Michigan's Congestion Management System

Cynthia VonKlingler, Michigan Department of Transportation

Abstract

Michigan's Congestion Management System has been developed concurrently with the development of the six management systems that were mandated by the Intermodal Surface Transportation Efficiency Act of 1991. While the development of the transportation management systems is no longer required, Michigan chose to continue the development of these 6 management systems. From the outset, the effort to develop transportation management systems has been seen as an integral part of several major developmental efforts within the Department including integration of isolated data bases, migration from mainframe operations to distributive data processing in a client/server environment, examination and re-engineering of major business processes within the Department, and enhanced coordination among Michigan transportation agencies through sharing data and meeting the combined information needs of this diverse group of users.

The Congestion Management System has been designed to aid users in identifying specific locations where congestion occurs or is expected to occur. The TMS data base incorporates historic traffic data and future traffic forecasts from the Statewide model and urban area models. The system also provides access to historic and forecast socioeconomic data and information from the Census. Socioeconomic data is stored at both the TAZ and County levels. The CMS also provides summary statistics for user-selected routes or for specific geographical areas of the State.

The Congestion Management System produces a list of viable candidate projects as input to the programming process. It also includes numerous performance measures and indicators that can be used to measure progress towards meeting the goals and objectives of the State Long Range Plan and long range plans of regional and metropolitan planning agencies.

Along with describing the features and uses of the Congestion Management System at its current development stage, this paper and presentation will include an evaluation of the development effort including which methods were successful and areas for improvement. The discussion also will include plans for the future refinements to the application.

Michigan's Congestion Management System (CMS) has been developed concurrently with the development of five other management systems that were mandated by the Intermodal Surface Transportation Efficiency Act of 1991. While the development of a congestion management system is no longer required outside of Transportation Management Areas (TMAs), Michigan chose to maintain a statewide focus for the development of these 6 management systems including the CMS. From the outset, the effort to develop transportation management systems has been seen as an integral part of several major developmental efforts within the Department including:

- integration of isolated data bases,
- migration from mainframe operations to distributive data processing in a client/server environment,
- examination and re-engineering of major business processes within the Department, and
- enhanced coordination among Michigan transportation agencies through sharing data and meeting the combined information needs of this diverse group of users.

The Congestion Management System has been designed to aid users in identifying specific locations where congestion occurs or is expected to occur. The supporting data base incorporates historic traffic data and future traffic forecasts from both the Statewide model and urban area models. The system also provides access to historic and forecast socio-economic data and information from the Census. Socio-economic data is stored at both the traffic analysis zone and county levels.

The CMS provides summary statistics and performance measures for user-selected routes, by geographical area, or by any of several road classification systems. Many performance measures and indicators are available and can be used to measure progress towards meeting the goals and objectives of the State Long Range Plan and long range plans of regional and metropolitan planning agencies.

The CMS application is integrated with five other management systems, collectively known as the Transportation Management System or TMS. Although each TMS subsystem is, in some sense, an independent entity and can operate independently for highly specialized tasks, users realize the greatest benefit when the information provided by all subsystems is applied to develop coordinated solutions to transportation issues, challenges and problems.

To visualize how the CMS can be used in conjunction with other subsystems to improve transportation systems in the State, some background information on the TMS will be useful. The next section of this paper presents some history and describes the foundations of the TMS.

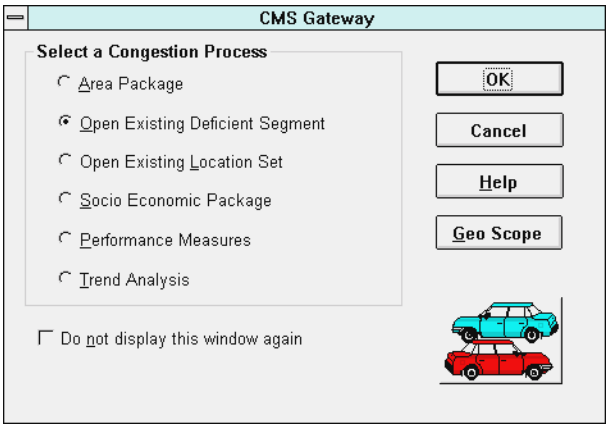
The Foundations of the TMS Application

In Michigan, the Bridge Management System (BMS), the Congestion Management System (CMS), the Intermodal Management System (IMS), the Pavement Management System (PMS), the Public Transit Management System (PTMS), and the Safety Management System (SMS) are collectively known as the Transportation Management Systems or *TMS*. All six subsystems are supported by an Oracle data base consisting of over 900 data and code tables containing approximately 5 gigabytes of data. Currently, the database contains inventory attributes and operational characteristics for all State Trunkline routes (9602 route miles) and National Highway System routes (4720 route miles) and will be expanded to include all federal aid roadways within the State. This fully integrated common data repository provides a storehouse of historical and forecast data and information needed to support sound investment decisions.

The TMS user interface is a Powerbuilder application that will continue to be enhanced as business operations and user needs grow and change. Providing access to data and information about roads, bridges, ports, transit fleets, border crossings and all other components of the transportation system in Michigan, the application brings a vast store of information to users throughout the State.

All users have access to all subsystems, although user rights are aligned with job functions so that sensitive or highly specialized data are available only to those who are trained in it’s use. For example, all users have access to socio-economic information including forecasts; all historical inventory and operational characteristics of roadways; and base year model runs, long range plan year model runs and 2 or 3 interim year model runs for all modelled areas in the State. Access to specialized model runs is restricted to core CMS users who fully understand travel demand models and the application and limitations of raw model outputs.

Each subsystem includes a Gateway, which is a starting point to help users find information or begin a process. The Gateways, combined with "bubble help" and other on-line help documents aid individuals in becoming proficient users of the vast data resources represented in the TMS database.

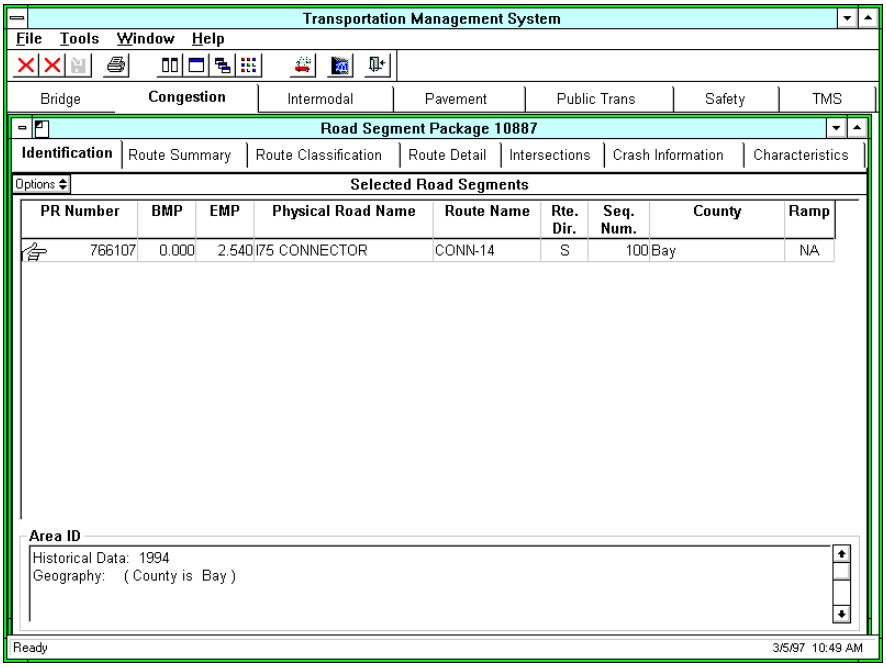


The CMS Gateway is a starting point for navigation through the Congestion Management System.

During system development, displays of information (screens) were grouped into *packages* such as the Road Segment Package shown above. Packages are designed to function similarly across subsystems so that users encounter a consistent method to complete tasks and solve problems. This is especially helpful for users who will primarily use one subsystem, but occasionally need to access information from another subsystem. Through these information packages, the TMS brings a wide array of information to users in many departments and agencies across the State.

Some of these packages such as the Transportation Analysis Notebook are shared across subsystems. The Transportation Analysis Notebook provides a means for users to record potential strategies for solving a problem and provides a means for cross-referencing to related notebooks. Users have access to these notebooks from anywhere within the TMS. This feature supports coordinated development of Transportation Improvement Programs and Long Range Plans.

Many of the packages display information in a spreadsheet format, making common spreadsheet functions readily available to users. Users can reorder columns, perform sorts and filters, export to



The Road Segment Package consists of 7 tabs or screens of information. The Tab Paradigm provides a common user interface across subsystems.

other applications, and create graphs easily within the TMS. These features are easy to invoke using a drag and drop operation or a right mouse click and making a few selections from pop-up windows within the application.

Major Features of the Congestion Management System

The functions of the seven core packages within CMS are described in the table below. As information needs change and expand, these packages will likely be restructured and enhanced.

Geographic Scoping and Filtering

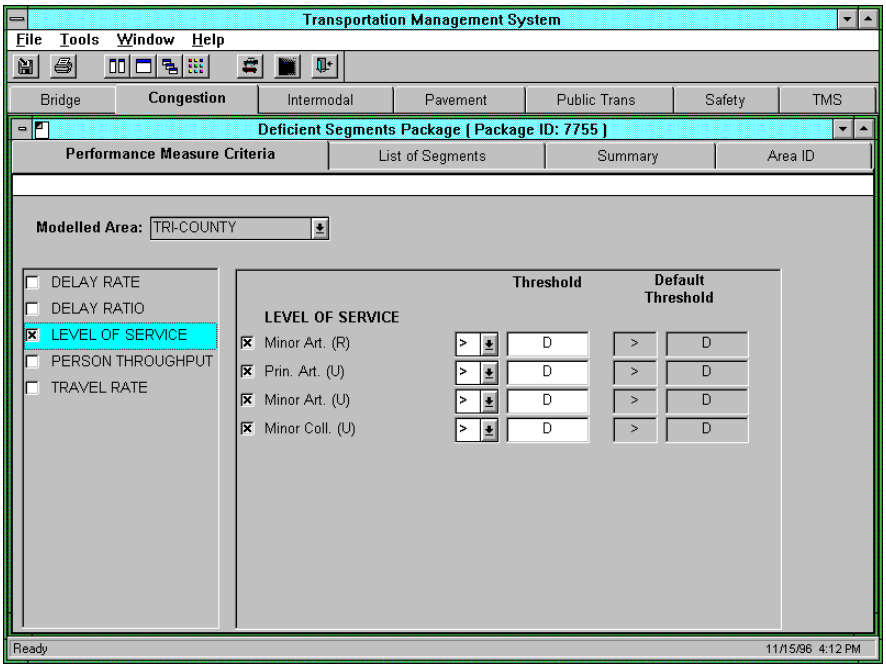
Upon entering the CMS, the user chooses a geographic scope for their query, a layer of the transportation system to focus on, and whether to view historic or modelled data. Geographic scopes include statewide, district, urban modelled area (MPO), county, and corridor or other type of subarea. This initial narrowing of the query results in a pared down list of routes from which the user can target a specific query to the TMS database and see results of the query displayed in the Road Segment Package, the Deficient Segments Package or the Performance Measure Package.

Choosing Performance Measures and Thresholds for Acceptable Performance

The CMS identifies deficient locations through the Deficient Segments Package. Segment-level performance measures, such as Level of Service (LOS), Travel Rate and Delay Rate are used

Congestion Management System Packages

Area Package	• view socio-economic data at the traffic analysis zone level • view a list of routes within a selected area and identify dual routes • choose routes (define query parameters) before entering the Road Segment Package or Deficient Segments Package or Performance Measure Package.
Road Segment Package	• view operational and physical characteristics for roadways at both detailed and summary levels. • view historical and forecast roadway information
Deficient Segments Package	• choose performance measures to be used to identify deficiencies and alter thresholds • view congestion deficiencies based upon the user's choice of performance measure and threshold • view a summary of deficiencies • identify and save a location for further analysis
Location Builder Package	• propose improvements to resolve deficiencies and associate preliminary costs with each • present a list of all facilities associated with the selected location • summarize preliminary costs to resolve deficiency at this location
Socio-economic Package	• view Census Journey-to-Work information by county • view county-level population and employment history and forecasts • view Census data at Statewide zone level
Performance Measure Package	• view high level trends in performance
Trend Analysis Package	• view growth of operational characteristics for the State, by county or by district. • apply a growth rate to operational characteristics • perform simple linear regression



Deficiencies can be identified using several performance measures. The user selects one and adjusts the thresholds as desired.

within this package to identify congested road segments. Policy-approved thresholds for acceptable level of performance are established by the MPO for roadways within the Metropolitan Area Boundary (MAB). In areas outside of a MAB, the thresholds are established by the agency with jurisdiction over the roadway. These policy-approved thresholds are stored in the TMS database and are displayed as *Default Thresholds* on the **PM Criteria** screen.

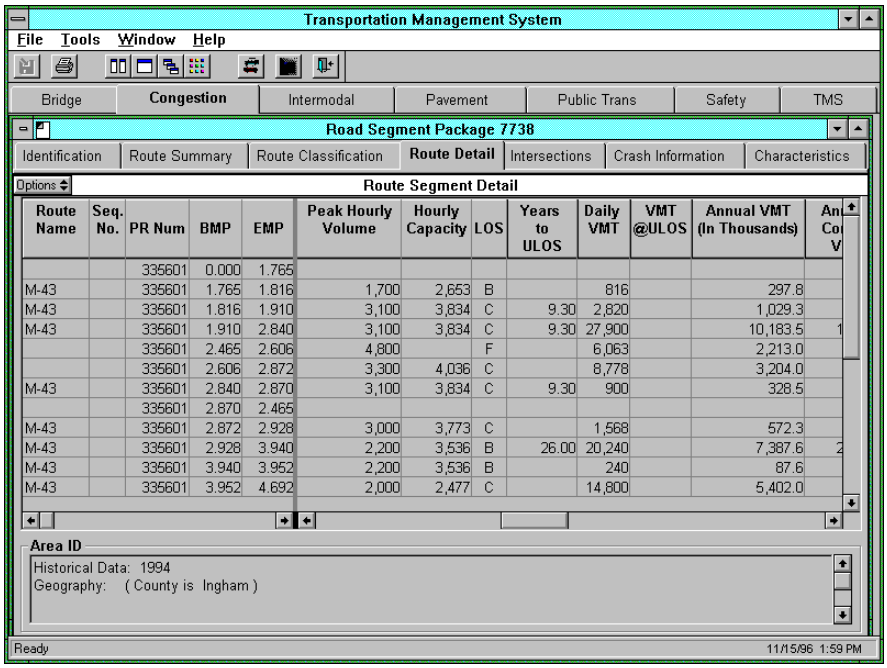
The CMS allows individual users to adjust these thresholds for a particular analysis and save the threshold settings with the analysis in a *Transportation Analysis Notebook* so that the analysis can be reconstructed at a later date.

Identifying and Scaling the Magnitude of Deficiencies

Once the performance measures are chosen, the CMS produces a **List of Segments** within the user- defined geographic area and year. The **List of Segments** will show either all road segments or deficient segments. *Additional Lanes* and *Additional Lane Miles Required to Resolve Deficiencies* help the user determine the magnitude of deficiencies. From the **List of Segments** screen, the user can use the sorting and filtering functions and can select a set of segments for further inquiry into possible causes of the congestion or for summarization. The **Summary** screen within the Deficient Segments Package, shows the distribution of *Miles, Lane Miles, VMT, Commercial VMT, VHT* and other performance indicators by Levels of Service.

Viewing Roadway Attributes and Operational Characteristics

Historic, current year and forecasted roadway attributes can be viewed through the Road Segment Package. The elements displayed vary, depending upon whether the user is viewing historic data or forecasted (modelled) data. The user can compare data for different years by opening additional packages and using the standard Windows features to navigate between or among opened

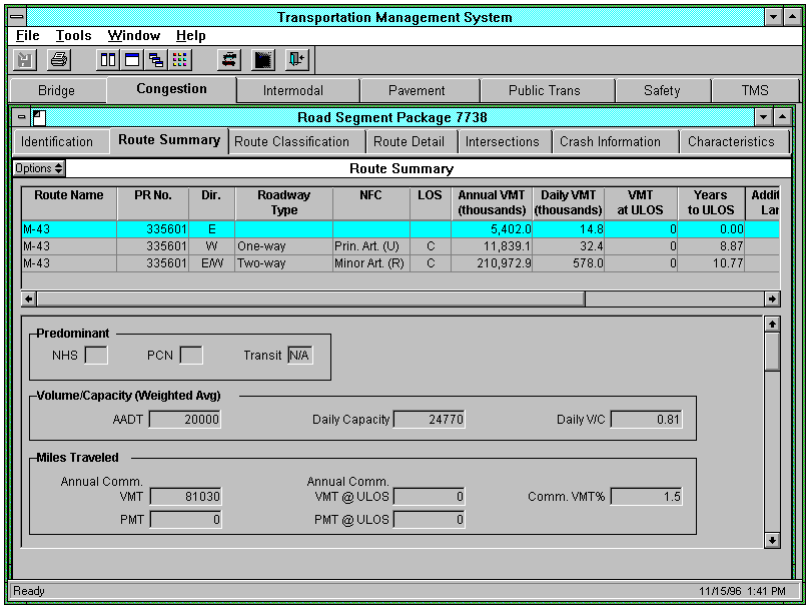


The Route Detail Screen

packages. The **Route Detail** screen presents information on a segment level. This is useful for identifying bottlenecks that may be causing congestion on adjacent or upstream segments.

The **Route Summary** screen presents aggregated information route by route for the user's selected roadways. Through this screen, comparisons are made between the roadway as a whole and those segments operating at an unacceptable Level of Service (e.g., Total Commercial VMT and Commercial VMT at Unacceptable LOS).

Roadway use constraints are also presented as Intermodal Restrictions (including minimum num-



The Route Summary Screen

ber of lanes; minimum lane width and shoulder width; and minimum and maximum ADT, commercial ADT and % commercial). The magnitude of a congestion problem is expressed as a weighted average of Years to Unacceptable LOS and Additional Lane Miles Required to Resolve Deficiencies. This screen provides a means of comparing two or more roadways (peer group analysis), as well. Mobility or accessibility problems can be investigated further by using the **Route Classification** screen. The **Route Classification** screen presents aggregated information by "system slice." If, for example, providing efficient access to an intermodal terminal is a problem, the user can summarize roadway attributes by Roadway Type or compare operation of roadways included in the Priority Commercial Network (PCN) to those that are not.

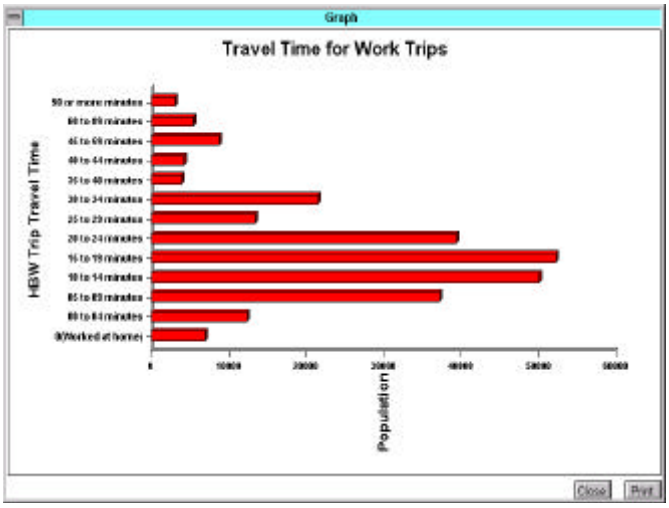
Analysis of Alternatives

Once a deficiency has been investigated through the Road Segment Package and Deficient Segments Package, the user can select segments to include in a proposed project and carry this selection of road segments to the Location Builder Package. The Location Builder Package presents a list of facilities (intersections, bridges, etc.) that are associated with the deficient roadway so that costs for modification of these associated facilities can be included. Costing tables used for this process contain rough unit and/or fixed costs for a variety of solutions and allow for regional variances in costs. The user has the option to use the cost tables or to enter a cost estimate of one's own.

Each solution package can be saved to the TMS database and retrieved from a list of all such locations by any user of the TMS.

Viewing Socio-economic/Demographic Information

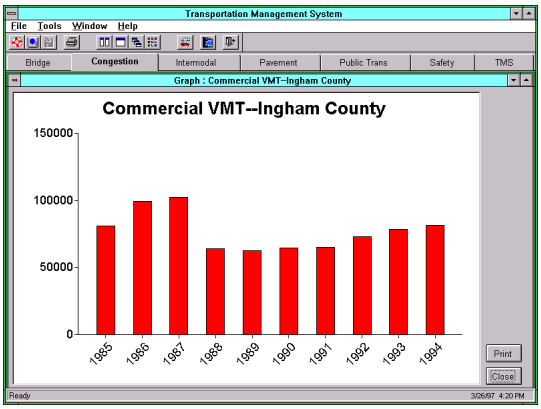
Current and forecasted population and employment characteristics are displayed by Traffic Analysis Zone through the Area Package screens. Socio-economic data is available for the Statewide zone configurations and for each urban area's zone configuration. In addition to zonal data, selected data from the Census is available for viewing at the county level. This Census information is presented in the Socio-economic Package along with selected socio-economic forecasts of employment by industry and population by gender and age developed by the University of Michigan using the REMI (Regional Econometric Modelling, Inc.) model.

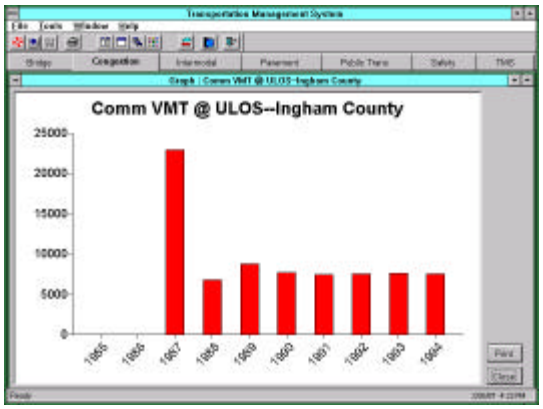


Spreadsheet displays are transformed into graphs with a few mouse clicks.

System level Performance Measures and Trends

New planning initiatives such as outcome-based assessment and performance-based planning require the availability of a broad range of data items so that progress toward objectives can be monitored on a regular basis. A broad range of performance measures is also needed to adequately evaluate the costs and benefits of proposed alterations to the transportation system. Without such measures, dollars cannot be effectively targeted toward





meeting transportation needs in an area in a balanced equitable manner.

A wide variety of performance measures and trends can be displayed through the CMS to identify and quantify mobility and accessibility problems or achievements. From the start, CMS development efforts focussed on supporting a variety of performance measures and performance indicators that would benefit users at all levels and that would be sensitive to improvements in efficiency (improved person movement and goods movement). This effort has resulted in a performance framework within CMS that, in one sense, stretches the limits of currently available data. The effort also is setting direction for future data collection priorities. Where data resources are weak, the CMS uses default factors in performance calculations. While using defaults does compromise the accuracy of information, on-line “bubble help” documents all system calculations so that users know which calculations use default factors. When presented with new measures, users can begin thinking about how they will use new measures and set priorities for data collection to support those that are most meaningful.

Other types of readily available historical information have been incorporated into the CMS Trends Package. These include total VHT, VMT, Commercial VMT, Lane Miles, Person Miles of Travel and accumulations of each of these at unacceptable Level of Service. A ten year history by county is available for these statistics. Corresponding forecasts are developed on an annual basis and can be displayed within the trends package. The user also has the option of applying simple linear regression to the historical data or applying a growth rate to project these statistics into the future.

The figures at the left compare the change in Commercial VMT to the change in Commercial VMT operating at unacceptable level of service (ULOS) for urban interstates in Ingham County. Commercial VMT at Unacceptable LOS remains stable in recent years while total Commercial VMT increases, translating to improved service to commercial traffic in this county.

Plans for Future Enhancements

The environment in which the TMS will be used is continually changing as it was when the original visioning exercises began over 4 years ago. Current changes affecting operations within the Department include implementation of a new MPO planning process, a new project development process, significant downsizing and a major decentralization of operations and staff. All of these developments will have some impact on user information needs and consequently on the direction of system enhancement.

Our first step is to gain more experience in using the CMS components of the TMS in the decision processes that support business operations at MDOT. The current TMS tool provides key pieces of information that help to identify problems and possible solutions. However, other information, such as detailed comparisons of alternatives, must be obtained from sources other than the TMS. As the practice of integrating solutions that resolve roadway deficiencies through ITS, modal and other types of actions matures, the TMS tool can be evaluated and future enhancements identified. Likewise, as more users gain experience in using the application and new types of information such as CMS performance measures, their feedback will provide direction for future development.

In the meantime, work will continue on cleaning up and filling out data sets, implementing the road referencing system (PR numbers) and expanding data sets to include all federal aid routes in the State. Generalized default factors for local areas, such as auto occupancy rates, will be refined as new data becomes available.

Evaluation of the Development Effort

Management vision of what the TMS and CMS could be was without question ambitious. Visioning workshops set the pace and expectations for an aggressive development effort that would change the way business is conducted at MDOT. The potential to reach that vision remains, but even after more than 3 years of design and development work, there are more milestones to pass. With continuing changes in technology and in the organization and business processes at MDOT, the horizon at which we are aiming continues to recede even as major strides are made toward reaching that vision.

The CMS vision included providing information support for diverse functions from detailed alternative analysis to assembling the annual program to surveying statewide trends in congestion for presentation to the State Legislature. We now realize that this scope was too broad to accomplish, considering available resources and the lack of actual experience with the reengineered business process. The currently available CMS functions support basic information needs of a few user groups. Enhancements will be designed and developed as users gain experience in using the system within the framework of the new business processes.

Data availability, reliability and compatibility problems continue to surface and are resolved as they arise. Since the TMS database does not replace all of the isolated legacy databases, there is still work to be done replacing or building interfaces between other systems and the TMS. Until the data base and these interfaces mature, data extraction, conversion and loading processes will continue to feed the TMS and consume more staff resources than originally anticipated.

Hardware and software (operating system) requirements of the TMS continue to grow as the system becomes more complex. Currently, the roll-out pace is dependent upon the client's ability to convert to a Windows NT operating system, running on a PC with at least a Pentium 90 processor with a minimum of 32 megabytes of RAM and 1 gigabyte of disk space. The CMS is currently available to 15 core users and an additional 30 general CMS users. The CMS subsystem is also available to users of the other 5 subsystems. Forty to fifty transit agencies have access to CMS through their PTMS connection.

The vision for the TMS (and the success of any system-wide integrated database) is predicated on having a common road referencing system in place with all legacy files converted to this common

system. This project chose to use the Michigan Accident Location Index (MALI) road referencing system developed in the early 1970s, adapting and expanding it to meet the requirements for this application while supporting the continued use of the scheme by the Michigan State Police and local enforcement agencies for accident reporting. That effort has progressed more slowly and required more resources than anticipated, but is now being adapted for inter-agency use through a statewide Framework Project.

The vision for the system was also predicated on having true GIS functionality included. At the start of the TMS development effort, GIS products that could operate in the three-tiered object-oriented environment of the TMS were not commercially available. This development lag had significant impact on our ability to realize our vision for the TMS. The TMS release scheduled for late May- June 1997 will include mapping capabilities for displaying system information.

Despite these stumbling blocks, what has been accomplished within 2½ years of development is remarkable. From the CMS perspective, socio-economic and traffic forecasts are readily available to a much broader group of users. Likewise, historical trends in VMT, Commercial VMT, vehicle hours of travel and person miles of travel are readily available, with graphs of these trends available with a few mouse clicks. A range of performance measures are available for identifying deficient locations. At a higher level, system performance indicators for the National Highway System, the Priority Commercial Network, various roadway types and most National Functional Classes enable users to view the extent of congestion in Michigan from many perspectives. Preliminary cost estimates can be applied to proposed solutions to congestion problems. Impacts of proposed solutions can be compared within a comprehensive performance measure framework that is aligned with State Long Range Plan goals and objectives.

Additional information about Michigan's TMS and the Congestion Management System is available from:

Susan Gorski
CMS Specialist
gorskis@mdot.state.mi.us

Michigan Department of Transportation
Bureau of Transportation Planning
PO Box 30050, Lansing Michigan 48909

Ron Vibbert
TMS Project Manager
vibbertr@mdot.state.mi.us