 \).

Step 2. Update travel times using volumes \( X_o \) in the simulation model. This produces travel times, \( T_1=f(X_o) \), or, more generally, \( T_n=f(X_{n-1}) \).

Step 3. Update travel times to be used by regional model assignment process (with damping), \( t_n=0.75(t_n)+0.25(T_1) \), or, more generally, \( t_n=0.75(t_{n-1})+0.25(T_n) \).

Step 4. Network Loading. Assign trips based on the new travel times \( t_n \) to obtain revised loadings, \( X_n \).

Step 5. Convergence Test. If \( \max\{|X_n-X_{n-1}|\}<k \) (for any link in the network) or a predetermined maximum number of iterations is reached, stop. Otherwise, repeat steps 2 through 5.

The method of successive averages can also be used to provide an equilibrium solution. For this approach, travel time changes are weighted by a step size (we choose \( 1/n \)) (20). For the method of successive averages, the following steps are performed:
Step 1. Initialization. In the regional model, perform the assignment based on the original travel times \( t_0 \) to get the original assignment \( \{X_q\} \). Set \( n=1 \).

Step 2. Update travel times using volumes \( X_q \) in the simulation model. This produces travel times, \( T_1 = f(X_0) \), or, more generally, \( T_n = f(X_{n-1}) \).

Step 3. Update travel times to be used by regional model assignment process (with weighting), \( t_1 = t_0 + (1/n)(T_1 - t_0) \), or, more generally, \( t_n = t_{n-1} + (1/n)(T_n - t_{n-1}) \).

Step 4. Network Loading. Assign trips based on the new travel times \( t_n \) to obtain revised loadings, \( X_n \).

Step 5. Convergence Test. If \( \max \{|X_n - X_{n-1}|\} < k \) (for any link in the network) or a predetermined maximum number of iterations is reached, stop. Otherwise, repeat steps 2 through 5.

3.1.13 Step 13, Use new travel times in regional model

The dampened travel times are imported back into the regional model at one of two locations, trip distribution or traffic assignment. If used to modify trip distribution, the updated travel times precipitate destination changes (new friction factors are computed), resulting in an updated origin-destination table (dynamic trip distribution). Figure 3-9 shows the flow of information required to perform this dynamic distribution process.

If the user does not wish to modify trip patterns, travel time is used only to update the assignment of trips. Recall that on subsequent iterations, use of the all-or-nothing or stochastic traffic assignment is required to prevent the regional model from re-computing travel times.
3.1.14 **Step 14, Repeat steps 1-13 for various levels of traveler information**

In the absence of traveler information, the methodology is run one time through only, and resulting measures of effectiveness are computed directly by exporting the results of step 13 to the simulation model (step 15). This process, or pseudo-dynamic model can provide superior assessment of travel patterns and conditions than either using regional models or traffic simulation models alone. However, as is most likely the case, the methodology is being applied to assess the benefit of traveler information. In this case, steps 1-13 should be performed for each level of traveler information provided to the public (starting with no traveler information to establish a base case for comparison). The simplest case is where a certain portion of drivers has pre-trip traveler information about a specific incident, whereas all other drivers assume that normal operating conditions prevail.

In this case, home-to-work trips. (or work-to-home trips depending on the peak period used), require special treatment. If we repeat steps 1-13, the gravity model (trip distribution
step) would perform a pseudo-dynamic route and destination choice for this trip purpose. However, work trips generally require fixed origins and destinations, independent of traffic conditions. Therefore, we do not wish to allow the model to modify work trip origins and destinations. Hence, an unmodified home-to-work (or work-to-home) trip table is used during each iteration of traffic assignment. All other trips are free to change origins and destinations, and, of course route during the process. Resulting travel patterns are then assumed to represent the drivers with pre-trip traveler information.

3.1.15 Step 15, Assess the combined travel pattern

The two traffic patterns (results of steps 13 and 14) are then combined to model travelers with different knowledge levels regarding traffic conditions. The combined pattern (or the results from step 13 only, if no traveler information is provided) represents a selected percentage of travelers on their perceived optimal paths, (travelers without information), and a selected percentage on truly optimal paths (those with information). The combined assignment is then exported to the simulation model which generates measures of effectiveness, such as travel time and delay, air pollution emissions levels or fuel usage, which are used in a cost benefit analysis to assess the benefits of providing the pre-trip information. A flowchart of the entire pre-trip information assessment process is provided in Figure 3-9.

An animation program included with the simulation model allows an analyst (or decision maker) to observe simulated vehicles as they encounter traffic queues, intersection traffic control, and congestion locations. In addition, since the data are continuously updated
Figure 3-9. Pre-trip traveler information assessment methodology.
in the GIS. GIS allows dynamic measures of effectiveness, such as emissions levels, to be spatially displayed. These visualization tools add a graphical and dynamic dimension into conventional transportation planning activities.

3.2 Scenario 2, Pre-trip information systems with addition network detail

(sketch-level approach)

If greater roadway detail is required (as compared with that typically provided in a regional model), a second scenario for analysis of traveler information is presented. Rather than develop a sub-area model (one that is simply cut out of and retains the density of the regional model) we can deploy a sketch level modeling approach. This approach allows increased roadway densities in localized areas, while simulating traffic for the entire region. (In the sub-area model, only the network in the sub-area was simulated) Sketch-level models usually contain freeway and major arterials throughout the region, and include minor arterials and collectors only in select locations (study areas). As in the first scenario, the approach combines two assignments.

A limitation of this approach (imposed by the regional model) is its lack of ability to incorporate feedback of travel times to modify origin-destination patterns. Because the sketch-level network does not retain the regional model's roadway and zone structure, feedback of travel time information into the trip distribution step is not possible. However, new travel times can still be used to improve traffic assignment of a static-origin-destination table. Because many of the procedures used to evaluate scenario two are similar to those described in the section on scenario one, above, only steps requiring different methods are
described in detail, below. To orient the reader, Figure 3-10 outlines the sketch-level modeling approach to assessing the benefits of traveler information. Steps include:

- Step 1. Obtain/develop network for regional model (same procedure as scenario one)
- Step 2. Generate Trips (same procedure as scenario one)
- Step 3. Distribute Trips for Internal Zones (same procedure as scenario one)
- Step 4. Add External Trips (same procedure as scenario one)
- Step 5. Adjust Demand for Peak Hour (or hour of interest) (same procedure as scenario one)
- Step 6. Use geographic information system (GIS) to develop sketch-level network
- Step 7. Create Origin-destination table for the sketch-level model
- Step 8. Assign Traffic
- Step 9. Export Data using Geographic Information System (GIS)
- Step 10. Test for Convergence
- Step 11. Export Data to Microsimulation Model
- Step 12. Compute Revised Travel Times
- Step 13. Export data into GIS
- Step 14. Use New Travel Times in Regional Model
- Step 15. Repeat steps 6-14 for various levels of traveler information
- Step 16. Assess the combined travel pattern

3.2.1 Steps 1-5 (same procedures as scenario one)

Early steps in the sketch-level modeling approach mirror those of the sub-area approach. Both approaches require a regional model with nominal network and demand attributes (steps 1 and 2). Step 3 is comprised of trip distribution and step 4 compiles external
Figure 3-10. Sketch-level modeling approach.
trip data with results of the internal trip distribution process. Recall, that in step 5, trip tables are adjusted to peak hour volumes (or the hour of interest).

3.2.2 Step 6, Use GIS to develop sketch-level network

The regional network is next imported into the GIS by using the MODEL.MB MapBasic program and TP_MI.FOR FORTRAN program (see Appendix C for code). Here, the regional model is converted (generalized) into a sketch-level model (to reduce the number of links to an amount within CORSIM limits). The conversion begins with the classification of existing regional roadway and identification of traffic conditions. All freeway, arterials, and others high volume/capacity links should be included in the basic sketch-level network (subject to the CORSIM link limit). Some additional links are added to provide system continuity.

While the sketch model represents the basic regional network, if an incident or investment relates to a specific location, the network in the vicinity of that location must be provided sufficient detail to evaluate the incident or investment. If detail is scarce, route alternatives are limited.

CORSIM limits the number or zones (origins or destinations for trips) to 75. As most regional networks greatly exceed this limitation, the user must aggregate zones in the sketch level model to comply with CORSIM requirements. Figure 3-11 shows a sketch-level planning model.
Figure 3-11. A sketch-level planning model.
The sketch-level model contains the same link attributes as the regional network. The node table for the sketch-level model has coordinates as does the regional model. However, there is no need for production and attractions to be tied to the sketch-level centroids because traffic assignment uses an origin-destination table, produced in the following step.

### 3.2.3 Step 7, Create origin-destination table for the sketch-level model

After defining the sketch-level planning network, the regional origin-destination tables must be modified to match the sketch-level model's aggregate zone structure. Trips that do not use the sketch-level network links should not be included in the sketch-level OD table. Further, as the number of zones needs to be reduced from say, over 600 to less than 75, many zones are aggregated. The methodology employs a series of operations, included with most travel demand models capable of developing a new trip tables comprised only of traffic flows assigned to selected roadways (select link analysis). Applying this operations, an origin-destination trip table based on the regional model zone structure is developed reflecting only traffic that use the roadway in the sketch-level network.

Two Fortran programs (NUMBERS.FOR and AGGREGAT.FOR, included in Appendix C) aggregate the origin-destination information from the regional structure to the new sketch-level model zones. The first program develops a "look-up" table which maps several regional model zones to one sketch-level zone. A central centroid is selected to represent the former set of zones. The second program aggregates total trips using the new zone designations to a sketch-level trip table (75 by 75).
3.2.4 Step 8, Assign traffic

This step is similar to step 6 of scenario one. Once the sketch-level trip table is developed, trips are assigned to the sketch-level planning model network using the travel demand model. The sketch-level forecasted roadway volumes depict the original model forecast as the origin-destination flows for the roadways are the same as those used in the regional assignment. Figure 3-12 shows the sketch-level model's origin-destination table development and assignment.

Figure 3-12. Flowchart for developing the trip table and assigning the sketch-level model.
3.2.5 Steps 9 - 16 (same as steps 7, 9-15 from scenario one)

After assigning the sketch-level model traffic, the model should be imported into GIS (Step 9) and tested for convergence (Step 10), as with the sub-area approach. If convergence is not attained, the model is input to the simulation model (Step 11), with intersection control, to obtain revised link travel times (Step 12). These travel times are then imported back into the GIS and joined with the sketch-level network, where existing travel times are modified by appropriate damping method. (Step 13).

Step 14, Use Revised Travel Times in Regional Model, differs slightly from the sub-area application. While we can feed revised travel times back into the regional assignment process, we cannot feed them into the distribution process. This is due to the fact that we no longer have the data in the proper form of the regional model. In fact, we no longer even have the same network structure. Therefore, no dynamic assignment is possible in the scenario.

After iterating the sketch-level model to a point of convergence, alternate networks-representing different knowledge levels are developed and combined (Step 15) or the combined assignments can be re-evaluated by CORSIM, with appropriate MOEs provided. (Step 16).

3.3 En-route traveler information

The final scenario describes the provision of en-route traveler information. In this case, information on short duration roadway traffic problems are provided to travelers in their vehicles, through variable message signs and/or highway advisory radio technologies.
Individuals can select alternate routes or destinations to avoid problem locations, thus minimizing their travel time. It is assumed that the portion of drivers with traveler information will choose to travel on the truly optimal paths. It is further assumed that drivers without the information will select their perceived optimal path, which we know is no longer optimal. The en-route assessment uses either the sub-area or sketch-level approach to determine travel patterns for each of the two classes of drivers. Combining the two classes of drivers into the simulation model provides the measures of interest to evaluation.

The en-route system assessment is similar to the pre-trip assessment in that it can incorporate selective availability of traveler information, but differs through the use of two distinct traffic modeling periods: pre- and post-awareness for an incident. Whereas the pre-trip information system assessment combined the two travel patterns before running the final simulation analysis, assessing en-route traveler information systems uses the combined flow patterns only after information about the incident is disseminated, and only until the network returns to pre-incident operating conditions. At all other times within the simulation period trips are assigned using the paths based on perceived optimal routes. Figure 3-13 outlines the methodology.

3.4 Model validation procedure

To enhance the credibility of the pseudo-dynamic modeling approach, it is prudent to validate some of the assumptions made before. We have assumed that the addition of the microsimulation traffic mode to the regional model would improve the replication of ground counts in the base year. To validate this assumption, we obtain hourly turning movement
Figure 3-13. Flowchart for en-route traveler information assessments.
counts, during the peak hour for the network to be studied. In the next chapter, we discuss the results of this validation.

Steps in the validation process include:

- Collect peak hour (or interest hour) traffic counts
- Input counts into regional model in GIS
- Develop comparison measures for differences and percent differences

Figure 3-14 shows how differences in model volumes predicted by the pseudo-dynamic modeling approach and the ground counts are shown in the GIS.

3-14. Differences in assigned volumes and traffic counts.
3.5 Benefit-cost analysis

To demonstrate the utility of the pseudo-dynamic modeling approach, we have developed steps to be followed in a benefit cost analysis. These include:

- Simulate travel for the sub-area or sketch-level network using perceived optimal routes (base line)
- Obtain base line estimates of travel delay
- Combine multiple assignments reflecting different knowledge levels in to a single assignment
- Simulate travel using combined assignment (either for the entire period for pre-trip systems or for the post-awareness period until incident removal for the en-route system)
- Obtain new travel delay estimates (with traveler information)
- Calculate the benefit of the system as reduction in travel time using a value of time
- Convert single benefit to annualized basis using projected number of incident occurrences
- Estimate annualized capital, operations and maintenance cost for proposed system
- Calculate benefit-cost ratio as annualized benefit divided by annualized costs.

3.6 Closure

This section presented three scenarios that are modeled using the pseudo-dynamic modeling approach. The first used a sub-area model and was capable of implementing dynamic traffic assignment. The approach to the second scenario used a sketch model and was capable of assessing larger, regional issues, but does not have the capability to perform dynamic trip distribution. Both methods employ superior assessment of traffic conditions as
compared to the use of regional models alone by improving traffic assignment. In the third scenario, the methodology outlines how users can address short-term incidents that either start during the simulation period and/or are cleared prior to model termination. To demonstrate the usefulness of the methodology, a case study of implementing traveler information in Des Moines, Iowa is performed in the next chapter.
CHAPTER 4. CASE STUDY AND EVALUATION

To demonstrate the integrated travel demand and simulation methodology, this chapter presents the results of a case study for Des Moines, Iowa. In section one, a peak period sketch-level model is developed using only the regional model software, Tranplan. The Tranplan Model is then validated. Section two integrates the model with GIS and CORSIM to develop dynamic assessment capability. Two travel-time updating techniques are demonstrated (the modified capacity restraint and the successive averages methods). These two methods are compared and a second validation is performed to quantify the assignment improvements resulting from the dynamic modeling approach. In section three, the sketch dynamic model is used to assess the benefits of providing pre-trip traveler information (scenario two as presented in the methodology). Scenario one of the methodology (subarea modeling) is not demonstrated for the case study area, as results are nearly identical to those attained by the sketch model approach. In section four, the model is used to assess two en-route traveler information system technologies (scenario three from the methodology). Section five explores an extension of the model to assess the benefits of improved incident response using video surveillance.

4.1 Sketch-level regional model

Sketch-level model development for Des Moines uses steps 1-8 from scenario 2 of the methodology chapter. These steps generate a base network assignment using only Tranplan software, reflecting the state of the practice available to most planning agencies. Link assignments are compared to ground counts to validate the model.
4.1.1 Developing the Des Moines baseline sketch-level Tranplan network

The Des Moines Metropolitan Planning Organization currently maintains a 24 hour Tranplan model with 2378 nodes and 3385 links. Figure 4-1 shows the regional model network. The model contains 643 traffic analysis zones with daily productions calculated using cross-classification and attractions calculated using regression equations. Five trip purposes are used for the model: home-based work (HBW), home based-other, non-home based, commercial truck and external-internal trips.

A gravity model is used to perform trip distribution and Tranplan matrix utilities to integrate external-external trips to produce a daily origin-destination table. As discussed in the methodology, the dynamic assignment requires hourly, or shorter, modeling duration to allow sensitivity to short duration incidents (lasting less than a day). Hourly trip distribution rates are obtained from published literature (46), and are shown in Table 4-1. As gravity model outputs imply that all trips begin at their production end and terminate at the attraction end, directionality must be removed. This is done using the Tranplan matrix utilities. However, as most to-work trips occur during the morning peak, the HBW trip table is not adjusted for directionality. All work trips occurring during the morning peak are assumed to go from home to work. (Note: this assumption should be checked in larger urbanized areas with higher numbers of second or third shift employees).

The regional network is then input to MapInfo GIS where the sketch-level network is defined as follows, links included in the sketch network correspond to those identified as important to regional ITS in the Des Moines Metropolitan Area ITS Strategic Plan (5).
Figure 4-1. The existing Des Moines travel demand model network.

Table 4-1. Peak hour factors by trip purpose (morning peak).

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Percentage of Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home-Based Work</td>
<td>20%</td>
</tr>
<tr>
<td>Home-Based Other</td>
<td>3%</td>
</tr>
<tr>
<td>Non-Home Based</td>
<td>3%</td>
</tr>
<tr>
<td>Commercial Truck</td>
<td>3%</td>
</tr>
<tr>
<td>External-Internal, External-External</td>
<td>3%</td>
</tr>
</tbody>
</table>
Additional links are included to provide continuity and densify the network in the area of interest (I-235 and downtown areas). Zone centroids, centroid connectors and nodes are selected to comprise the sketch-level network, which contains 71 zones (aggregated from original 643 zones), 125 nodes, and 232 links. As in the regional network, the sketch-level network models interchanges as uncontrolled, at-grade intersections. Although some improvements may be afforded by modeling cheese interchanges with multiple links (ramps, etc.), they are represented as single point intersections in the sketch model to conserve links (recall CORSIM limits the user to 500 links). Peak hour link capacities are derived from 24-hour capacities provided in the original Tranplan model. Free-flow travel speeds are input directly from regional model link attributes and the GIS program is used to calculate segment length. The sketch-level network developed for Des Moines is shown in Figure 4-2.

Tranplan Select Link Analysis is used to identify only the trips that utilize the links of the sketch level network. This produces a revised version of the 643 zone peak hour trip table. NUMBER.FOR and AGGREGAT.FOR software program are used to convert this table into a peak period sketch-level trip table, by aggregating travel from the 643 zone structure to the 71 zone structure. This trip table is then assigned to the sketch-level network, using Tranplan, generating an assigned, peak period sketch-level model. For the Des Moines network, 56 percent of the trips from the regional model were assigned to the roadways in the sketch-level model.
4.1.2 Validating the base Tranplan network

The peak period sketch level model represents the state of the practice available to most planning agencies in medium to large metro areas. To provide a baseline for assessing the accuracy of the dynamic model developed in the next section, the sketch level Tranplan model is validated. This consists of comparing peak period turning movement ground counts to link volumes produced by the sketch level Tranplan model. Results indicate a baseline correlation coefficient of 0.79 with an average error percentage of 56 percent. This is similar to the correlation coefficient of the original regional Tranplan model, 0.80. A MapInfo table (Figure 4-4) is presented to show the spatial distribution of model error (gray indicates the model is low, black indicates the model is high).
4.2 Baseline sketch-level dynamic model

The sketch level network described in section 4.1 is converted to CORSIM using the MapInfo interface, in the same manner as scenario 2, steps 9-14 in the methodology chapter. Intersection control parameters are input to CORSIM to improve assignment. The steps are repeated until traffic volume changes less than 100 vehicles between iterations. After convergence is attained, the "pseudo-dynamic" model results are validated to the peak period ground counts. Variants of the baseline sketch-level model are used in later steps to assess the benefit of improved traveler information. The next two sections describe this process in more detail.
4.2.1 Developing the baseline pseudo-dynamic sketch-level model

The peak-hour sketch level network is exported through MapInfo to CORSIM using procedures from the methodology. Intersection traffic control parameters are input to the simulation control file for all traffic signal locations. Green-time for each signal is evenly split among approaches, this can be adjusted manually to improve the assignment, but was not adjusted for the purposes of this study. Traffic volumes are set to follow a uniform distribution during the one-hour simulation period. this too can be adjusted to more closely replicate actual conditions and to introduce more dynamic response.

CORSIM generates updated travel times based on congestion levels and intersection traffic control effects. These travel times are input to the sketch model, maintained in MapInfo, to improve the assignment. Two alternative damping methods for improving travel times were tested, a modified capacity restraint and a modified method of successive averages. (As discussed in the methodology, the sketch-level model approach does not allow for the updated travel times from CORSIM to change the original regional assignment. As a result, the fixed origin-destination trip table from the regional model is used and new travel times affect traffic assignment only.) Two MapBasic programs, UPDATE.MB and TRAN.MB, were written to automate repetitive steps of the travel time updating process (these programs can be found in Appendix C).

Using the modified capacity restraint method to incorporate feedback into the modeling process required 18 iterations to reach convergence. The modified method of successive averages took 12 iterations to reach the same convergence point.
Time-specific measures of network performance are generated by CORSIM during each iteration. Because Tranplan provides only hourly turning movements, time-specific (less than one hour) measures of intersection performance can not be obtained. The simulation model provides average and maximum traffic queues, by lane, for each intersection approach. Output measures are readily exported to the MapInfo software for display and further analysis (see Figure 4-4).

Figure 4-4. Maximum queue for intersection approaches of node 77.

The simulation package also provides measures of fuel usage and vehicle emissions. These measures should be used with caution, for all applications, as some network inputs can greatly affect results (e.g., grade, fleet characteristics, ...). For the sketch model, default values were used for each of these parameters (e.g., all links were attributed as level terrain).
Hydrocarbons, carbon monoxide and nitrous oxides emissions by link, are exported to the GIS where design alternatives are assessed. Figure 4-5 shows vehicle emissions by link for the case study baseline model.

During the test of the two feedback methods, CORSIM calculates values of total network delay. Figure 4-6 shows the delay experienced at each iteration, in person-minutes, for both methods.

Finally, an output file is provided by the simulation allowing network visualization in TRAF-VU. Two examples are provided (Figures 4-7 and 4-8).

Figure 4-5 Vehicle carbon-monoxide emissions.
Figure 4-6. Delay experienced for each iteration.

Figure 4-7. The Des Moines sketch-level network in TRAF-VU.
4.2.2 Validating the baseline pseudo-dynamic sketch-level model

All of the output measures from the Des Moines sketch-level model can be validated, but most require considerable data collection efforts. Data must be collected under similar conditions as assumed in the model. Present efforts to validate the model approach consist of comparing peak period turning movement ground counts to link volumes produced by the sketch-level pseudo-dynamic model. Results indicate a correlation coefficient of 0.85 with an average error of 46 percent. This represents an improvement over both the original regional Tranplan model, 0.80 and the sketch level Tranplan model, 0.79. As correlation coefficient is only one measure of model fidelity, a MapInfo table (Figure 4-9) is presented to show the spatial distribution of model error (gray indicates model is low, black indicates the model is high).
4.3 Assessment of a pre-trip traveler information system

To assess the benefit of pre-trip traveler information, the baseline regional network is modified to include a major construction project on I-235 through downtown Des Moines (a major commuting corridor - see Figure 4-10). During construction, the facility is modeled with one of three lanes closed, and the speed limit reduced from 55 mph to 40 mph. Further, a parallel major route, normally considered to be a preferred detour, is also under construction (capacity reduced from two lanes to one - see Figure 4-11). (Figures 4-10 and 4-11, as well as Figure 4-14, were obtained using MapQuest located on the Internet at www.mapquest.com.)
Figure 4-10. Interstate location in Des Moines.

Figure 4-11. Construction locations.
4.3.1 Modeling the pre-trip traveler information system

Two variants of the regional baseline model are developed, one with arterial construction and one without (both versions include the reduced freeway capacity). In the construction variant, increased travel time on the arterial results in a second origin-destination table (reflecting that some drivers may change destinations due to traffic conditions - a limited form of dynamic distribution). However, the home based work portion of the trip table is held constant (it is assumed that these trips have fixed OD patterns on a day-to-day basis).

Following the procedure described above, sketch level models are prepared and simulated for each "level" of traveler information (all drivers have information and all drivers do not have information). Acceptance of traveler information is modeled to vary from 5 to 25 percent, and travel patterns in the two sketch-level models are combined accordingly. e.g., for 5 percent traveler information compliance, traffic assignments are comprised as 5 percent load from the "with information" model and 95 percent load from the "without information" model.

In the absence of arterial construction, the sketch level dynamic model estimates 16,700 person-minutes of delay during the peak hour. With arterial construction, and without providing any traveler information, the delay estimate increases to 21,600 person-minutes. As the percentage of travelers with information increases from 5 to 25%, delay is reduced as shown in Table 4-2.
Table 4-2. Benefits of a pre-trip information system.

<table>
<thead>
<tr>
<th>Percent using system</th>
<th>hourly delay (person-minutes)</th>
<th>delay reduction (person-minutes)</th>
<th>delay reduction (person-hours)</th>
<th>cost savings of reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>21.608</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>21.519</td>
<td>89</td>
<td>1.5</td>
<td>15.28</td>
</tr>
<tr>
<td>10</td>
<td>20.902</td>
<td>706</td>
<td>11.8</td>
<td>121.20</td>
</tr>
<tr>
<td>15</td>
<td>19.804</td>
<td>1804</td>
<td>30.1</td>
<td>309.69</td>
</tr>
<tr>
<td>20</td>
<td>18.483</td>
<td>3125</td>
<td>52.1</td>
<td>536.46</td>
</tr>
<tr>
<td>25</td>
<td>17.653</td>
<td>3955</td>
<td>65.9</td>
<td>678.94</td>
</tr>
</tbody>
</table>

4.3.2 Benefit/cost analysis for pre-trip information system

Benefits from travel time savings are calculated using a $10.30 per-hour, per-vehicle value of time (twice the minimum wage as used in the Des Moines ITS Study) (5). For the scenario tested above, benefits of traveler information for one hour are listed in Table 4-2 and shown graphically in Figure 4-12.

Figure 4-12. Delay reductions using pre-trip information system.
The minimum capital cost for pre-trip information is reported to be in the range of $15,000 for a simple internet site or cable TV access (5). Amortized over 3 years at a discount rate of 7 percent, annual capital cost for the system is $5,200. Operations and maintenance costs will vary dependent on how traffic information is obtained, but a simple scenario of cell phone or fax updates can be envisioned that would result in annual operation and maintenance costs of, say, $10,000. Total annualized cost of the system, therefore, may be approximately $15,600.

The number of hours the system must be used to justify investment depends on the provision and compliance with traveler information as shown in Figure 4-12. If only five percent of drivers comply with the pre-trip information system, approximately 1000 annual hours of compliance are required to break even. However, if as many as 25 percent of the drivers comply, the benefits of the system are expected to quickly recover investment costs in as few as 25 hours (see Figure 4-13 for the range of system benefits).

4.4 Assessment of an en-route traveler information system

An assessment of en-route traveler information technologies is performed using the pseudo-dynamic model with convergence attained using the modified method of successive averages. The assessment uses the same network as the pre-trip assessment with the interstate construction. A short duration incident replaces the arterial construction activity (essentially, the "full-hour" arterial restriction is shortened to less than one hour). Following the assessment methodology, a certain percentage of the travelers are allowed to alter their route and destination choices based on improved information about the incident after
reaching a post-awareness period. This section presents the results of providing improved traveler information via HAR and VMS. Benefits and costs are analyzed for each individually, and for a system that uses both technologies.

4.4.1 Modeling the conventional en-route traveler information system

As with the pre-trip scenario, two regional models are developed. One model contains only the interstate construction and the other contains the interstate construction and a traffic incident causing a lane blockage on the arterial (modeled as if the lane were blocked for the entire period). Again, origin-destination trip tables are developed for each situation allowing two OD patterns.
A 20 minute incident is scheduled to begin ten minutes into the simulation. This incident causes a single-lane blockage for traffic entering the downtown area. Before and during the first ten minutes of the incident, all traffic assignment is based on patterns that reflect no knowledge of the incident. During the last 10 minutes of the incident, the travel patterns from two assignments are combined (according to the percentage of drivers expected to receive and comply with the information). After the incident is cleared (30 minutes into the incident), assignment returns to the original, pre-incident pattern. Four scenarios are tested:

- the incident with no traveler information (base case).
- the incident with five percent of travelers responding to a highway advisory radio system (HAR).
- the incident with 20 percent of travelers responding to a system of variable message signs (VMS), and
- the incident with 25 percent of travelers responding to information provided by a combination of the two technologies.

Table 4-3 shows total delay for each of the four scenarios.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>hourly delay (person-minutes)</th>
<th>hourly delay (vehicle-hours)</th>
<th>time savings (vehicle-hours)</th>
<th>cost savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>No technology</td>
<td>18,509</td>
<td>308</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HAR 5%</td>
<td>17,901</td>
<td>298</td>
<td>10</td>
<td>103</td>
</tr>
<tr>
<td>VMS 20%</td>
<td>15,695</td>
<td>262</td>
<td>46</td>
<td>473</td>
</tr>
<tr>
<td>HAR and VMS</td>
<td>14,924</td>
<td>248</td>
<td>60</td>
<td>618</td>
</tr>
</tbody>
</table>
4.4.2 Benefit/cost analysis for conventional en-route information system

The capital cost for highway advisory radio systems range from $55,000 to $110,000 (5). Using a seven percent discount rate, a 15 year life, and 15 % maintenance costs, and $10,000 per year operations cost, the annual cost of the system is between $16,800 and $23,700. Assuming that an incident occurs every other day, the total annual benefit (assuming 5 percent compliance) is $18,800 (again, a $10.30 for the value of time is assumed). This results in a benefit-cost ratio ranging from 0.9 to 1.25.

Cost estimates for variable message signs range from $55,000 to $90,000 (arterial) and $115,000 to $190,000 (freeway) (5). It is assumed that four variable message signs are required to notify travelers about this incident. Using two VMS signs on each of the freeway and arterial locations, and again, using a seven percent discount rate, 15 year life, 15 percent maintenance and $10,000 per year operations cost, the annual cost ranges between $37,288 and $50,858. Assuming that an incident occurs every other day, the total annual benefit (assuming 20 percent compliance) is $86,086 per year. This results in a benefit-cost ratio ranging from about 1.7 to 2.3.

For both technologies, the total cost is assumed to be less than $64,500 (without duplicating operating costs). Using the potential cost savings of $618 per incident, annually, there need to be 104 twenty-minute incidents to break-even.

4.5 Assessment of improved incident response time

This section uses the pseudo-dynamic model to assess video surveillance as a technology to improve incident response. Video surveillance has been estimated to reduce the
time to clear an incident by 5-8 minutes (47). Incident costs have been estimated to increase with the square of clearance time, which suggests that video surveillance may be cost effective in many cases (48).

To observe only the benefits of video surveillance, the technology is tested in the absence of any traveler information system. The principal objective of surveillance is to verify the presence of an incident and assist in determining an appropriate mitigating response. A sensitivity analysis varies the time required to clear an incident from the network.

4.5.1 Modeling a video surveillance system

To test the ability of video surveillance to reduce incident costs, the sketch-level dynamic modeling approach is used (using the method of successive averages). Variable duration incidents, occurring during the morning peak, are used to calculate reductions in delay associated with improved response. An incident is located in the right, eastbound lane on the interstate system, just northwest of downtown, as shown in Figure 4-14. Incident duration is varied from 10 to 40 minutes (each incident is started five minutes into the simulation period), and delay is computed by CORSIM. The impact of the incident on area traffic is illustrated in the TRAF-VU output shown in Figure 4-15. Video surveillance benefits are then estimated due to 5 to 8 minute reduction in incident duration. Figure 4-16 shows delay, and potential reductions in delay associated with each incident duration.
Figure 4-14. Incident location.

Figure 4-15. Incident effect in TRAF-VU.
4.5.2 Benefit/cost analysis for the video surveillance system

The Des Moines ITS Early Deployment Study recommends 13 potential locations for installation of video surveillance cameras along the interstate. Each camera is assumed to cost $40,000 (5). Communications and other equipment is assumed to cost $20,000, resulting in a total capital cost of the entire, 13 camera system of $540,000. Annual maintenance and operation cost of $10,000 (as the monitoring of the cameras will be added to the duties of an employed individual) is assumed for a 10 year life of the system. At seven percent interest, annual cost is approximately $70,000 per year.
Again using a $10.30 per hour value of vehicle delay, table 4-4 shows potential system benefits of a number of incidents of varying duration. There were 571 crashes reported for the interstate during 1993. 228 during peak periods (5). 114 accidents are thus assumed to comprise a typical annual, a.m. peak crash frequency. Nationally, about 10 percent of incidents result from accidents (5). Using this ratio, approximately 1140 incidents can then be expected during the morning peak. It is assumed that most incidents clear within 10 to 15 minutes. Benefits during the a.m. peak calculate to approximately $43,000.

If benefits during the p.m. peak are assumed to equal those of the a.m. peak, a benefit cost ratio of approximately 1.2 can be obtained. Clearly, video surveillance would complement en-route traveler information technologies, although some double counting of benefits would result, as reduced incident times (caused by video surveillance) result in a reduction of potential benefits of improved traveler information.

Table 4-4. Cost savings with incident response technology.

<table>
<thead>
<tr>
<th>Incident time</th>
<th>Delay (person-minutes)</th>
<th>8 minute response improvement</th>
<th>5 minute response improvement</th>
<th>Average reduction in delay</th>
<th>number of assumed incidents</th>
<th>annual delay (per-hrs)</th>
<th>Annual Cost savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>12,789</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>13,210</td>
<td>13,031</td>
<td>13,089</td>
<td>150</td>
<td>300</td>
<td>750</td>
<td>$7,725</td>
</tr>
<tr>
<td>15</td>
<td>13,433</td>
<td>13,190</td>
<td>13,210</td>
<td>233</td>
<td>250</td>
<td>971</td>
<td>$10,000</td>
</tr>
<tr>
<td>20</td>
<td>13,568</td>
<td>13,399</td>
<td>13,433</td>
<td>152</td>
<td>200</td>
<td>507</td>
<td>$5,219</td>
</tr>
<tr>
<td>25</td>
<td>13,769</td>
<td>13,335</td>
<td>13,568</td>
<td>317</td>
<td>150</td>
<td>792</td>
<td>$8,163</td>
</tr>
<tr>
<td>30</td>
<td>13,853</td>
<td>13,605</td>
<td>13,769</td>
<td>166</td>
<td>100</td>
<td>276</td>
<td>$2,849</td>
</tr>
<tr>
<td>35</td>
<td>14,069</td>
<td>13,593</td>
<td>13,853</td>
<td>346</td>
<td>80</td>
<td>416</td>
<td>$4,752</td>
</tr>
<tr>
<td>40</td>
<td>14,444</td>
<td>13,979</td>
<td>14,069</td>
<td>420</td>
<td>60</td>
<td>420</td>
<td>$4,326</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$43,034</td>
</tr>
</tbody>
</table>
CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

During the course of this study, a "pseudo-dynamic" network assignment model was developed. The approach integrates a regional travel demand model and micro-simulation package in a GIS environment. Two methods were used to compress the regional model network to conform to size limits imposed by the micro-simulation model, a sub-area analysis and a sketch-level modeling analysis. To test the model, three traveler information assessment scenarios were developed:

• provision of pre-trip information (tested using sub-area model approach).
• provision of pre-trip information (tested using sketch-level model approach).
and
• provision of en-route information (tested using sketch-level model approach).

A case study was developed for the Des Moines, Iowa metropolitan area. The model and two of the traveler information scenarios were tested. This chapter summarizes the study results, comments on limitations of the modeling environment, and makes recommendations for future research.

5.1 Summary

This study is about the evaluation of new systems. Intelligent transportation systems (ITS) represent a new way to approach the provision of transportation services - services one would not necessarily expect conventional assessment methods to effectively address. While development of new transportation modeling methods has begun (through the Travel Model Improvement Program), practical tools remain several years away. Once developed, these
tools will certainly be unfamiliar to planners and are likely to be data intensive, if not prohibitive for some agencies. While no single tool can assess all ITS services, this dissertation shows that, by combining familiar approaches, analysts can effectively address some ITS services (e.g., traveler information).

The methodology builds upon the strength of a widely used urban transportation model, Tranplan, to assess regional implications of ITS. It incorporates the graphical and spatial data management strengths of desktop mapping (MapInfo). The approach also draws on the capabilities of CORSIM, FHWA's traffic microsimulation modeling environment. CORSIM is used to compute time dependent measures of effectiveness such as intersection queues, stop delay, fuel economy and vehicle emissions, while Tranplan permits limited-dynamic destination and route choices and assignments based on optimal as well as perceived-optimal paths.

In the case study, the methodology is successfully demonstrated as model information is shared between packages to approximate dynamic assignment. The case study also demonstrates the use of several programs written to streamline an otherwise cumbersome process. The model is shown to improve regional model fidelity while making use of familiar tools and readily available data.

Scenarios assessed in the case study showed that providing improved traveler information systems reduces system travel time and results in positive benefit cost ratios for system deployment. Average benefit cost ratios for en-route information systems are shown to range from 1.08 for highway advisory radio to 2.0 for variable message signs.
5.2 Limitations

Several assumptions limit the applicability of the pseudo-dynamic model developed in this study. These limitations are discussed as follows:

- Traffic signals - In the case study, all cycle lengths input the CORSIM control file were 80 seconds with green-time divided evenly between approaches. In reality, traffic signal controls are set to optimize traffic flow through an intersection, if not an entire corridor. To address this problem, the user has two options. Existing traffic signal control parameters can be input to CORSIM (for pretimed signals) or a Fortran data conversion program may be modified to calculate signal timing based on demand levels (for actuated signals).

- Sketch-level problem - The principal advantage of the sketch level model is the ability to densify the network prior to assessment by CORSIM. However, links added to represent network detail in the area of interest will have no base-level volume, they do not exist in the original Tranplan network assignment. Therefore, when Tranplan assigns trips to the new links, volume to capacity ratios will be underestimated, resulting in overestimation of trips using the new links. To correct this problem the user has two options. A base volume may be entered into the new links representing a typical, "off-system" demand level or, the user may reduce the capacity of the new links to a level approximating the "available capacity" on those links.

- Different knowledge levels - The case study examined the benefit of providing improved traveler information about a single incident or construction location. While not
specifically a limitation of the model, the case study does not examine the more-realistic situation where multiple incidents and maintenance/construction activities occur simultaneously. The limitation becomes a problem if multiple incidents requires network focus or densification that cause the network to exceed CORSIM size limits.

- Cost estimates - Cost estimates are based on the Des Moines Metropolitan Area ITS Early Deployment Study. Capital, operation, and maintenance costs are likely to differ with technology selected and deployment location.

- User interface - At least two limitations have been identified in the conversion software developed in this study. Specification of turning movements directions and volumes can be a problem in special cases. Networks with acute angles and zero turning movement volumes will not be modeled correctly. For these cases, CORSIM input data must be manually adjusted. And, although the software was developed specifically to support the analysis of this study, other users may wish to use the software. In any case, the users will need to be familiar with the individual models because the models are not a single integrated package and there is not a user-manual to assist with all variations for their systems.

5.3 Recommendations

In addition to addressing model limitations, several modifications and applications are suggested as extension to this work.

- Include FRESIM module - Using the FRESIM component of CORSIM can provide a more accurate simulation of freeway operations and delay calculations when incidents
occur on these segments. This study used only the NETSIM components of CORSIM to model all network links.

- Incorporate mode choice - Mode choice was not included in either the methodology or the case study. However, in larger metropolitan areas, where transit is a viable alternative to automobiles, omitting this step can reduce model accuracy as dynamic mode choice decisions are eliminated. Clearly, research to include mode choice decisions within the travel demand model would allow quantification of the benefits of providing improved traveler information across modes.

- Model the time distribution of trips leaving each zone - The number of trips leaving each zone was assumed to follow a uniform distribution for the simulation period (one hour). Model dynamics were predicated on this assumption, allowing feedback only into destinations and route choice. To incorporate trip departure dynamics, additional data could be obtained and used to approximate and calibrate future models.

- Improve estimates of traveler information compliance - Level of compliance with traveler information is likely to vary across regions, and even within regions. The level is also affected by type, timing and placement of traveler information. Compliance is likely to change over time, particularly once travelers begin to learn how to most effectively use the information provided. Provision of erroneous or untimely information will likely have a detrimental impact on compliance. All of these influences motivate the need for additional study prior to use of the system to more precisely quantify the benefits of providing improved traveler information.
• Incorporate destination changes - The assessment of traveler information assumes that drivers are aware of problems and have the ability to change routes and destinations accordingly. In the en-route scenario, travelers have already left their origin when they receive information. However, Trainplan assigns hourly travel patterns from origins to destinations. The assignment re-directs trips to new destinations based on the origin zone, not the actual vehicle location. The effect of the trip re-direct is that vehicle in close proximity to its original destination might be re-routed to alternative destinations. Only a comprehensive, truly dynamic network demand and simulation model is likely to address this concern (e.g., TRANSIMS type approach).

• Include fuel and air quality in B/C. safety benefits and sensitivity analysis for value of travel time - Future researchers may wish to validate CORSIM's measures of fuel efficiency and emission levels, and incorporate some measure of safety improvement. Validation for specific areas is likely to require an empirical, before and after analysis for an area that has implemented traveler information systems. It is possible to foresee a relationship between some of the measures of the pseudo-dynamic model and safety measures. In this study, traveler information benefits were calculated simply as reductions in delay using a single value of travel time. The inclusion of benefits, derived from changes in emissions, fuel-use, and safety will clearly increase benefit-cost ratios. As a first step, sensitivity analysis for existing delay, air quality and fuel use measures would be relatively straightforward.
5.4 Closure

The principal contribution of this research is the development of a pseudo-dynamic modeling environment suitable for assessing traveler information or other ITS services. The identification and combination of optimal and "perceived-optimal" paths in a regional network simulation is original to this work. The system allows region-wide assessment of pre-trip and en-route traveler information services and incorporates travel time feedback into the trip making and route selection processes. Specifically, the work provides a practical approach to assessing ITS improvements. In general, the work shows that conventional transportation modeling environments can be integrated to perform analyses of new transportation systems.
APPENDIX A. SAMPLE TRANPLAN CONTROL FILE

$BUILD HIGHWAY NETWORK
$FILES
  OUTPUT FILE = HWYNET. USER ID = $net90x.bin$
$OPTIONS
  LARGE COORDINATES
$PARAMETERS
  NUMBER OF ZONES = 643
  MAXIMUM NODE = 3410
$DATA
N  1 37641 10867
N  2 37625 10956
N  3 37523 10913
N  4 37408 10916
N  5 37552 10992
N  6 37483 10991
N  7 37392 11036
N  8 37414 11015
N  9 37425 10983
N 10 37390 10973
...
N 3404 38215 10735
N 3405 37534 10324
N 3408 37858 11696
N 3409 37858 11646
N 3410 37758 11646
  13370 40S15001500 0000 0 34S15001500 0000 0 82
  13280 23S15001500 0000 0 107S15001500 0000 0 64
  13450 48S20002000 0000 0 21S20002000 0000 0 16
  13430 10S15001500 0000 0 7S15001500 0000 0 5
  33435 10S15001500 0000 0 69S15001500 0000 0 46
  413410 10S15001500 0000 0 9S15001500 0000 0 23
  13530 10S15001500 0000 0 109S15001500 0000 0 616
  512780 10S15001500 0000 0 210S15001500 0000 0 144
  513250 20S15001500 0000 0 19S15001500 0000 0 15
  612770 10S15001500 0000 0 174S15001500 0000 0 130
...
3391 33920 0T 0 01000 0 7S 0 01000 0 10
3393 33940 88S34973497 1200 2500 0S34973497 1200 2500 1
3395 33960 50S34883488 1200 2500 0S34883488 1200 2500 2
3395 33970 50S34883488 1200 2500 13S34883488 1200 2500 5
3408 34090 50S34883488 1200 6450 5S34883488 1200 6450 4
$INCLUDE TURN90.PRO
$END TP FUNCTION

$HIGHWAY SELECTED SUMMATION
$FILES
  INPUT FILE = HWYNET, USER ID = $NET90X.BINS
  OUTPUT FILE = HWYSKIM, USER ID = $SKIM90.SKI$
$HEADERS
  DES MOINES I-235 ** 1990 HIGHWAY SKIMS ** NO INTRAS  RUN-13
$DATA
  TABLE = TIME 1
$END TP FUNCTION

$BUILD INTRAZONAL IMPEDANCES
$FILES
  INPUT FILE = IZIN, USER ID = $SKIM90.SKI$
  OUTPUT FILE = IZOUT, USER ID = $SKIMGM90.SKIS$
$OPTION
  PRINT DETAIL
$PARAMETERS
  NUMBER OF ADJACENT ZONES = 2
$END TP FUNCTION

$GRAVITY MODEL
$FILES
  INPUT FILE = GMSKIM, USER ID = $SKIMGM90.SKIS$
  OUTPUT FILE = GMVOL, USER ID = $GM90.TRP$
$HEADERS
  DES MOINES I-235 ** GRAVITY MODEL ** 1990 TRIPS  RUN-13
  1 = WORK  2 = OTHER  3 = NHB  4 = COMM VEH  5 = EXT-INT
$OPTIONS
  MERGED PURPOSE FILE
  PRINT TRIP ENDS
  PRINT TRIP LENGTH STATISTICS
  PRINT ATTRACTIONS
$PARAMETERS
  MAXIMUM PURPOSE = 5
  MAXIMUM TIME = 51
  IMPEDANCE = TIME 1
  ITERATIONS ON ATTR ACTIONS = 3
ATTRACTION CLOSURE = 5.0
$DATA
$INCLUDE GM1990.PA
$INCLUDE FRICFAC.DAT
$END TP FUNCTION

$MATRIX UPDATE
$FILES
   INPUT FILE = UPDIN, USER ID =$GM90.TPS$
   OUTPUT FILE = UPDOUT, USER ID =$GM90X.TPS$
$HEADERS
   DES MOINES I-235 ** YEAR 1990 TOTAL TRIPS AVERAGED RUN-13
$DATA
   T1,1-643,1-643, * .2
   T2,1-643,1-643, * .03
   T3,1-643,1-643, * .03
   T4,1-643,1-643, * .03
   T5,1-643,1-643, * .03
$END TP FUNCTION

$MATRIX UPDATE
$FILES
   INPUT FILE = UPDIN, USER ID =$EXT90.TPS$
   OUTPUT FILE = UPDOUT, USER ID =$EXT90X.TPS$
$HEADERS
   DES MOINES I-235 ** YEAR 1990 TOTAL TRIPS AVERAGED RUN-13
$DATA
   T1,1-643,1-643, * .03
$END TP FUNCTION

$MATRIX MANIPULATE
$FILES
   INPUT FILES = TMAN1, USER ID =$GM90X.TPS$
   INPUT FILES = TMAN2, USER ID =$EXT90X.TPS$
   OUTPUT FILES = TMAN3, USER ID =$GM90TOTX.TPS$
$HEADERS
   DES MOINES I-235 ADD YEAR 1990 TRIPS FOR BALANCING RUN-13
$DATA
   TMAN3,T1 = TMAN1,T2 + TMAN1,T3 + TMAN1,T4 + TMAN1,T5
            + TMAN2,T1
$END TP FUNCTION
$MATRIX MANIPULATE
$FILES
  INPUT FILES = TMAN1, USER ID =$GM90X.TPS$
  OUTPUT FILES = TMAN2, USER ID =$HBW90X.TPS$
$HEADERS
  DES MOINES 1-235 ADD YEAR 1990 TRIPS FOR BALANCING RUN-13
$DATA
  TMAN2,T1 = TMAN1,T1
$END TP FUNCTION

$MATRIX TRANSPOSE
$FILES
  INPUT FILE = TRNSPIN, USER ID =$GM90TOTX.TPS$
  OUTPUT FILE = TRNSPOT, USER ID =$DUM.TPS$
$HEADERS
  DES MOINES TRANSPOSE FOR BALANCING
$PARAMETERS
  SELECTED TABLES = 1
$END TP FUNCTION

$MATRIX MANIPULATE
$FILES
  INPUT FILE = TMAN1, USER ID =$GM90TOTX.TPS$
  INPUT FILE = TMAN2, USER ID =$DUM.TPS$
  OUTPUT FILE = TMAN3, USER ID =$TOT90.TPS$
$HEADERS
  DES MOINES 1-235 ADD TRANSPOSE AND TOTAL FOR BALANCING RUN-13
$DATA
  TMAN3,T1 = TMAN1,T1 + TMAN2,T1
$END TP FUNCTION

$MATRIX UPDATE
$FILES
  INPUT FILE = UPDIN, USER ID =$TOT90.TPS$
  OUTPUT FILE = UPDOUT, USER ID =$TOT90X.TPS$
$HEADERS
  DES MOINES 1-235 ** YEAR 1990 TOTAL TRIPS AVERAGED RUN-13
$DATA
T1.1-643.1-643, * .5
$END TP FUNCTION

$MATRIX MANIPULATE
$FILES
  INPUT FILE = TMAN1, USER ID =$TOT90X.TP$
  INPUT FILE = TMAN2, USER ID =$HEW90X.TP$
  OUTPUT FILE = TMAN3, USER ID =$TOT90Y.TP$
$HEADERS
  DES MOINES l-235  ADD TRANSPOSE AND TOTAL FOR BALANCING RUN-13
$DATA
  TMAN3.T1 = TMAN1.T1 + TMAN2.T1
$END TP FUNCTION
APPENDIX B. TRANPLAN TRAFFIC ASSIGNMENT CONTROL FILES

First iteration assignment method

$EQUILIBRIUM HIGHWAY LOAD
$FILES
  INPUT FILE = HWYNET. USER ID =$NET90X.BIN$
  INPUT FILE = HWYTRIP. USER ID =$TOT90Y.TP$
  OUTPUT FILE = LODHIST. USER ID =$NETXLOD.BIN$
$HEADERS
  DES MOINES
  *** 1990 EQUILIBRIUM ASSGN ***
  1990 NETWORK
$PARAMETERS
  SAVE TURNS = 1000-3410
  EQUILIBRIUM ITERATIONS = 4
$END TP FUNCTION

Successive iteration assignment methods

$LOAD HIGHWAY NETWORK
$FILES
  INPUT FILE = HWYNET. USER ID =$NET.BIN$
  INPUT FILE = HWYTRIP. USER ID =$SKETCH.TRPS$
  OUTPUT FILE = LODHIST. USER ID =$OUT.BIN$
$PARAMETERS
  SAVE TURNS = 1 - 1125
$END TP FUNCTION
APPENDIX C. PROGRAM WRITTEN TO SUPPORT RESEARCH

TP_MI.FOR

C Program to develop the file containing the node and productions and attractions information to be used by Mapinfo.

C Identifying the variables.
integer no.xcoord,ycoord,taz
integer node.line,type1,type2,type3
integer type4,type5,nodep.linep,type1p
integer type2p,type3p,type4p,type5p,coord
real xcoor,ycoor,xfact,yfact
character* 1 A2
character*2 type,typep
character*12 nodes
character*12 pa
character*12 output

integer a, b, al, x, y, ag, d, s, s2
* .dc.11,12,13.c1,c2,s3,s4,dc1
* .l4,l5,l6,c3,c4
real x1,x2,y1,y2
character* 1 o, q
character*1 o2
character*7 u
character*12 LINKS2
character*12 OUTPUT2
character*6 name1,name2

C Opens files needed for the program.
write(*,*)' Please input the name of the file containing the'
write(*,*)' node data :
read(*,990)nodes

write(*,*)
write(*,*)' Please input the name of the file containing the'
write(*,*)' productions and attractions data :
read(*,990)pa
write(*,*)
write(*,*)' Please input the name of the file containing the'
write(*,*)' link data :
read(*,990)LINKS2
990 format(a12)
write(*,*)

101 continue

Open (unit = 60, file = LINKS2, status = 'OLD')
Open (unit = 80, file = OUTPUT2, status = 'unknown')
Open (unit = 10, file = nodes, status = 'old')
Open (unit = 30, file = pa, status = 'old')
open (unit = 40, file = output, status = 'unknown')
open (unit = 300, file = 'filename.txt', status='unknown')

write(*,*)
write(*,*)
write(*,*)' Please enter the number of centroids in the network'
read(*,*)taz
write(*,*)

C Write titles for the table.

write(40,*') N/NODE/X/Y/GP/x/1/2/3/4/5/GA/x/1/2/3/4/5'

C Read information from the nodes file

write(*,*)
write(*,*)'If TRANPLAN coordinates are in 1/100th miles or any'
write(*,*)'fraction of miles, Y would be appropriate'
write(*,*)'Would you like to multiply the x and y coordinates''
write(*,*)'by a factor? (Y/N)'

read(*,991)q
991 format(a1)
if((q.eq.'y').or.(q.eq.'Y')) then
write(*,*)
write(*,*)'please input the factor for the x coordinate'
read(*,99)xfact
write(*,*)
write(*,*)'please input the factor for the y coordinate'
read(*,99)yfact
99 format(f10.2)
else
xfact=1.
yfact=1.
end if

write(*,*)
write(*,*)'Enter the appropriate description for the node file.'
write(*,*)' Enter 1 for small coordinate format.'
write(*,*)' Enter 2 for large coordinate format.'
read(*,*)coord

1 if(coord.eq.2) then
read(10,100,err=40)A2,no,xcoord,ycoord
100  format(A1,15,2X,I9,2X,I9)
goto 1313
end if

read(10,1314,err=40)A2,no,xcoord,ycoord
1314  format(A1,I5,2X,I5,I5)
1313  if (xcoord.eq.0) goto 40589
xcoor=xcoord*xfact
ycoor=ycoord*yfact
10  continue

if(no.gt.taz) goto 30000
10000 read(30,300)type,node,line,type1,type2
  ,type3,type4,type5
300   format(A2,I5,I2,1X,I7,17,I7,I7,I7)
   if(type.ne.'GP') goto 10000
   if(node.eq.no) goto 20000
   goto 10000
30  continue

20000 read(30,400)typep,nodep,linep,type1p,type2p
  ,type3p,type4p,type5p
400   format(A2,I5,I2,1X,I7,17,I7,I7,I7)
   if(typep.ne.'GP') goto 20000
   if(nodep.eq.no) goto 40000
   goto 20000
35  continue

30000 continue
402   node=no
   line=0
   type1=0
   type2=0
   type3=0
   type4=0
   type5=0
104

nodep=no
linep=0
tyep1p=0
tyep2p=0
tyep3p=0
tyep4p=0
tyep5p=0

write(40,600)A2,no,xcoor,ycoor

*type,line,type1,type2,
*type3,type4,type5,typep,linep,
*tyep1p,type2p,type3p,type4p,type5p

format(A1,'I5','F12.2','F12.2','A2',*)
*12,'*',17,'*',17,'*',17,'*',17,'*',A2,*)
*12,'*',17,'*',17,'*',17,'*',17,'*',17)

rewind 30
goto 1

continue

rewind 10

to develop data for links to be placed in the
model.
developed in Microsoft FORTRAN Powerstation.

C Sets initial values to zero.
x1=0
x2=0
y1=0
y2=0

write (80,*)'A/AX/AY/B/BX/BY/A/D/O/S1/S2/D/L1/L2/L3/C1/C2/OP/S3/S4
*/D2/L4/L5/L6/C3/C4/U1/D'

C Compare the "a" node of the link to the same node in the
node file to determine the xy coordinates.
Read information from the links file.

2 continue
read (60,120,err=500) a,b,ag,d,o,s2,dc1,12,l3,c1,c2,o2,s3,s4,
*dc1,l4,15,l6,c3,c4,u

12 continue

if(o2.eq."2") then
o2="S"
s3=s
s4=s2
C Read information from the nodes file.

continue
read (10,200) a1,x,y
200 format (1X,15.2X,19.2X,19)

C Match the nodes in the links file with the coordinates

if (a.ne.a1) goto 7
    x1=x*xfact
    y1=y*yfact
end if

Rewind 10

continue
read (10,200) a1,x,y

C Compare the "b" node of the link to the same node in the
C node file to determine the xy coordinates.

if (b.ne.a1) goto 3
    x2=x*xfact
    y2=y*yfact
end if

Rewind 10

C Write the link information with xy coordinates into a file
C to be used by MapInfo.
write (80,320) a,x1,y1,x2,y2,ag,d,o,s,s2,dc,l1,l2,l3,c1,c2,o2
    * ,s3,s4,dc1,l4,l5,l6,c3,c4,u,a,b
320 format (I5,",",f12.2,",",f12.2,",",f12.2,",",f12.2,",",f12.2,",",f12.2,",",f12.2,
    * ,",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",",","
goto 2

500  continue

c  this segment writes filenames to a file to be used by MapBasic.

    write(300,700)name1
700  format('',a6,'.dat'')
    write(300,705)name1
705  format('',a6,'.1.tab''
    write(300,710)name1
710  format(a6,'1')
    write(300,715)name1
715  format('',a6,'.z.tab''
    write(300,720)name1
720  format('',a6,'z''

    write(300,700)name2
    write(300,705)name2
    write(300,710)name2
    write(300,715)name2
    write(300,720)name2

    write(300,715)name1
    write(300,716)name1
    write(300,715)name2
    write(300,716)name2

end
MODEL.MB

Include "mapbasic.def"
Include "menu.def"

Declare Sub main

Declare Sub About
Declare Sub Export
Declare Sub Plot
Declare Sub Calib_plot
Declare Sub turn_move
Declare Sub turn_add
Declare Sub Bye
Declare Sub register
Declare Sub information
Declare Sub tpmi
Declare Sub path
Declare Sub back
Declare Sub compare
Declare Sub progress1
Declare Sub fortran1
Declare Sub tranplan
Declare Sub utilities
Declare Sub fortran2
Declare Sub finish

Sub main

Create menu "TP &MI" as
   "&Registering" calling register,
   "(c"
   "&Model runs" calling tpmi,
   "(c"
   "&About the environment...." calling information,
   "(c"
   "&Exit the Environment" calling bye

Alter Menu Bar Add "TP MI"

end sub

Sub register

Note "The intial step is to run a fortran program to format the Tranplan data into MapInfo format. The program is called TP_MI.EXE."

run program "command.com"

note "Now the program will register your network into MapInfo tables."

Dim more As Logical
Dim newname, newname2 As String
Dim filename1 As string
Dim tablename1 As string
Dim table1 As string
Dim tablename2 As string
Dim table2, table2b As string
Dim table3 As string
Dim table3a, table3b, table3c, table3d As string
Dim wid as string
Open file "filename.txt" for input as #1

Input #1, filename1
Input #1, tablename1
Input #1, table1
Input #1, tablename2
Input #1, table2
Input #1, table3
Register table filename1 type "ascii" delimiter "/" titles into tablename1
Open Table tablename1 Interactive
Browse * From table1
Commit Table table1 As tablename2 TYPE NATIVE Charset "WindowsLatin1"
Open Table tablename2 Interactive
browse * from table2
create map for table2
map from table2
close table table1 interactive

Input #1, filename1
Input #1, tablename1
Input #1, table1
Input #1, tablename2
Input #1, table2b
Input #1, table3
Register table filename1 type "ascii" delimiter "/" titles into tablename1
Open Table tablename1 Interactive
Browse * From table1
Commit Table table1 As tablename2 TYPE NATIVE Charset "WindowsLatin1"
Open Table tablename2 Interactive
browse * from table2b
create map for table2b
map from table2b
close table table1 interactive

set map redraw off
Add Map Layer table2
set map redraw on
close all interactive

Input #1, table3b
Input #1, table3a
Input #1, table3d
Input #1, table3c

Open Table table3b interactive
Map From table3a
Open Table table3d Interactive
Add Map Auto Layer table3c

Select NODE, X, Y from table3a into Selection

if FileExists ("NODES.TP") then goto next2r
end if

Export "Selection" Into "NODES.TP" Type "ASCII" Delimiter "."
goto next3r

next2r: kill "nodes.tp"
Export "Selection" Into "NODES.TP" Type "ASCII" Delimiter "."

next3r:

if FileExists ("NODES.TXT") then goto next4r
end if

EXPORT table3a INTO "NODES.TXT" TYPE "ASCII" DELIMITER " "
goto next5r

next4r: kill "nodes.txt"
EXPORT table3a INTO "NODES.TXT" TYPE "ASCII" DELIMITER " "

next5r:

if FileExists ("links.txt") then goto next6r
end if

EXPORT table3c INTO "LINKS.TXT" TYPE "ASCII" DELIMITER " "
goto next7r

next6r: kill "links.txt"
EXPORT table3c INTO "LINKS.TXT" TYPE "ASCII" DELIMITER " "

next7r:

note "The next action item is to select the appropriate coordinate system for the network. This selection is made by choosing the Map -> Options -> Projection button. After specifying the appropriate projection, hit O.K."
run menu command M_MAP_OPTIONS

note "Press O.K. to continue."

update nodes 1z set obj = createpoint (X,Y)
update links 1 z set obj = createline (ax, ay, bx, by)
Commit Table table3c
Commit Table table3a
Alter Table table3c ( add total_loaded_volume Integer, traffic_counts Integer, traf_diff Integer, Traf_diff_pct Float, Loaded_volume_1000 Float, Travel_time Float, vc_ab Float, vc_ba Float)
Alter Table table3c (rename s2 speed2, s4 speed4, c2 capacity2, c4 capacity4, d length, c1 capacity1, c3 capacity3 )
set map redraw off
Add Map Layer table3c Set Map Order 2,1
Set Map Layer 2 Display Graphic Editable Off Selectable On Global Line (1,2,0) Global Pen (1,2,0) Global Brush (2,16777215,16777215) Global Symbol (35,12632256,12) Global Font ("Arial",0,9,0) Zoom (0,100000) Units "mi" Off Label Line Arrow Position Above Font ("Arial",0,9,0) Pen (1,2,0) With O Parallel On set map redraw on

run menu command M_MAP_ENTIRE_LAYER

Commit Table table3c
Commit Table table3a

Rename table table3c as "links"
Rename table table3a as "nodes"

Commit table links
Commit table nodes

close file # 1
note "The Tranplan network has been registered into MapInfo. Press O.K. to continue."

end sub

Sub tpmi

Create menu "Modeling" as
"&Model Run" calling export,
"&Join a Model Run in Progress" calling progress1,
"&Visualization Plot" calling plot,
"&Calibration Plot" calling calib_plot,
"&Turning Movements" calling turn_move,
"&Additional Turning Movements" calling turn_add,
"&Shortest Path" calling path,
"Com&parison plot" calling compare,
"A&bout" calling about,
"&Exit" calling back
Alter Menu Bar Add "Modeling"

Create buttonpad "modeling" As

pushbutton calling export icon 4
  helpmsg "Run MI/TP procedure"
pushbutton calling plot icon 2
  helpmsg "Create visualization plot"
pushbutton calling calib_plot icon 7
  helpmsg "Create calibration plot"
pushbutton Calling turn_move icon 1
  helpmsg "Display turning movements"
pushbutton calling turn_add icon 3
  helpmsg "Additional turning movements"
pushbutton calling path icon 6
  helpmsg "shortest path"
pushbutton calling compare icon 9
  helpmsg "Compare two similar networks"
pushbutton Calling About icon 2
  helpmsg "About the environment"
pushbutton calling back icon 8
  helpmsg "Exit the environment"

Title "TP/MI Environment"
  width 5
  position (5,2) units "in"

show

End Sub

sub progress 1

Create menu "&Continue" as
  "Run &Netbid" calling fortran1,
  "Run &Tranplan" calling tranplan,
  "Run &Utilities" calling utilities,
  "Run &Loaded or Tums-f" calling fortran2,
  "&Into MapInfo" calling finish

Alter menu bar add "Continue"

end sub

sub turn_move
  'VARIABLES ARE DEFINED.
  dim cosmet as string
  dim x1 as integer
  dim MOVE as object
  dim counter, last_1 as integer
  dim arrowx1, arrowy1, arrowx2, arrowy2, arrowx3, arrowy3 as float
  dim q_one as logical

  'ASK IF THE APPROPRIATE TABLES ARE OPEN AND THE APPROPRIATE NODES SELECTED
q_one=Ask("Are the NODES and TURNS tables open, TEMPI table not open, and the appropriate
nodes selected? If yes, continue. If no, stop and do so."."Continue"."Stop")
if q_one=FALSE then goto key
End If

'THE SELECTED NODES ARE SAVED AS A TEMPORARY TABLE (TEMPI), AND TEMPI IS
OPENED.
Commit Table selection As "TEMPI.TAB" TYPE NATIVE Charset "WindowsLatin1"
Open Table "TEMPI.TAB" Interactive

'AN INDEX IS CREATED ON THE TEMPI TO SPEED UP JOINS.
Create Index On TEMPI(Node)

'TEMPI IS ADDED TO THE OPEN MAP LAYERS (NODES, LINKS).
Add Map Auto Layer TEMPI

'THE SELECTED NODES RECORDS ARE JOINED WITH THE TURNS TABLE.
Select TURNS.node_num, TURNS.node_from, TURNS.node_to, TURNS.arrowxl, TURNS.arrowy1,
TURNS.arrowx2, TURNS.arrowy2, TURNS.arrowx3, TURNS.arrowy3, TURNS.volume from TURNS,
TEMPI where TURNS.node_num=TEMPl.Node into Selection

'THE JOINED SELECTION IS SAVED AS TABLE TURNMOVE, OPENED, AND ADDED TO
THE OPEN MAP LAYERS.
Commit Table selection As "TURNMOVE.TAB" TYPE NATIVE Charset "WindowsLatin1"
Open Table "TURNMOVE.TAB" Interactive
Add Map Auto Layer TURNMOVE

'THE APPROPRIATE MAPPING PARAMETERS ARE SET FOR TURNMOVE.
set map redraw off
Set Map Layer 1 Display Graphic Editable On Selectable On Global Font ("Arial",0,3,0)
set map redraw on
Set coordsys window windowID(1)

'THE LAST RECORD OF TURNMOVE IS FETCHED.
fetch last from TURNMOVE

'THE VARIABLE LAST_1 IS SET TO THE ROW NUMBER OF THE LAST RECORD IN
TURNMOVE.
last_1 = TURNMOVE.rowid

'PLINES ARE DRAWN FOR EACH TURNING MOVEMENT RECORD.
counter = 1
do fetch rec counter from TURNMOVE
arrowxl = TURNMOVE.arrowxl
arrowy1 = TURNMOVE.arrowy1
arrowx2 = TURNMOVE.arrowx2
arrowy2 = TURNMOVE.arrowy2
arrowx3 = TURNMOVE.arrowx3
arrowy3 = TURNMOVE.arrowy3
Create Pline Into Variable MOVE 3 (arrowxl,arrowy1)(arrowx2,arrowy2)(arrowx3,arrowy3) Pen
(2,59,0)
update TURNMOVE Set obj = MOVE where rowid = counter
counter = counter + 1
loop while counter <= last_i

'THE AUTOLABLING PARAMETERS ARE SET FOR THE NEW TABLE.
set map redraw off
Set Map Layer 1 Label line none Font ("Arial",0,3,0) With volume
set map redraw on

'TURNING MOVEMENT VOLUMES ARE LABELED.
Autolabel Layer 1 Overlap On Duplicates On

'THE ORIGINAL TEMPORARY TABLE IS DROPPED.
drop table TEMP1

'THE UPDATED TURNMOVE IS SAVED.
Commit Table TURNMOVE

'THE COSMETIC LAYER IS SAVED TO TABLE TURN_VOL.
x1=WindowID(1)
cosmet=WindowInfo(x1,WIN_INFO_TABLE)
Commit table cosmet as "TURN_VOL.TAB" TYPE NATIVE Charset "WindowsLatin1"

'THE COSMETIC LAYER IS CLEARED.
run menu command M_MAP_CLEAR_COSMETIC

'TURN_VOL IS OPENED AND ADDED TO THE OPEN MAP LAYERS.
Open Table "TURN_VOL.TAB" Interactive
Add Map Auto Layer TURN_VOL

'NOTE STATEMENT
Note "The turning movement diagrams have been saved as table TURNMOVE and opened. The
turning movement volumes have been saved as table TURN_VOL and opened. Table TEMP1 has been
deleted."
Key: end sub

sub tum_add

dim cosmet as string
dim x1 as integer
dim MOVE as object
dim counter, last_i as integer
dim arrowx1,arrowy1,arrowx2,arrowy2,arrowx3,arrowy3 as float
dim q_one as logical

'ASK IF THE APPROPRIATE TABLES ARE OPEN AND THE APPROPRIATE NODES SELECTED
q_one=Ask("Are the NODES,TURNS,TURNMOVE, and TURN_VOL tables open, TEMP1, TEMP3, TEMP4 tables not open, and the appropriate nodes selected? If yes, continue. If no, stop and do
so.","Continue","Stop")
if q_one=FALSE then goto key1
End If
THE SELECTED NODES ARE SAVED AS A TEMPORARY TABLE (TEMPI), AND TEMPI IS OPENED.
Commit Table selection As "TEMPI.TAB" TYPE NATIVE Charset "WindowsLatin1"
Open Table "TEMPI.TAB" Interactive

AN INDEX IS CREATED ON THE TEMPI TO SPEED UP JOINS.
Create Index On TEMPI(Node)

Add Map Auto Layer TEMPI
Select TURNS.node_num, TURNS.node_from, TURNS.node_to, TURNS.arrowx1, TURNS.arrowy1,
TURNS.arrowx2, TURNS.arrowy2, TURNS.arrowx3, TURNS.arrowy3, TURNS.volume from TURNS,
TEMPI where TURNS.node_num=TEMPI.Node into Selection
Commit Table selection As "TEMP3.TAB" TYPE NATIVE Charset "WindowsLatin1"
Open Table "TEMP3.TAB" Interactive
Add Map Auto Layer TEMP3
set map redraw off
Set Map Layer 1 Display Graphic Editable On Selectable On Global Font ("Arial",0,3,0)
set map redraw on
Set Map XY Units "m" CoordSys Earth Projection 8, 62, "m", -93, 0, 0.9996, 500000, 0
fetch last from TEMP3
last_1 = TEMP3.rowid
counter = 1
do fetch rec counter from TEMP3
arrowx1 = TEMP3.arrowx1
arrowy1 = TEMP3.arrowy1
arrowx2 = TEMP3.arrowx2
arrowy2 = TEMP3.arrowy2
arrowx3 = TEMP3.arrowx3
arrowy3 = TEMP3.arrowy3
Create Pline Into Variable MOVE 3 (arrowx1.arrowy1)(arrowx2.arrowy2)(arrowx3.arrowy3) Pen
(4,59,0)
update TEMP3 Set obj = MOVE where rowid = counter
counter = counter + 1
loop while counter <= last_1
set map redraw off
Set Map Layer 1 Label Font ("Arial",0,1,0) With volume
set map redraw on
Autolabel Layer 1 Overlap On Duplicates On
Insert into TURNMOVE select • from TEMP3
drop table TEMPI
drop table TEMP3
Commit Table TURNMOVE
xl=WindowID(1)
cosmet=WindowInfo(xl,WIN_INFO_TABLE)
Commit table cosmet as "TEMP4.TAB" TYPE NATIVE Charset "WindowsLatin1"
Open Table "TEMP4.TAB" Interactive
Insert into TURN_VOL select • from TEMP4
run menu command M_MAP_CLEAR_COSMETIC
drop table TEMP4
'NOTE STATEMENT
Note "The turning movement diagrams have been added to table TURNMOVE. The turning
movement volumes have been added to table TURN_VOL. Tables TEMP1, TEMP3, and TEMP4 have been
deleted."

key l: end sub

sub calib_plot
  dim x1 as integer
  dim cosmet as string
  dim y1 as integer
  dim y2 as integer
  dim links3 as string

Dialog
  TITLE "ENTER THE NAME OF THE LINK FILE"
  CONTROL EDITTEXT
  POSITION 55,10
  WIDTH 160
  INTO LINKS3

  CONTROL OKBUTTON
  CONTROL CANCELBUTTON

  Select * from linksS where traffic_counts > 0 into counts

  if selectioninfo(sel_info_nrows) = 0 then

    note "To operate the Calibration plot, existing traffic counts must be entered for at least one link. The
Visualization plot feature will still be available for analysis of this network."

    goto NEXT1C

  end if

dialog
  title "Select tolerance for buffering and labeling"

  control statictext
  title "select the traffic percent greater than to use:" 
  position 2, 20
  control listbox
  title "5;10;15;20;25;30;35"
  value 7
  into y1
  ID 7
  position 2, 30 width 65 height 35

  control statictext
  title "select the traffic percent less than to use:" 
  position 4, 80
  control listbox
title "-5;-10;-15;-20;-25;-30;-35"
value 7
into y2
ID 7
position 4, 90 width 65 height 35
control OKbutton
position 65, 165
control cancelbutton
position 120.165

if commandInfo(CMD_INFO_DLG_OK) then
    'the user clicked ok
else
    'the user clicked cancel
end if

y1=y1*5
y2=y2*-5

select * from links where total_loaded_volume>0 into Selection
Commit Table selection As "VOLUME.TAB" TYPE NATIVE Charset "WindowsLatin1"

Open Table "VOLUME.TAB" Interactive
Add Map Auto Layer VOLUME
set map redraw off
Set Map Layer 2 Editable On
set map redraw on
select * from VOLUME into Selection
Set style Pen (1,1,0)
Set Style Brush (2,12632256,12632256)
Create Object As Buffer From Selection Width loaded_volume_1000 Units "yd" Resolution 12 Into Table VOLUME Group by Rowid

select * from links where traffic_counts>0 into Selection
Commit Table selection As "COUNTS.TAB" TYPE NATIVE Charset "WindowsLatin1"

Open Table "COUNTS.TAB" Interactive
Alter Table "COUNTS" ( add label Char(25) )
Update COUNTS Set Label = total_loaded_volume + " " + "(" + TRAF_DIFF_PCT + ")"
Add Map Auto Layer COUNTS
set map redraw off
Set Map Layer 2 Editable On
set map redraw on

select * from COUNTS where TRAF_DIFF_PCT>y1 into Selection
set map redraw off
Add Map Layer selection
Set Map Layer 1 Display Graphic Editable On Selectable On Line (1,2,0) Global Pen (1,2,0) Global Brush (2,16777215,16777215) Global Symbol (35,12632256,12) Global Font ("Arial",0,9,0) Zoom (0.100000) Units "mi" Off Label Line None Position Center With label Parallel On
set map redraw on
Autolabel Window windowid(1) Layer 1 Duplicates On

select * from COUNTS where TRAF_DIFF_PCT<y2 into Selection
set map redraw off
Add Map Layer selection
Set Map Layer 1 Display Graphic Editable On Selectable On Line (1,2,0) Global Pen (1,2,0) Global Brush (2,16777215,16777215) Global Symbol (35,12632256,12) Global Font ("Arial",0,9,0) Zoom (0.100000) Units "mi" Off Label Line None Position Center With label Parallel On
set map redraw on
Autolabel Window windowid(1) Layer 1 Duplicates On

select * from COUNTS where TRAF_DIFF_PCT>y2 and TRAF_DIFF_PCT<y1 into Selection
set map redraw off
Add Map Layer selection
Set Map Layer 1 Display Graphic Editable On Selectable On Line (1,2,0) Global Pen (1,2,0) Global Brush (2,16777215,16777215) Global Symbol (35,12632256,12) Global Font ("Arial",0,9,0) Zoom (0.100000) Units "mi" Off Label Line None Position Center With label Parallel On
set map redraw on
Autolabel Window windowid(1) Layer 1 Duplicates On

x1=WindowID(1)
cosmet=WindowInfo(x1,WINFO_TABLE)
Commit table cosmet as "LABEL.TAB" TYPE NATIVE Charset "WindowsLatin1"
delete from cosmet
open table "label.tab" interactive
set map redraw off
Add Map Layer label Remove Map Layer 2, 3, 4 Set Map Order 2,5,1,3,4
Set Map Layer 3 Display Graphic Editable Off Selectable On Line (1,2,0) Global Pen (1,2,0) Global Brush (2,16777215,16777215) Global Symbol (35,12632256,12) Global Font ("Arial",0,9,0) Zoom (0.100000) Units "mi" Off Label Line None Position Center With Id Parallel On
set map redraw on
NEXTIC: end sub

sub plot
dim x1 as integer
dim cosmet as string

select * from links where total_loaded_volume>0 into Selection
Commit Table selection As "VOLUME.TAB" TYPE NATIVE Charset "WindowsLatin1"
Open Table "VOLUME.TAB" Interactive
Add Map Auto Layer VOLUME
set map redraw off
Set Map Layer 2 Editable On
set map redraw on
select * from VOLUME into Selection
Set style Pen (1,1,0)
Set Style Brush (2,12632256,12632256)
Create Object As Buffer From Selection Width loaded_volume_1000 Units "yd" Resolution 12 Into Table VOLUME Group by Rowid

select * from links where traffic_counts>0 into Selection
Commit Table selection As "COUNTS.TAB" TYPE NATIVE Charset "WindowsLatin1"

Open Table "COUNTS.TAB" Interactive
Add Map Auto Layer COUNTS
set map redraw off
Set Map Layer 2 Editable On
set map redraw on

select * from COUNTS INTO SELECTION
set map redraw off
Add Map Layer selection
Set Map Layer 1 Display Graphic Editable On Selectable On Global Line (1,2,0) Global Pen (1,2,0) Global Brush (2,16777215,16777215) Global Symbol (35,12632256,12) Global Font ("Arial",0,9,0) Zoom (0, 100000) Units "mi" Off Label Line None Position Center Font ("Arial",0,3,0) With total loaded_volume Parallel On
set map redraw on
Autolabel Window windowid(1) Layer 1 Duplicates On

x1=WindowID(1)
cosmet=WindowInfo(x1,WINFO_TABLE)
Commit table cosmet as "LABEL.TAB" TYPE NATIVE Charset "WindowsLatin1"

delete from cosmet
open table "label.tab" interactive

set map redraw off
Add Map Layer label Set Map Order 1,2,3,4,6,5
Set Map Layer 1 Display Graphic Editable Off Selectable On Global Line (1,2,0) Global Pen (1,2,0) Global Brush (2,16777215,16777215) Global Symbol (35,12632256,12) Global Font ("Arial",0,9,0) Zoom (0, 100000) Units "mi" Off Label Line None Position Center With Id Parallel On
set map redraw on

end sub

sub export

DIM LINK_NAME AS STRING
DIM NODE_NAME AS STRING
DIM Q1 AS LOGICAL
DIM Q2 AS LOGICAL
DIM Q3 AS LOGICAL
DIM Q4 AS LOGICAL
DIM Q5 AS LOGICAL
dim links1 as string
dim filename1 as string
dim tablename1 as string
dim table1 as string
dim links2 as string
dim q_two as logical

DIALOG
  TITLE "ENTER THE NAME OF THE LINK FILE"
  CONTROL EDITTEXT
  POSITION 55,10
  WIDTH 160
  INTO LINK_NAME

  CONTROL OKBUTTON
  CONTROL CANCELBUTTON

IF COMMANDINFO(CMD_INFO_DLG_OK) THEN

  if FileExists("LINKS.TXT") then goto next2
  end if

  EXPORT LINK_NAME INTO "LINKS.TXT" TYPE "ASCII" DELIMITER " "
goto next3

next2:kill "links.txt"

  EXPORT LINK_NAME INTO "LINKS.TXT" TYPE "ASCII" DELIMITER " "

next3:END IF

DIALOG
  TITLE "ENTER THE NAME OF THE NODE FILE"
  CONTROL EDITTEXT
  POSITION 55,10
  WIDTH 160
  INTO NODE_NAME

  CONTROL OKBUTTON
  CONTROL CANCELBUTTON

IF COMMANDINFO(CMD_INFO_DLG_OK) THEN

  if FileExists("NODES.TXT") then goto next4
  end if

  EXPORT NODE_NAME INTO "NODES.TXT" TYPE "ASCII" DELIMITER " "
goto next5

next4:kill "nodes.txt"

  EXPORT NODE_NAME INTO "NODES.TXT" TYPE "ASCII" DELIMITER " "

next5:END IF
q_two=Ask("Is the TURNS tables open?","Yes","No")
if q_two=TRUE then
Close Table TURNS
End If

if FileExists ("NODES.TP") then goto next6
end if

Select NODE, X, Y from node_name into Selection
Export "Selection" Into "NODES.TP" Type "ASCII" Delimiter "."
goto next7

next6:kill "nodes.tp"
Select NODE, X, Y from node_name into Selection
Export "Selection" Into "NODES.TP" Type "ASCII" Delimiter "."

code for next7:

Note "The next step is to run a fortran program to build the tranplan control file. Type NETBLD at the
DOS prompt."

run program "command.com"

Note "To continue, run the Tranplan control file required to perform a model run."

run program "c:\urbansys\tpcntl.exe"
	note "To continue, run the Tranplan Utilities, Netcard and Turns."

run program "c:\urbansys\tpmisc.exe"
	note "The next step is to run the Fortran programs, loaded.exe and turns-f.exe."

run program "command.com"
	note "The final stage of the process will load the new speeds and volumes to the network. And, will
incorporate the new turning movement counts into the table turns.tab."

Open file "filename2.txt" for input as #1
Input #1, links1
Input #1, filename1
Input #1, tablename1
Input #1, table1
Input #1, links2

Register Table "new_data.dat" TYPE ASCII Delimiter 47 Titles into "new_data.tab"
open table "new_data.tab"
Commit Table table_1 As "NEW_DAT2.TAB"
Close Table table_1 Interactive
Open Table "NEW_DAT2.TAB" Interactive
Browse * From NEW_DAT2
Select * from links, NEW_DAT2 where links.id = NEW_DAT2.id into Selection
Update Selection Set speed2 = S2
Update Selection Set speed4 = S4
Update Selection Set capacity2 = C2
Update Selection Set capacity4 = C4
Update links2 set total_loaded_volume = capacity2 + capacity4
Update links2 set traf_diff = total_loaded_volume - traffic_counts
Commit Table links2
drop index links2 (TRAFF DIFF PCT)
Select * from links2 where traffic_counts > 0 into counts
if selectioninfo(set_info_nrows) = 0 then goto next1
end if
Update counts set TRAF DIFF PCT = ((TRAFF DIFF)/traffic_counts) * 100
next1:
Update links2 set loaded_volume_1000 = total_loaded_volume /125
select * from links2 where speed2 > 0
Update selection set travel_time = length / speed2 * 60
Select * from links2 where capacity1 > 0
Update selection set vc_ab = capacity2 / capacity1
Select * from links2 where capacity3 > 0
Update selection set vc_ba = capacity4 / capacity3
close file #1
close table new_dat2 interactive
if FileExists ("TURNS.TXT") then goto next6
else goto next7
end if
next6:
REGISTER TABLE "TURNS.TXT" TYPE "ASCII" DELIMITER "/" TITLES INTO "TURNS_T.TAB"
Open Table "TURNS_T.TAB" Interactive
Commit Table TURNS_T As "TURNS.TAB" TYPE NATIVE Charset "WindowsLatin1"
Drop Table TURNS_T
Open Table "TURNS.TAB" Interactive
Create Index On TURNS(node_num)
next7:
end sub

Sub About
Dialog Title "About the modeling environment"
"Mi/TP" is an application which allows you to perform Tranplan runs from MapInfo.
The modeling environment was developed at the Center for Transportation Research.
and Education, Ames, Iowa.
Iowa State University.

Sub back
Alter Menu Bar Remove "Modeling"
Alter menu Bar remove "Continue"
Alter ButtonPad "TP/MI Environment" hide

Sub path
dim slinks as string
dim snodes as string
dialog
TITLE "ENTER THE NAME OF THE LINK FILE"
CONTROL EDITTEXT
POSITION 55,10
WIDTH 160
INTO SLINKS
CONTROL OKBUTTON
CONTROL CANCELBUTTON

Commit Table SLINKS As "P-LINKS.TAB" TYPE NATIVE Charset "WindowsLatin1"
Open Table "P-LINKS.TAB" Interactive
Add Map Auto Layer P_LINKS
Alter Table "P_LINKS" ( drop
ax,ay,bx,by,a_2,length,0,sl,speed2,d_2,l2,l3,capacity1,capacity2,OP,s3,speed4,d2,l4,l5,l6,capacity3,capacity4,U,ID,total_loaded_volume,traffic_counts.vc_ab,vc_ba,TRAFF_DIFF,TRAFF_DIFF_PCT,loaded_volume_1000)

if FileExists ("P-LINKS.TXT") then goto next2p end if

EXPORT P_LINKS INTO "p-LINKS.TXT" TYPE "ASCII" DELIMITER " "
goto next3p

next2p: kill "p-links.txt"
EXPORT P_LINKS INTO "p-LINKS.TXT" TYPE "ASCII" DELIMITER " "
next3p:

dialog
TITLE "ENTER THE NAME OF THE NODE FILE"
CONTROL EDITTEXT
POSITION 55,10
WIDTH 160
INTO SNODES

CONTROL OKBUTTON
CONTROL CANCELBUTTON

IF COMMANDINFO(CMD_INFO_DLG_OK) THEN

if FileExists ("NODES.TXT") then goto next4p end if

EXPORT SNODES INTO "NODES.TXT" TYPE "ASCII" DELIMITER " "
goto next5p

next4p: kill "nodes.txt"
EXPORT SNODES INTO "NODES.TXT" TYPE "ASCII" DELIMITER " "

next5p: END IF

Close Table P_LINKS Interactive

Commit Table selection As "PATH-IN.TAB" TYPE NATIVE Charset "WindowsLatin1"
Open Table "PATH-IN.TAB" Interactive
Add Map Auto Layer PATH_IN

if FileExists ("route.in") then goto next6p end if
EXPORT PATH_IN INTO "route.in" TYPE "ASCII" DELIMITER " "

goto next7p

next6p: kill "route.in"
EXPORT PATH_IN INTO "route.in" TYPE "ASCII" DELIMITER " "

next7p:
Close Table PATH_IN Interactive

Note "The next step is to run a fortran program to determine the minimum length path. Type S-PATH at the DOS prompt."

run program "command.com"

note "Press O.K. to continue."

Register Table "ROUTE.OUT" TYPE ASCII Delimiter 32 Charset "WindowsLatin1" Into "RT.TAB"
Open Table "RT.TAB" Interactive
Commit Table RT As "ROUTE.TAB" TYPE NATIVE Charset "WindowsLatin1"
drop table RT
Open Table "ROUTE.TAB" Interactive
Create Map For ROUTE CoordSys Earth Projection 1, 0
Add Map Auto Layer ROUTE

set map redraw on
  Set coordsys window windowID(1)Set Style Pen (3,2,16711935)
update ROUTE set obj = CreateLine (_COL2,_COL3,_COL5,_COL6)
'COMMIT TABLE ROUTE
'Select Sum(_col7) from Route into query1
'Browse * From query1

end Sub

sub compare
  run menu command M_FILE_OPEN

  run menu command M_QUERY_SQLQUERY

  Browse * From Selection
  Commit Table selection As "TEST.TAB" TYPE NATIVE Charset "WindowsLatin1"

  Open Table "TEST.TAB" Interactive
  Add Map Auto Layer TEST
  Browse * From TEST

  Alter Table "TEST" ( add difference Integer ) Interactive

  Update TEST Set difference = total_loaded_volume_2-total_loaded_volume
  Browse * From TEST
  set map redraw off
Add Map Layer TEST
Set Map Layer 1 Display Graphic Editable Off Selectable On Global Line (1,2,0) Global Pen (1,2,0)
Global Brush (2,16777215,16777215) Global Symbol (35,12632256,12) Global Font ("Arial",0,9.0) Zoom (0,
100000) Units "mi" Off Label Line Arrow Position Above Font ("Arial",0,9.0) Pen (1,2,0) With total_loaded_volume Parallel On Auto Off Overlap Off Duplicates Off Offset 2 Max Visibility On Nodes Off Arrows Off Centroids Off
set map redraw on

select * from TEST where difference>0 into Selection
Commit Table selection As "TESTGTO.TAB" TYPE NATIVE Charset "WindowsLatin1"

select * from TEST where difference<0 into Selection
Commit Table selection As "TESTLTO.TAB" TYPE NATIVE Charset "WindowsLatin1"

Open Table "testgt0.tab"
Add Map Auto Layer testgt0

Open Table "testlt0.tab"
Add Map Auto Layer testlt0

set map redraw off
Set Map Layer 2 Editable On
set map redraw on

select * from testgt0 into Selection
set style brush (2,16711680,16711680)
set style pen (0,1,0)
Create Object As Buffer From Selection Width difference Units "in" Resolution 12 Into Table testgt0
Group by Rowid

set map redraw off
Set Map Layer 1 Editable On
set map redraw on

select * from testlt0 into Selection
set style brush (2,255,255)
set style pen (0,1,0)
Create Object As Buffer From Selection Width difference Units "in" Resolution 12 Into Table testlt0
Group by Rowid

select * from TEST where traffic_counts>0 into Selection
set map redraw off
Add Map Layer Selection
Set Map Layer 1 Display Graphic Editable Off Selectable On Global Line (1,2,0) Global Pen (1,2,0)
Global Brush (2,16777215,16777215) Global Symbol (35,12632256,12) Global Font ("Arial",0,4.0) Zoom (0,
100000) Units "mi" Off Label Line None Position Above Font ("Arial",0,4.0) Pen (1,2,0) With difference Parallel On Auto On Overlap On Duplicates On Offset 2 Max Visibility On Nodes Off Arrows Off Centroids Off
set map redraw on

run menu command M_QUERY_UNSELECT
close table query1
end sub

sub information
    note "Visit the web site at http://www.ctre.iastate.edu/fhwa for more information."
end sub

Sub bye  
End Program
End Sub

sub fortran 1
    DIM LINK_NAME AS STRING
    DIM NODE_NAME AS STRING
    DIM Q1 AS LOGICAL
    DIM Q2 AS LOGICAL
    DIM Q3 AS LOGICAL
    DIM Q4 AS LOGICAL
    DIM Q5 AS LOGICAL
    dim links1 as string
    dim filename1 as string
    dim tablenamel as string
    dim table1 as string
    dim links2 as string
    dim q_two as logical
    Note "The next step is to run a fortran program to build the tranplan control file. Type NETBLD at the DOS propmt."
run program "command.com"
    Note "To continue, run the Tranplan control file required to perform a model run."
run program "c:\urbansys\tpcntl.exe"
    note "To continue, run the Tranplan Utilities, Netcard and Turns."
run program "c:\urbansys\tpmisc.exe"
    note "The next step is to run the Fortran programs, loaded.exe and turns-f.exe."
run program "command.com"
    note "The final stage of the process will load the new speeds and volumes to the network. And, will incorporate the new turning movement counts into the table turns.tab."
Open file "filename2.txt" for input as #1
Input #1, links1
Input #1, filename1
Input #1, tablename1
Input #1, table1
Input #1, links2

Register Table "new_data.dat" TYPE ASCII Delimiter 47 Titles into "new_data.tab"
open table "new_data.tab"

Commit Table table1 As "NEW_DAT2.TAB"
Close Table table1 Interactive
Open Table "NEW_DAT2.TAB" Interactive
Browse * From NEW_DAT2
Select * from links, NEW_DAT2 where links.id = NEW_DAT2.id into Selection
Update Selection Set speed2 = S2
Update Selection Set speed4 = S4
Update Selection Set capacity2 = C2
Update Selection Set capacity4 = C4
Update links2 set total_loaded_volume = capacity2 + capacity4
Update links2 set traf_diff = total_loaded_volume - traffic_counts
Commit Table links2

drop index links2 (TRAFFIC_DIFF_PCT)
Select * from links2 where traffic_counts > 0 into counts

if selectioninfo(sel_info_nrows) = 0 then goto next1
end if

Update counts set TRAF_DIFF_PCT = ((TRAFFIC_DIFF)/traffic_counts) * 100

next1: Update links2 set loaded_volume_1000 = total_loaded_volume /125
select * from links2 where speed2 > 0
Update selection set travel_time = length / speed2 * 60
Select * from links2 where capacity1 > 0
Update selection set vc_ab = capacity2 / capacity1
Select * from links2 where capacity3 > 0
Update selection set vc_ab = capacity4 / capacity3

Close file #1
Close table new_dat2 interactive

REGISTER TABLE "TURNS.TXT" TYPE "ASCII" DELIMITER "/" TITLES INTO "TURNS_T.TAB"
Open Table "TURNS_T.TAB" Interactive
Commit Table TURNS_T As "TURNS.TAB" TYPE NATIVE Charset "WindowsLatin1"
Drop Table TURNS_T
Open Table "TURNS.TAB" Interactive
Create Index On TURNS(node_num)

end sub
sub tranplan

    DIM LINK_NAME AS STRING
    DIM NODE_NAME AS STRING
    DIM Q1 AS LOGICAL
    DIM Q2 AS LOGICAL
    DIM Q3 AS LOGICAL
    DIM Q4 AS LOGICAL
    DIM Q5 AS LOGICAL

    dim links1 as string
    dim filename1 as string
    dim tablename1 as string
    dim table1 as string
    dim links2 as string
    dim q_two as logical

Note "To continue, run the Tranplan control file required to perform a model run."

run program "c:\urbansys\tpcntl.exe"

note "To continue, run the Tranplan Utilities, Netcard and Turns."

run program "c:\urbansys\tpmisc.exe"

note "The next step is to run the Fortran programs, loaded.exe and turns-f.exe."

run program "command.com"

note "The final stage of the process will load the new speeds and volumes to the network. And, will incorporate the new turning movement counts into the table turns.tab."

Open file "filename2.txt" for input as #1
Input #1, links1
Input #1, filename1
Input #1, tablename1
Input #1, table1
Input #1, links2

Register Table "new_data.dat" TYPE ASCII Delimiter 47 Titles into "new_data.tab"
open table "new_data.tab"

Commit Table table1 As "NEW_DAT2.TAB"
Close Table table1 Interactive
Open Table "NEW_DAT2.TAB" Interactive
Browse * From NEW_DAT2
Select * from links, NEW_DAT2 where links.id = NEW_DAT2.id into Selection
Update Selection Set speed2 = S2

Update Selection Set speed4 = S4
Update Selection Set capacity2 = C2
Update Selection Set capacity4 = C4
Update links2 set total_loaded_volume = capacity2 + capacity4
Update links2 set traf_diff = total_loaded_volume - traffic_counts
Commit Table links2
drop index links2 (TRAFF_DIFF_PCT)
Select * from links2 where traffic_counts > 0 into counts

if selectioninfo(sel_info_nrows) = 0 then goto next1
end if

Update counts set TRAF_DIFF_PCT = ((TRAFF_DIFF)/traffic_counts) * 100

next1: Update links2 set loaded_volume_1000 = total_loaded_volume / 125
select * from links2 where speed2 > 0
Update selection set travel_time = length / speed2 * 60
Select * from links2 where capacity1 > 0
Update selection set vc_ab = capacity2 / capacity1
Select * from links2 where capacity3 > 0
Update selection set vc_ba = capacity4 / capacity3

close file #1

close table new_dat2 interactive

REGISTER TABLE "TURNS.TXT" TYPE "ASCII" DELIMITER "/" TITLES INTO
"TURNS_T.TAB"
Open Table "TURNS_T.TAB" Interactive
Commit Table TURNS_T As "TURNS.TAB" TYPE NATIVE Charset "WindowsLatin1"
Drop Table TURNS_T
Open Table "TURNS.TAB" Interactive
Create Index On TURNS(node_num)

end sub

sub utilities

DIM LINK_NAME AS STRING
DIM NODE_NAME AS STRING
DIM Q1 AS LOGICAL
DIM Q2 AS LOGICAL
DIM Q3 AS LOGICAL
DIM Q4 AS LOGICAL
DIM Q5 AS LOGICAL
dim linksI as string
dim filename1 as string
dim tablename1 as string
dim table1 as string
dim links2 as string
dim q_two as logical
note "To continue, run the Tranplan Utilities, Netcard and Turns."

run program "c:\urbansys\tpmisc.exe"

note "The next step is to run the Fortran programs, loaded.exe and turns-f.exe."

run program "command.com"

note "The final stage of the process will load the new speeds and volumes to the network. And, will incorporate the new turning movement counts into the table turns.tab."

Open file "filename2.txt" for input as #1
Input #1, links1
Input #1, filename1
Input #1, tablename1
Input #1, table1
Input #1, links2

Register Table "new_data.dat" TYPE ASCII Delimiter 47 Titles into "new_data.tab"
open table "new_data.tab"

Commit Table #1 As "NEW_DAT2.TAB"
Close Table #1 Interactive
Open Table "NEW_DAT2.TAB" Interactive
Browse * From NEW_DAT2
Select * from links, NEW_DAT2 where links.id = NEW_DAT2.id into Selection
Update Selection Set speed2 = S2
Update Selection Set speed4 = S4
Update Selection Set capacity2 = C2
Update Selection Set capacity4 = C4
Update links2 set total Loaded_volume = capacity2 + capacity4
Update links2 set traf_diff = total Loaded_volume - traffic_counts
Commit Table links2
drop index links2 (TRAF_DIFF_PCT)
Select * from links2 where traffic_counts > 0 into counts
if selectioninfo(sel_info_nrows) = 0 then goto next1
end if
Update counts set TRAF_DIFF_PCT = ((TRAFF_DIFF)/traffic_counts) * 100
next1: Update links2 set loaded_volume_1000 = total_loaded_volume /125
select * from links2 where speed2 > 0
Update selection set travel_time = length / speed2 * 60
Select * from links2 where capacity1 > 0
Update selection set vc_ab = capacity2 / capacity1
Select * from links2 where capacity3 > 0
Update selection set vc_ba = capacity4 / capacity3

close file #1
close table new_dat2 interactive

REGISTER TABLE "TURNS.TXT" TYPE "ASCII" DELIMITER "/" TITLES INTO "TURNS_T.TAB"
Open Table "TURNS_T.TAB" Interactive
Commit Table TURNS_T As "TURNS.TAB" TYPE NATIVE Charset "WindowsLatin1"
Drop Table TURNS_T
Open Table "TURNS.TAB" Interactive
Create Index On TURNS(node_num)
end sub

sub fortran2

DIM LINK_NAME AS STRING
DIM NODE_NAME AS STRING
DIM Q1 AS LOGICAL
DIM Q2 AS LOGICAL
DIM Q3 AS LOGICAL
DIM Q4 AS LOGICAL
DIM Q5 AS LOGICAL

dim links1 as string
  dim filename1 as string
  dim tablename1 as string
  dim table1 as string
  dim links2 as string
  dim q_two as logical

note "The next step is to run the Fortran programs, loaded.exe and turns-f.exe."

run program "command.com"

note "The final stage of the process will load the new speeds and volumes to the network. And, will incorporate the new turning movement counts into the table turns.tab."

Open file "filename2.txt" for input as #1
Input #1, links1
Input #1, filename1
Input #1, tablename1
Input #1, table1
Input #1, links2

Register Table "new_data.dat" TYPE ASCII Delimiter 47 Titles into "new_data.tab"
open table "new_data.tab"

Commit Table table1 As "NEW_DAT2.TAB"
Close Table table1 Interactive
Open Table "NEW_DAT2.TAB" Interactive
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Browse * From NEW_DAT2
Select * from links. NEW_DAT2 where links.id = NEW_DAT2.id into Selection
Update Selection Set speed2 = S2
Update Selection Set speed4 = S4
Update Selection Set capacity2 = C2
Update Selection Set capacity4 = C4
Update links2 set total_loaded_volume = capacity2 + capacity4
Update links2 set traf_diff = total_loaded_volume - traffic_counts
Commit Table links2
Drop index links2 (TRAFF_DIFF_PCT)
Select * from links2 where traffic_counts > 0 into counts

if selectioninfo(sel_info_nrows) = 0 then goto next1
end if

Update counts set TRAF_DIFF_PCT = ((TRAFF_DIFF)/traffic_counts) * 100

next1: Update links2 set loaded_volume_1000 = total_loaded_volume / 125
select * from links2 where speed2 > 0
Update selection set travel_time = length / speed2 * 60
Select * from links2 where capacity1 > 0
Update selection set vc_ab = capacity2 / capacity1
Select * from links2 where capacity3 > 0
Update selection set vc_ba = capacity4 / capacity3

Close file #1
Close table new_dat2 interactive

Register table "TURNS.TXT" type "ASCII" delimiter "/" titles into
"TURNS_T.TAB"
Open Table "TURNS_T.TAB" interactive
Commit Table TURNS_T as "TURNS.TAB" type native charset "WindowsLatin1"
Drop Table TURNS_T
Open Table "TURNS.TAB" interactive
Create Index On TURNS(node_num)

End Sub

Sub finish

Dim Link_Name As String
Dim Node_Name As String
Dim Q1 As Logical
Dim Q2 As Logical
Dim Q3 As Logical
Dim Q4 As Logical
Dim Q5 As Logical

Dim Links1 As String
Dim FileName1 As String
Dim TableName1 As String
dim table1 as string
dim links2 as string
dim q_two as logical

note "The final stage of the process will load the new speeds and volumes to the network. And, will incorporate the new turning movement counts into the table turns.tab."

Open file "filename2.txt" for input as #1
Input #1, links1
Input #1, filename1
Input #1, tablenamel
Input #1, table1
Input #1, links2

Register Table "new_data.dat" TYPE ASCII Delimiter 47 Titles into "new_data.tab"
open table "new_data.tab"

Commit Table table1 As "NEW_DAT2.TAB"
Close Table table1 Interactive
Open Table "NEW_DAT2.TAB" Interactive
Browse * From NEW_DAT2
Select * from links, NEW_DAT2 where links.id = NEW_DAT2.id into Selection
Update Selection Set speed2 = S2
Update Selection Set speed4 = S4
Update Selection Set capacity2 = C2
Update Selection Set capacity4 = C4
Update links2 set total loaded volume = capacity2 + capacity4
Update links2 set traf_diff = total loaded volume - traffic_counts
Commit Table links2
drop index links2 (TRAF_DIFF_PCT)
Select * from links2 where traffic_counts > 0 into counts
if selectioninfo(sel_info_nrows) = 0 then goto next1
end if

Update counts set TRAF_DIFF_PCT = ((TRAF_DIFF)/traffic_counts) * 100

next1: Update links2 set loaded_volume_1000 = total_loaded_volume /125
select * from links2 where speed2 > 0
Update selection set travel_time = length / speed2 * 60
Select * from links2 where capacity1 > 0
Update selection set vc_ab = capacity2 / capacity1
Select * from links2 where capacity3 > 0
Update selection set vc Ba = capacity4 / capacity3

close file #1

close table new_dat2 interactive
   O p e n T a b l e " T U R N S _ T . T A B " I n t e r a c t i v e  
   C o m m i t T a b l e T U R N S _ T A s " T U R N S . T A B " T Y P E  N A T I V E  C h a r s e t " W i n d o w s L a t i n 1 "  
   D r o p T a b l e T U R N S _ T  
   O p e n T a b l e " T U R N S . T A B " I n t e r a c t i v e  
   C r e a t e I n d e x O n T U R N S ( n o d e _ n u m )  

d e n d s u b
SIM.MB

select * from nodes where node<100 into cent
Update cent Set NODE = node+9000
Update nodes Set NODE = node-1000

select * from links where a<100 into a
Update a Set A = a+9000
select * from links where b<100 into b
Update b Set B = b+9000
Update links Set A = a-1000
Update links Set B = b-1000

select * from turns where node_num<100 into node_num
Update node_num Set node_num = node_num+9000
select * from turns where node_from<100 into node_from
Update node_from Set node_from = node_from+9000
select * from turns where node_to<100 into node_to
Update node_to Set node_to = node_to+9000
Update turns Set node_num = node_num-1000
Update turns Set node_from = node_from-1000
Update turns Set node_to = node_to-1000

Select NODE, X, Y, PI from nodes into nodeexport
Export "nodeexport" Into "C:\diss\iterate\nodes.tp" Type "ASCII" Overwrite Delimiter "," CharSet "WindowsLatin1"
Select A, AX, AY, B, BX, BY, LENGTH, S1, lgl, capacityl from links into linksexport
Export "linksexport" Into "C:\diss\iterate\network.txt" Type "ASCII" Overwrite Delimiter "," CharSet "WindowsLatin1"
Select node_from, node_num, node_to, volume from turns into tumsexport
Export "tumsexport" Into "C:\diss\iterate\turns.tp" Type "ASCII" Overwrite Delimiter "," CharSet "WindowsLatin1" Titles
NETWORK.FOR

integer from2,node2,left2,thru2,right2,nodenum,x,y,prod,s3
integer from,node,to,leftpt,thrup,ptotal,node,c2
integer a,ax,ay,b,bx,by,NEWA,NEWB,from1,node1,left1,thru1,right1
integer length,s1,c1,a1,ax1,ay1,b1,bx1,by1,left1,thru1,right1,dist
real x1,y1,x2,y2,x3,y3
real xa,ya,xb,yb,xc,yc,xd,yd,xe,ye,xf,yg,yg
character*12 LINKS
character*12 NODES
character*12 OUTPUT
character*12 TURNS
character*78 title, name

LINKS='NETWORK.TXT'
NODES='NODES.TP'
OUTPUT='NETWORK2.TRF'
TURNS='TURNS.TP'

890 continue

Open (unit = 10, file = LINKS, status = 'OLD')
Open (unit = 20, file = NODES, status = 'OLD')
Open (unit = 30, file = OUTPUT, status = 'unknown')
Open (unit = 40, file = 'direct.txt', status = 'unknown')
Open (unit = 50, file = TURNS, status = 'OLD')

read(*, 15)title
15 format(A78)
write (30,101)title
101 format(A78,'00')

read(*, 16)name
16 format(A78)
write (30,102)name
102 format(A78,' 1')

write (30,103)
103 format(7x,'1',3x,'0',6x,'15',16x,'0',3x,'0000',7x,'3',27x,'2')

write (30,104)
104 format('3600',75x,'3')

write (30,105)
105 format(18x,'60',59x,'4')
write (30,106)
106 format (79x,'5')

8888 continue

do 9999 j=1,257
   read(10,*)a,ax,ay,b,bx,by,length,s1,c1
   write(*,*)a,ax,ay,b,bx,by,length,s1,c1
rewind 10
left=0
thru=0
right=0

if((a.gt.8000).or.(b.gt.8000)) goto 12000

do 998 i=1,257
   read(10,*)a1,ax1,ay1,b1,bx1,by1
   if ((a1.EQ.a).or.(b1.EQ.a)) goto 7778
goto 998

7778 CONTINUE

IF ((a1.eq.b).and.(b1.eq.a)) goto 998

if(a1.eq.a) then
   x1=bx
   y1=by
   x2=ax1
   y2=ay1
   x3=bx1
   y3=by1
else if (b1.eq.a) then
   x1=bx
   y1=by
   x2=bx1
   y2=by1
   x3=ax1
   y3=ay1
end if
\[ dx = x_2 - x_1 \]
\[ dy = y_2 - y_1 \]
\[ H = \sqrt{(x_2-x_1)^2+(y_2-y_1)^2} \]
\[ H_{23} = \sqrt{(x_3-x_2)^2+(y_3-y_2)^2} \]
\[ H_{13} = \sqrt{(x_3-x_1)^2+(y_3-y_1)^2} \]

\[
\text{if}(H \text{eq} 0) \text{ then} \quad H = 0.01 \\
\text{end if}
\]
\[
\text{if}(H_{23} \text{eq} 0) \text{ then} \quad H_{23} = 0.01 \\
\text{end if}
\]
\[
\text{if}(H_{13} \text{eq} 0) \text{ then} \quad H_{13} = 0.01 \\
\text{end if}
\]
\[
x_e = x_2 - 150*\frac{dx}{H} \\
y_e = y_2 - 150*\frac{dy}{H} \\
x_d = x_2 - 300*\frac{dx}{H} \\
y_d = y_2 - 300*\frac{dy}{H} \\
x_a = x_d - 75*\frac{dy}{H} \\
y_a = y_d + 75*\frac{dy}{H} \\
x_b = x_e - 75*\frac{dy}{H} \\
y_b = y_e + 75*\frac{dy}{H} \\
x_c = x_e - 100*\frac{dy}{H} \\
y_c = y_e + 100*\frac{dy}{H} \\
x_f = x_d + 75*\frac{dy}{H} \\
y_f = y_d - 75*\frac{dy}{H} \\
x_g = x_e + 75*\frac{dy}{H} \\
y_g = y_e - 75*\frac{dy}{H} \\
x_h = x_e + 100*\frac{dy}{H} \\
y_h = y_e - 100*\frac{dy}{H}
\]
\[
domain = (\frac{(H^{*2} + H_{23}^{*2} - H_{13}^{*2})}{2*H*H_{23}}) \\
\text{if}(\text{domain} \lt -1)\text{ then} \quad \text{domain} = -1. \\
\text{end if} \\
\text{if}(\text{domain} \gt 1)\text{ then} \quad \text{domain} = 1. \\
\text{end if} \\
\phi = 57.3*\text{acos}(\text{domain})
\]
\[
400 \quad \text{continue}
\]
\[
\text{if}((\phi \lt 200)\text{ and } (\phi \gt 160)\text{ and } (a_1 \text{eq} a))\text{ then} \\
\quad \text{thru} = \text{b1} \\
\text{end if}
\]
\[
\text{if}((\phi \lt 200)\text{ and } (\phi \gt 160)\text{ and } (b_1 \text{eq} a))\text{ then} \\
\quad \text{thru} = \text{a1} \\
\text{end if}
\]
if (phi.lt.50) goto 9997

dg=sqrt((x3-xg)**2+(y3-yg)**2)
db=sqrt((x3-xb)**2+(y3-yb)**2)

if((thru.eq.b1).or.(thru.eq.a1)) goto 9997

if (dg.lt.db) then
  right=a1
  if ((a1.eq.a).or.(a1.eq.b)) then
    right=b1
  end if
end if

if (db.lt.dg) then
  left=a1
  if ((a1.eq.a).or.(a1.eq.b)) then
    left=b1
  end if
end if

9997 continue

998 continue

  write(*,*)left,thru,right

  dist=length*5.28

  if(dist.lt.50) then
    dist=50
  end if

  if(dist.gt.4000) then
    dist=4000
  end if

  if(c1.ge.7200) then
    c2=2
  else if (c1.lt.7200) then
    c2=1
  end if

  s3=s1/100

  if(a.gt.8000) then
    dist=0
s1=0
end if

if(b.gt.8000) then
    dist=0
    s3=0
end if

write (30,5000)b,a,dist,c2,left.thru.right.thru.s3
5000 format(I4,I4,I4,9x,l1,7x,'9',6x,l4,l4,l4,l4,'--',25,22',
    =l2.'01',7x,'11')

write(40,*b,a,left.thru.right

12000 continue

rewind 10

left=0
thru=0
right=0

if(b.gt.8000) then
    newa=a
    newb=b
    newax=ax
    neway=ay
    newbx=bx
    newby=by

    a=newb
    b=newa
    ax=newbx
    ay=newby
    bx=newax
    by=neway
end if

do 997 i=1,257
    read(10,*)a1,ax1,ay1,b1,bx1,by1

    if (((a1.EQ.b).or.(b1.EQ.b)) goto 7777
GOTO 997

7777 CONTINUE

    if (((a1.eq.a).and.(b1.eq.b)) goto 997

    if(a1.eq.b) then
else if (bl.eq.b) then
  x1=ax
  y1=ay
  x2=bx1
  y2=by1
  x3=ax1
  y3=ay1
end if

dx=x2-x 1
dy=y2-y 1
H=sqrt((x2-x 1)**2+(y2-y 1)**2)
H23=sqrt((x3-x2)**2+(y3-y2)**2)
H13=sqrt((x3-x 1)**2+(y3-y 1)**2)

if(H.eq.0) then
  H=0.01
end if

if(H23.eq.0) then
  H23=0.01
end if

if(H13.eq.0) then
  H13=0.01
end if

xe=x2-150*dx/H
ye=y2-150*dy/H
xd=x2-300*dx/H
yd=y2-300*dy/H
xa=xd-75*dy/H
ya=yd+75*dx/H
xb=xe-75*dy/H
yb=ye+75*dx/H
xc=xe-100*dy/H
yc=ye+100*dx/H
xf=xd+75*dy/H
yf=yd-75*dx/H
\[xg = xe + 75\cdot dy/H\]
\[yg = ye - 75\cdot dx/H\]
\[xh = xe + 100\cdot dy/H\]
\[yh = ye - 100\cdot dx/H\]

\[\text{domain} = \left(\frac{(H^{**2} + H23**2 - H13**2)}{(2\cdot H\cdot H23)}\right)\]
\[\text{if}(\text{domain} < -1)\text{then}\]
\[\text{domain} = -1.\]
\[\text{endif}\]
\[\text{if}(\text{domain} > 1)\text{then}\]
\[\text{domain} = 1.\]
\[\text{endif}\]
\[\phi = 57.3\cdot \arccos(\text{domain})\]

399 continue

\[\text{if}((\phi < 200)\text{.and.}(\phi > 160)\text{.and.}(\text{a I .eq.b}))\text{then}\]
\[\text{thru} = \text{b I }\]
\[\text{endif}\]

\[\text{if}((\phi < 200)\text{.and.}(\phi > 160)\text{.and.}(\text{bl .eq.b}))\text{then}\]
\[\text{thru} = \text{a I }\]
\[\text{endif}\]

\[\text{if}(\phi < 50)\text{ goto 9996}\]

\[dg = \sqrt{(x3-xg)^2 + (y3-yg)^2}\]
\[db = \sqrt{(x3-xb)^2 + (y3-yb)^2}\]

\[\text{if}((\text{thru.eq.b1).or.}(\text{thru.eq.a1}))\text{ goto 9996}\]

\[\text{if}(dg < db)\text{ then}\]
\[\text{right} = \text{b I }\]
\[\text{if}((\text{bl.eq.a}).or.((\text{bl.eq.b}))\text{ then}\]
\[\text{right} = \text{a I }\]
\[\text{endif}\]
\[\text{endif}\]

\[\text{if}(db < dg)\text{ then}\]
\[\text{left} = \text{b I }\]
\[\text{if}((\text{bl.eq.a}).or.((\text{bl.eq.b}))\text{ then}\]
\[\text{left} = \text{a I }\]
\[\text{endif}\]
\[\text{endif}\]

9996 continue

997 continue
write(*,*)left,thru,right

dist=length*5.28

if(dist.lt.50) then
  dist=50
end if

if(dist.gt.4000) then
  dist=4000
end if

if(cl.ge.7200) then
  c2=2
else if (cl.lt.7200) then
  c2=1
end if

s3=s1/100

if((a.gt.8000).or.(b.gt.8000)) then
  dist=0
  s3=0
end if

write (30,4999)a,b,dist,c2,left,thru,right,thru,s3
4999 format(I4,I4.I4,9x,Il,7x,'9'.6x,I4,I4.I4,4.x,I4,' 25 22
  =I2,'01',7x,'11')

write(40,* )a,b,left,thru,right

rewind 10

5011 read(10,*)a2,ax2,ay2,b2,bx2,by2
  if((a2.eq.a).and.(b2.eq.b)) goto 9999
  if((a2.eq.b).and.(b2.eq.a)) goto 9999
goto 5011

9999 continue

rewind 40

15100 read(40,*,err=15600)from1,node1,left1,thru1,right1

  if((left1.eq.0).and.(right1.eq.0)) then
    write (30,15110)fi-om 1 ,node 1
  15110 format(I4,I4,4x; 100',62x,'2r)
goto 15100
end if

if(right1.eq.0).and.(thru1.eq.0)) then
  write(30,15120)from 1 ,node 1
15120 format(I4,I4,'100',66x,'21')
goto 15100
end if

if((thru1.eq.0).and.(left1.eq.0)) then
    write(30,15130)from 1, node 1
15130 format(I4,8x,'100',58x,'21')
goto 15100
end if

rewind 50
t1=0
t2=0
t3=0
15010 read(50,15001)
15001 format(/
15200 read(50,*,eiT=15500)from,noden,to,volume
if((from.eq.from 1).and.(node 1.eq.noden)) then
    if(to.eq.left1) then
t1=t1+volume
    end if
    if(to.eq.thru1) then
t2=t2+volume
    end if
    if(to.eq.right1) then
t3=t3+volume
    end if
end if
goto 15200
15500 total=t1+t2+t3
if(total.eq.0) then
total=1
end if
leftpt=(t1*100)/total
thrupt=(t2*100)/total
rightpt=(t3*100)/total
write (30,15400)from 1,node 1,leftpt,thrupt,rightpt
15400 format(I4,I4,I4,I4,58x,'21')
goto 15100
15600 continue
rewind 40
rewind 20

16000 continue

read(20,*,err=16200)nodenum

if(nodenum.gt.8000) goto 16000

rewind 40

16100 read(40,*)from2,node2,left2,thru2,right2

if(node2.eq.nodenum) then
write(30,16110)node2,from2,left2,thru2,right2
16110 format(I4,4x,I4,I4,I4,54x,'35')
goto 16000
end if

goto 16100

16200 continue

rewind 20

16300 read(20,*,err=16500)nodenum

if(nodenum.gt.8000) goto 16300

rewind 40

16400 read(40,*)from2,node2,left2,thru2,right2

if((from2.gt.8000).or.(node2.gt.8000)) goto 16400

if(node2.eq.nodenum) then
  if(left2.eq.0) then
    if(thru2.eq.0) then
      write(30,16410)node2
16410 format(I4,1x,'11 ',69x,'36')
goto 16300
    end if
  end if
  if(right2.eq.0) then
    write(30,16420)node2
16420 format(I4,1x,'11 ',69x,'36')
goto 16300
  end if
write(30,16430)node2
16430 format(I4,1x,'11 ',69x,'36')
goto 16300
end if
if(thru2.eq.0) then
  if(left2.eq.0) then
    write(30,16440)node2
    16440 format(i4,1x,'ll',69x,'36')
goto 16300
  end if
  if(right2.eq.0) then
    write(30,16450)node2
    16450 format(i4,1x,'ll',69x,'36')
goto 16300
  end if
  write(30,16460)node2
  16460 format(i4,1x,'ll',69x,'36')
goto 16300
end if

if(right2.eq.0) then
  if(thru2.eq.0) then
    write(30,16470)node2
    16470 format(i4,1x,'ll',69x,'36')
goto 16300
  end if
  if(left2.eq.0) then
    write(30,16480)node2
    16480 format(i4,1x,'ll',69x,'36')
goto 16300
  end if
  write(30,16490)node2
  16490 format(i4,1x,'ll',69x,'36')
goto 16300
end if

write(30,16495)node2
16495 format(i4,1x,'lll',69x,'36')
goto 16300
end if

goto 16400

16500 continue

rewind 40
rewind 20

16600 read(20,*,err=16700)node2,x,y,prod
      if(node2.lt.8000) goto 16600
rewind 40

16605 read(40,*)from,node
if (node.eq.node2) then
  write(30,16610) node, from, prod
16610  format(14,14,14,66x,'50')
  goto 16600
end if

if (from.eq.node2) then
  write(30,16612) from, node, prod
16612  format(14,14,14,66x,'50')
  goto 16600
end if

goto 16605

16700 continue

write(30,16800)
16800 format(77x,'170')

rewind 20

16900 continue

read(20,*,err=17000) node, x, y

if (node.lt.8000) then
  write(30,16910) node, x, y
16910  format(I4,I8,I8,57x,'195')
end if
goto 16900

17000 continue

write(30,17010)
17010 format(3x,'1',73x,'210')

write(*,*) node, node_num, node, volume

format(14,'/',I4,'/',I4,'/',F15.2,'/',F15.2,'/',F15.2,'/',F15.2,'/',F15.2,'/',F15.2,'/',F15.2,'/',I6)

end
NUMBERS.FOR

integer node1, node2, node3, x1, x2, y1, y2
real dist, distance

open (unit=20, file = 'few.txt', status = 'unknown')
open (unit=10, file = 'lots.txt', status = 'unknown')
open (unit=30, file = 'node_taz.txt', status = 'unknown')

10 continue

read(10,*,err=1000) node1, x1, y1

distance=5000000

node3=0

rewind 20

20 continue

read(20,*,err=500) node2, x2, y2

dist=((x1-x2)**2+(y1-y2)**2)**0.5

if(dist.lt.distance) then
    distance=dist
    node3=node2
end if

goto 20

500 write(30,*) node1, node3
write(*,*) node1, node3

 goto 10

1000 end
AGGREGAT.FOR

integer orig1,dest1,volume, zone1,zone2,orignew,destnew,totalvol
integer i,j,o1,d1

character*12 od1,od2,od3

write(*,*)' Please input the name of the file containing the'
write(*,*)' trip table data :
read(*,990)od1
write(*,*)

write(*,*)' Please input the name of the file containing the'
write(*,*)' aggregation variables :
read(*,990)od2
write(*,*)

write(*,*)' Please input the name of the file to contain the'
write(*,*)' aggregated trip table :
read(*,990)od3
990 format(a12)
write(*,*)

101 continue
  Open (unit = 10, file = od1, status = 'old')
  Open (unit = 30, file = od2, status = 'old')
  Open (unit = 40, file = 'temp.dat', status = 'unknown')
  Open (unit = 50, file = od3, status = 'unknown')
10 continue
  read(10,*,err=40)orig1,dest1,volume
  rewind30
100 continue
  read(30,*)zone1,zone2
  if(orig1.eq.zone1) then
    orignew=zone2
    goto 200
  end if
  goto 100
200 rewind 30
300 continue
   read(30,*),zone1,zone2
   if(dest1.eq.zone1) then
      destnew=zone2
      goto 400
   end if
   goto 300
400 continue
   write(40,*),orignew, destnew, volume
   goto 10
40 continue
   do 9999 i=1,71
   do 9998 j=1,71
      totalvol=0
      rewind 40
300 read(40,*),err=1000),ol,dl,volume
   if((ol.eq.i).and.(dl.eq.j)) then
      totalvol=totalvol+volume
   end if
   goto 500
1000 write(50,1001) i,j,totalvol
1001 format (15,15,*,1',17)
   write(*,1001) i,j,totalvol
9998 continue
9999 continue
   end
UPDATE.MB

Browse * From Links
Select * from Links, new_tt where Links.idab = new_tt.LINE into Selection
Update Selection Set speed2 = mph*100
Select * from Links, new_tt where Links.idba = new_tt.LINE into Selection
Update Selection Set speed4 = mph*100
select * from Links where a<8000 into Selection
Update Selection Set S1 = (0.25*speed2) + (0.75*s1)
select * from Links where a<8000 into Selection
Update Selection Set S3 = (0.25*speed4) + (0.75*s3)

select * from links where a<8000 into selection
update selection set vc_ab = S1-speed2
update selection set vc_ba = s3-speed4
TRAN.MB

Update nodes set NODE=NODE+1000
Select * from nodes where node>8000 into n
update n set node=node-9000

Update links Set A = a+1000
Update links Set B = b+1000
select * from links where a>8000 into a
Update a Set A = a-9000
select * from links where b>8000 into b
Update b Set B = b-9000
select * from links where b>a into ba
update ba set ID=a+" "+b
select * from links where a>B into ab
update ab set ID=B+" "+a

Update links set traffic_counts=total_loaded_volume
APPENDIX D. USER'S MANUAL FOR TRANPLAN - GIS INTERFACE

Tranplan - MapInfo

Manual for the Tranplan - MapInfo Modeling environment

Tranplan - MapInfo Modeling Environment

The first section documents the process of registering an existing Tranplan network into the MapInfo environment.

This section contains a narrative description of registering the network into MapInfo. The goal is to bring the existing, unloaded, Tranplan network into MapInfo. This operation will develop a base network for the area, with new scenarios being developed as modifications of the original network.

1. The initial step is the collection of the required files, node, link, production and attraction. These file should be placed in the directory where the scenario is to be developed. Other flies that should be placed in this directory are the executable files required by the environment and the files required to perform a Tranplan run.

The three required files (link data, node data, and production and attraction data) need to be stored in separate files in the appropriate Tranplan format. Examples of the three files are shown:

Node file.
Link file.

Production and attraction file.

2. After the files are gathered and placed in the appropriate directory, the user should enter MapInfo run the MapBasic program written to operate the environment. The Mapbasic program is run by selecting the FILE - RUN MAPBASIC PROGRAM option from the menu.
A new window will appear, in this window, change the directory to the appropriate directory where the files are stored and the file MODEL.MBX should appear. Either double click the file name or select and press O.K. will start the program. After starting the program, a new menu item should appear at the top of the screen after the Help menu.
Example of the new TP_Ml pull down menu.

3. After the new menu is created, the network will be registered after selecting TP_Ml - REGISTERING.

This option produces a dialog box which informs the user the first step in registering the network is running the Fortran program called TP_MI.EXE. Selecting O.K. will call a DOS window, where in the appropriate directory, the user needs to type TP_Ml at the prompt. This program will ask the user a few questions about the model and will read in the appropriate data from the files to create MapInfo tables from the data. The questions the user will be asked are:

1. enter the name of the file containing the node data
2. enter the name of the file containing the production and attraction data
3. enter the name of the file containing the link data
4. enter the number of zones or total number of centroids on the network (any node with production and attraction data associated with it)
5. enter whether or not the coordinates for the nodes need to be factored to align them within a real-world coordinate system
   - if YES, enter the factors
   - if NO, continue
6. enter the appropriate description for the nodes file (small or large coordinates)

The program will then run and read the Tranplan information and re-format the information into an acceptable format for MapInfo to read in the data. This program may take considerable time to run, possibly over an hour depending on hardware and network size. After the program is complete, the DOS prompt will return and the user can continue by typing "exit". This will return the user back to MapInfo where the program will be waiting to continue. Selecting O.K. will then register the node and link information.

4. At this point, MapInfo will be registering the network. The registration process will open an close numerous windows called nodes and links with various extensions (11, 1Z). These files are intermediate files that MapInfo uses. The next action item for the user is to enter the appropriate projection system for the network when prompted to do so by the program.
Pressing the OK button will display a new map option window that has the ability to change the projection system for the map. The user needs to select the projection button from the dialog box.

Selecting this option will display a new dialog window with all the available MapInfo projections.
In the example, the Tranplan network was developed in UTM NAD 27 and Zone 15 for the US. (This is the case for the Ames network.)

The user continues by selecting the appropriate coordinate systems and selects the OK button to cause the program to continue running.

5. The program will then create the linework for the network. After creating the linework, the program will ask if the user would like to view the entire layer.

After viewing the network, the program will continue to register the network and will change the name of the file to nodes.tab and links.tab. These files are the node and link file for the network. After this step, the network will be completely registered in MapInfo and ready to be routed through Tranplan.
After completing the registration process, the network will be completely incorporated into MapInfo. At this phase, it is possible to perform a Tranplan model run or, if desired, make changes to the model and perform a model run.
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ACKNOWLEDGMENTS

Completion of this research effort would not have been possible without the support of so many. I wish to begin by thanking Iowa State University and the Center for Transportation Research and Education for providing the technology and administrative resources necessary for this work as well as the United States Department of Transportation Eisenhower Fellowship Program for the financial support to help make this dream a reality. Zachary Hans, Dan Geiseman, Michael Pawlovich, and many other staff members and students need to be thanked for sharing laughs and struggles during the course of this work.

I wish to thank my committee member Dr. Doug Gemmill for his guidance and sharing of his knowledge about simulation at the beginning of the research. Dr. Tom Maze for providing insight and constructive feedback throughout the course of this study. I would like to thank Dr. Tim Strauss for providing his time and energy during the final months of this work. I wish to extend my gratitude to Dr. Edward Kannel in appreciation of the countless hours he spent reviewing and improving this manuscript. Finally, I would like to thank my mentor, advisor and major professor, Dr. Reginald Souleyrette for his guidance, both professionally and personally, that I will carry with me through my entire life.

I would like to offer thanks to my parents, Glen and Susan Anderson, and my other parents, Duane and Pam, as well as all extended family members for understanding the challenges required to complete this degree. Finally, I am forever grateful to my family. My wife, Jennifer, and son, Carter, made this all possible through their continued support of my desire to complete this work and needed words of encouragement when times were tough.
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