The Balance of Decision Support: MDOT's Intermodal Management System

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Abstract

Prior to passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the Michigan Department of Transportation (MDOT) dealt with intermodal decision making using mode specific tools defined by appropriate federal or state agencies. ISTEA mandates, now recommendations, provided the impetus to find a means by which these varied methods could be, if not standardized, made common enough to allow comparison of the needs of one mode with those of another. The Intermodal Management System (IMS) allows planners and managers to balance issues required to efficiently make effective decisions leading to seamless connections for nonmotorized, rail, road and waterborne people and goods.

The first balance struck is between modal systems. MDOT divides its network of connecting segments into nonmotorized, rail, road and water systems. Due to mileage, highways receive much of the attention. However, each system allows users to establish and store routes/corridors for analysis. Each is also able to geographically display results of an analysis. When integration is complete in February, 1998, users will be able to establish routes across modes; effectively making the transportation system an homogenous unit.

The points at which people and goods are exchanged between systems, or between different parts of a system, are facilities. These include airports, border crossings, carpool parking lots, intercity bus and rail stations, pipeline terminals, ports, container/trailer terminals, rail freight stations and weigh stations. The balance here gives each equal treatment in the management of physical inventory, usage, trend and image data. Also, any user has access to the supplemental comment function; a free form text utility which is MDOT's corporate conscience.

The proper balance does not always mean a decision near the middle of the spectrum. Highway decisions made without knowledge of nonhighway alternatives may be less than optimal. Thus for IMS, the proper balance in data accessibility is for all personnel to have access to all data. The common bond is location, and all facilities and systems can be balanced with each other based on this link.

Another balance not made by splitting the difference was that of scheduled passenger services. Though MDOT does not track freight service provision, the supply of intercity air, bus, marine and rail passenger services are tracked and compared across modes through IMS. Where appropriate, information on subsidy/guarantee, equipment loans and ridership can be managed and displayed.

The balance most important to IMS is between support for strategic and tactical decisions. The ability to assess a project's ability to meet long term goals, is balanced against the day to day tasks of personnel who manage such projects. To assure user acceptance of the tool as the means of performing their tasks, an easy to use interface, which structures and eases many of the time consuming data management functions, is provided by IMS. Now structured modal specialists, with no additional work on their part, also provide data necessary to answering strategic questions. This is done through performance measures; indicators of facility performance compared against standards or benchmarks.

Using actual output from the system, this paper will discuss balances struck in the development, user acceptance and operation of IMS. It will include discussion of the impacts of database design, common interfaces, data accessibility, training, performance measures and geographic indexing on the ability of personnel to use the tool in their tactical decision making, while still assuring that managers have the ability to take a step back from such decisions to make strategic assessments.

Prior to passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the Michigan Department of Transportation (MDOT) used mode specific tools defined by appropriate federal or state agencies to support intermodal decision making. ISTEA mandates, later relegated to recommendations, provided the impetus to find a means by which these varied methods could be, if not standardized, made common enough to allow comparison of the needs of one mode with those of another. The Intermodal Management System (IMS) was developed to allow planners, engineers, analysts and managers to balance issues required to efficiently make effective decisions, leading to seamless connections for nonmotorized, rail, road and waterborne people and goods.

MDOT assigned a very high priority to development of the Transportation Management System (TMS), of which IMS is a part. And though the state placed a very strong emphasis on automation of processes, this was not the main or only purpose of the effort. Early in the development process, it became apparent that issues of database design, data accessibility, commonality, training and user acceptance, performance measures and geographic indexing had to be addressed in more than a cursory manner. Perhaps most traumatic for MDOT, even the way we made modal decisions had to be questioned.

Automation & Integrated Decisions

When Congress passed the ISTEA legislation, it was made clear that each state was to improve or develop their planning process to integrate all aspects of transportation planning. Unfortunately, the very breadth of the issues requiring integration, was partially responsible for segregation. Bridge, congestion, intermodal, pavement, public transit and safety issues are generally handled by specialists in each field. And these people rarely have the time to consider the perspective of people in other disciplines, let alone the fiscal ramifications of their actions.

Politics aside, this segregation is more often because each group lacks *quick* access to the *frame of reference* in which the others work. This occurs despite the fact that each cell of workers is using essentially the same means of arriving at a decision (i.e., Set goal, collect data, analyze data, produce solution, check results against goal). Most organizational or paper based schemes can provide the means to integrate the various *frames of reference*. However, only an automated structure can provide the *quick* response required to make integration truly feasible. For this reason, MDOT developed an *automated* TMS.

However, an automated TMS does <u>not</u> assure integrated decision making. TMS is a *toolbox*, with several *tools* used to *support* integrated decision making. IMS is but one of these tools, each of which provides all transportation professionals with the timely ability to view their work from the perspective of others. This distinction between the planning process and the support provided by the automated functions, or tools, is important. To reinforce this difference in the minds of users, the department's bimonthly TMS newsletter is even referred to as *TMS Toolbox*.

Balance vs. Compromise

A *compromise* is defined as, "A settlement of differences in which each side makes concessions or a concession to something that is detrimental or pejorative."[1] Under this definition, one side of an issue is sacrificed to benefit the other, or a negative impact to one side of an issue accrues in obtaining the accepted result. Given the nature of modal planning, which may include comparisons of publicly and privately owned infrastructure, this means of resolving development issues was not considered acceptable.

Alternatively, a *balance* is defined as, "An harmonious or satisfying arrangement or proportion of parts or elements."[2] This is the way in which MDOT met the development challenge of IMS. In striking *balances* between various issues, one aspect of an issue was optimized to the point at which any further improvement would create a negative feature in other aspects. In this way, the department avoided creating situations in which some aspect of an issue was sacrificed to benefit another. This, in turn, led to the combining of the best facets of the various modal methods into a consistent and usable management system.

Given MDOT's organization of personnel, which utilizes experienced specialists for each mode of transportation, it must be admitted that this did not always work smoothly. It is not uncommon for people to resist change. However, our experience was that when a balance proved difficult to achieve, the process tended to force scrutiny of the perceived negative aspect. Often, those most resistant to change found a superior way of doing what was under consideration. And since in many cases that way was to make it easier, or not to do it at all, balance was achieved with a minimum of friction.

System Integration: Full vs. None

In an intermodal decision support tool, the first *balance* required was that between modal systems. Systems are the transportation connections by which people and/or goods are moved between points. For purposes of administration, MDOT divides its overall transportation network into nonmotorized, rail, road and water (marine ferry) systems. Each of these networks is defined as a set of distinct segments. Analyses are performed on *routes*; user defined groups of segments selected to connect two pertinent points.

Due to the preponderance of mileage, highways received much of MDOT's attention. In fact, the Bridge, Pavement and Safety portions of the department's TMS are tools devoted almost exclusively to decision support required to maintain the state's roadways. Additionally, the Congestion part of TMS is concerned with the mobility of Michigan's citizens, visitors and commercial interests over the highway system. However, to support analysis of movements of passengers and goods, IMS was designed to manage the assets that constitute the nonmotorized, rail and waterway systems.

In this regard, IMS balanced the unique natures of each mode against the desire and need to treat our transportation network as an integrated whole. The result was the adaptation of the same linear reference model used for our highway system, to the other systems. This model is a commonly used method in which each piece of the network is assigned a unique identifier. At MDOT this is known as a *Physical Reference* (PR) number. The segment is further described by a beginning and ending milepoint. Thus any data attribute can be ascribed to a segment by denoting the PR number and milepoint (for point specific data), or beginning and ending milepoints (for data over a length). The example of the number of mainline tracks maintained by Canadian National Railways in Clinton, Eaton and Ingham Counties (commonly called the Tri-County area) is shown in Exhibit 1.

Each data attribute is stored in a separate table of the database. Thus, as shown in Exhibit 2, the data for freight train frequency is stored in a table separate from that for number of tracks.Only when the user defines a route for study, and selects the data attributes required for analysis, does the application select those elements and construct a unique study segment through a process known as *Dynamic Segmentation*.

For example, the previously mentioned Tri-County area is served by the Chicago Subdivision of Canadian National Railways. In the study area, this line is designated *PR* segment 7308900. To analyze rail issues related to the number of mainline tracks and the frequency of freight train movements, TMS/IMS creates the study segment shown in Exhibit 3.

Within this study segment (sometimes referred to as a detail or break report), the Lansing/East Lansing Amtrak Station (a point) is located at milepoint 223.900 on PR number 7308900. From the information shown, we know that at this station, the line is double tracked and handles approximately 28 trains per day. Similar analysis can be performed over any length or at any point of the route.

The application allows users of each modal system to establish and store routes/corridors for analysis. Each will also be able to graphically display results of an analysis. However, MDOT was forced to balance the ability to fully integrate across all modes, with the ability to develop and release our tools in a timely manner. For though the rail referencing system is complete (though not fully supported by data) and the waterway system requires little data of its own, the road system currently includes only National Highway System (NHS) and state trunkline routes, and the nonmotorized system is being constructed as projects are undertaken. Thus, the balance achieved was to fully utilize the highway reference example, but *temporarily* maintain the modes separately. When referencing of the roadway system is complete (February, 1998), full integration of the separate modal networks will begin. For planning and decision making purposes, this will effectively make the transportation system an homogenous unit.

The impact of this balance of various

Exhibit 1: Number of mainline tracks on Canadian National rail lines in the Tri-County area

PR Nbr.	Beg. MP	End MP	Subdivision	Nbr. of Tracks
7308900	188.451	214.800	CN-Chicago	2
7308900	214.800	221.500	CN-Chicago	1
7308900	221.500	232.699	CN-Chicago	2

Exhibit 2: Freight train frequency on Canadian National rail lines in the Tri-County area

PR Nbr.	Beg. MP	End MP	Subdivision	Frgt. Freq.
7308900	188.451	201.995	CN-Chicago	30
7308900	201.995	202.140	CN-Chicago	24
7308900	202.140	202.385	CN-Chicago	30
7308900	202.385	202.975	CN-Chicago	24
7308900	202.975	217.880	CN-Chicago	30
7308900	217.880	225.220	CN-Chicago	28
7308900	225.220	228.260	CN-Chicago	24
7308900	228.260	232.699	CN-Chicago	28

Exhibit 3: Dynamic segmentation of Canadian National rail lines in the Tri-County area

PR Nbr.	Beg. MP	End MP	Subdivision	Nbr. Tracks	Frgt. Freq.
7308900	188.451	201.995	CN-Chicago	2	30
7308900	201.995	202.140	CN-Chicago	2	24
7308900	202.140	202.385	CN-Chicago	2	30
7308900	202.385	202.975	CN-Chicago	2	24
7308900	202.975	214.880	CN-Chicago	2	30
7308900	214.880	217.880	CN-Chicago	1	30
7308900	217.880	221.500	CN-Chicago	1	28
7308900	221.500	225.220	CN-Chicago	2	28
7308900	225.220	228.260	CN-Chicago	2	24
7308900	228.260	232.699	CN-Chicago	2	28

issues was generally positive:

Database Design: This type of linear reference model is perfectly suited to the construction of a fully normalized, relational database. As each data attribute can be stored in a separate table, updates to one attribute do not require resegmentation of the entire database. Also, the addition of attributes at a later date can be done with minimal or no disruption to existing elements.

Data Accessibility: Data security can be part of the database, as well as any application interface. This allows the database to be used by any user on a read only basis, even if they lack access via TMS. In turn, this allows MDOT to leverage the cost of data gathering for management tools across other applications.

Training: Relational databases are often difficult for novice users to understand. However, by leveraging data collection over the entire organization, the need to train large numbers of personnel in its use can be mitigated by designing custom applications for commonly performed functions.

Commonality: The use of the commonly accepted linear reference methodology will ease the transition from separate modal systems to a comprehensive, multimodal transportation network.

Geographic Indexing: Similarly, the shift from a linear reference method of system inventory to a map coordinate based method will be relatively simple. Efforts with other departments of Michigan government are underway to assure that as many different types of geographically referenceable data as possible are being commonly indexed. This will allow the state to leverage the costs of the next, logical steps across large numbers of functions.

Performance Measures: Each mode exists to serve a different part of the transportation market. Thus, a comparison of the speed of a truck on the highway network to the ability to move large tonnages by rail currently has little or no meaning. However, consistently managed data may eventually allow modal network comparisons of *customer* utility.

Tactical Decision Making: All data collected on each modal system (except that which the department is legally prohibited from disseminating), is available to any user who requires access. Assuring all users timely access to data which may impact their workflow, minimizes the possibility of decisions being made without due consideration of all factors, regardless of mode.

Strategic Assessments: Management of data on all modal systems in a consistent manner will allow easier comparisons of benefits and costs across all modes. With eventual full integration, decisions on policy and spending could be made irrespective of mode.

Facilities: Inclusive vs. Exclusive

The points at which people and goods are exchanged between systems, or between different parts of a system, are facilities. In Michigan, these include airports, border crossings, carpool parking lots, intercity bus and rail stations (henceforth referred to as intermodal passenger facilities), pipeline terminals, ports, container/trailer terminals, rail freight stations and weigh stations.

In this instance, a decision as to what facilities would be monitored by IMS was required. One choice was an exclusive model; in which facilities would be included only if they meet a predetermined standard of mode, data access, activity level, importance to the jurisdiction served and/or governmental ability to influence. The alternative was an inclusive model; in which all facilities were included, regardless of how they fit into the transportation system. The balances struck proved fairly simple.

With regards to mode, all of the aforementioned types of facilities were included. Originally, this was due to ISTEA mandates. However, even when these requirements were removed, the functions of the department made it clear that failure to include any of these components would be detrimental to the overall decision making process.

In terms of activity levels and importance to jurisdictions served, it was not deemed feasible or appropriate for MDOT to set a threshold level for inclusion in a management tool which would be shared with other governmental agencies. Also, to assure inclusion of all facilities that met such strictures, it was determined that all facilities would need to be monitored anyway.

Thus, the balance the department wanted to achieve was the inclusion of *all* facilities. However, the ability of the government to influence, or even gain access to data about certain facilities, did result in an inability to include some facilities in the inventory. Due to their negligible impact on other modes, or the communities they served, privately owned and used airports (i.e.: not open to the public), were not included.

A second balance struck on this issue was the level of information to be kept about each facility. The *balance* here requires a certain minimum level of physical inventory and modal access data from each facility. IMS then incorporated mode specific functions which reflected the levels of physical inventory, usage, trend and image data already monitored by the department. Thus, the impact of this decision was minimal to most facility types. Those facilities which were required or had chosen to maintain more detailed data, such as airports, continued to do so. Those modes for which minimal data was available, such as pipeline terminals, met the established minimums and went no further. In short, IMS reflected organizational functions. It did not impose an inappropriate or unattainable standard of data maintenance.

One function which IMS does provide for all modal facilities, and which all authorized users can access, is *Supplemental Comment*. This is a free form text utility which links and organizes non-quantifiable data to the facility to which it is related. Any user can use the utility to store everything from quick notes to summaries of completed reports.

Several facility types have chosen to use supplemental comment for more structured purposes. Planners working with the state's carpool parking lots use the function to store citizen survey comments from periodic polls. Planners dealing with airports use it to store explanations of Federal Aviation Administration and MDOT classification schemes, as well as data collection methodologies. Regardless, as this function is used, it will become the transportation memory for the state and our partners in planning and development.

The degree of commonality and improved access to the data provide one immediate benefit to planners, engineers and analysts; the ability to say *no*. Often, governmental agencies receive requests for infrastructure, or studies leading to projects that are not in their interest to pursue. Until now, even a cursory analysis to determine the feasibility of continued study was, in and of itself, a time consuming study. Much of this time was spent gathering data to document why the project was not worthwhile.

With TMS/IMS, modal data can be quickly integrated, analyzed and presented to the party making the request. If the project makes sense, it can be passed on for further work. If the project is marginal, the requesting agency has an idea of what is necessary for resubmission. If the project is not worthwhile, MDOT or our governmental partners can give a definitive, well documented negative answer.

This capability is in keeping with MDOT's desire to empower the lowest appropriate level of management with decision making authority. By documenting their decision with readily available data, the professional eliminates one source of citizen/customer complaint; the lack of a timely and definitive answer.

The impact of this balance of various issues was generally positive:

Database Design: The database reflects the department's current and expected needs. Those modes required to maintain more detailed data, continue to do so. Thus, the database design and subsequent data loading, can reflect relationships already understood by modal specialists, if not by most users.

Commonality: When accessing information on facilities, the user is no longer required to search for airports in one application, and ports in another. Now they search for *Intermodal Facilities* and receive data on all pertinent sites, regardless of mode. While IMS allows an analysis to treat all facilities as common entities, the application does not lose the unique nature of individual modes.

Data Accessibility: Meeting the established minimum level of physical inventory and modal access data assures that transportation professionals are able to ascertain what facilities might be impacted by their work.

Training: It is hoped that supplemental comment will help to minimize the impacts that changes of personnel have upon programs with small staffs.

Performance Measures: The ability to treat all intermodal facilities in a similar manner allows augmentation of mode specific performance measures with development of measure common to all facility types. By developing common, access related measures, the effectiveness of projects on the transportation system as a whole can be considered without regard to the mode involved.

Geographic Indexing: By tagging all intermodal facilities with their location, analyses on corridors and other geographic areas can include all transportation assets with little or no additional effort.

Tactical Decision Making: The ability to quickly access, display and forward basic information on transportation infrastructure is a benefit to modal specialists. It is unknown if the ability of all users to access this same information will increase or decrease the workload of specialists. If users find the data adequately answers their query, a decrease should occur. If it does not, or users did not previously understand the importance of intermodal facilities, a temporary increase in questions caused by a sort of *learning curve* will occur. Either way, an overall improvement in the quality of tactical decisions should occur.

Strategic Assessments: The ability to provide information in a format that allows quick overview by programming/funding and policy personnel will improve not only the speed of strategic decision making but, as all modal issues are now easily blended, the quality of those decisions. In addition, the ability to prevent less consequential decisions from being elevated to higher levels of authority, allows management to concentrate on cohesive programming and policy decisions, not on minutia.

Services: Necessity vs. Extra

Another *balance* struck was in the area of *services*. Services are scheduled or regular intercity movements of people and/or goods, along a system, between facilities and/or their points of origin. In some instances, MDOT was also responsible for information on subsidy/guarantee, equipment loans and ridership. Once again, the choice was whether to include or exclude the management and display of various service information.

Analysis of benefits to be derived from direct tracking of freight services indicated that, even if possible, the cost would be prohibitively high. Conversely, the periodic tracking of scheduled passenger services could be performed with readily available, inexpensive to maintain data. Thus, MDOT struck a balance by not directly tracking provision of freight services. However, the supply of scheduled intercity air, bus, marine and rail passenger services are tracked and compared across modes through IMS.

The inclusion of services in IMS was the result of history and need. Historically, MDOT has maintained data on both the demand for intercity passenger services (dis/embarking passengers) and the supply provided by serving carriers (arrivals/departures). This was needed to justify state expenditures on air carrier airport development, air service guarantees, intercity bus subsidies/ equipment loans, and *Section 403b* state subsidized intercity rail services. However, the decisions made based on this data were specific to the individual mode of transportation.

To promote provision of seamlessly integrated intercity passenger services required a change in thinking. The balance struck was to change our focus from *what cities can a mode serve*, to *which service(s) provide the best customer service or utility to a community*? MDOT's tracking of services provided gave the necessary method of comparing services across modes: *weekly arrivals/ departures*[3]. Eventually, comparing this to passenger demand experienced at various levels of supply in demographically defined areas (peer groups), will allow utility thresholds to be established.

With properly developed utility measures in place, MDOT can work with providers of scheduled passenger services to achieve a service provision balance that meets the needs of a community on a cost effective basis. Where that service balance cannot be achieved, the documentation of why service support is not feasible can be used to prevent expenditure of funds due to political pressure.

The impact of this balance of various issues was generally positive:

<u>Database Design</u>: While the use of periodic sample data from published sources does not allow direct measurement of certain aspects of service provision, it does allow analysis of trends and establishment of utility measures in demographic peer groups at a reasonable cost. More importantly, this can be done across modes and without the problems inherent in asking deregulated, private sector companies to submit data they may consider proprietary.

<u>Commonality</u>: The use of the weekly arrivals/ departures measure allows service comparisons across modes.

Data Accessibility: As the data is not proprietary in nature, private sector service providers can/will not block dissemination to TMS users. Additionally, weekly arrivals/departures are fairly logical and well understood measures of importance amongst transportation professionals and public officials.

Performance Measures: It is not in the state's interest to attempt to *enforce* a level of service on private sector carriers. However, the use of service utility measures to justify state support of air, bus or rail services in a community makes sense and could help remove this decision from the political arena.

Geographic Indexing: The location of services along the proper segments allows analysis of services to communities using all data in TMS/IMS. No additional work is necessary from transportation professionals.

Tactical Decision Making: The ability to quickly access, display and forward basic information on transportation services is a benefit to modal specialists and other users. However, most decisions regarding services are strategic in nature.

Strategic Assessments: Prior to IMS, development and management of a balanced air/bus/rail passenger strategy has been difficult. The drawing together of data and standardization of comparative measures will allow a shift in thinking from where is the service, to where should we have service. Expenditures of state funds to support services by federal (Amtrak) or private entities (airlines, bus lines) need to serve the greatest numbers of people possible for each dollar, while supporting Michigan's goals of assuring its residents, visitors and commercial interests have appropriate choices in intercity passenger transportation.

Data Access: No One vs. Everyone

As seen in the preceding sections, the proper *balance* does not always mean a decision near the middle of the spectrum. Nowhere is this more true than in the issue of data access. Highway decisions made without knowledge of nonhighway issues or alternatives will almost certainly be less than optimal. And as we are aiming for optimal *transportation* solutions, the proper balance of data accessibility is for *all* personnel to have access to *all* data.

Of course, there are restrictions to what *all* data encompasses. Aside from MDOT's short term inability to integrate data from every legacy application into TMS, what is accessible through our tool is limited by existing legal restrictions related to privacy and/or collection of proprietary information. To allow access to data under existing legal restrictions, it is aggregated in a way which does not allow a user to see privileged information, yet still allows its use in planning and decision making. In the example of air carrier activity statistics, the reports of the individual airlines are amalgamated to the airport level prior to display in IMS. In the case of legacy applications, some data access is provided through use of *Object Link Embedding* (OLE).

To prevent data overload, a user requires a commonly understood relationship of information to know which data to access. The simplest of these, and the one chosen by TMS, is location. All facilities and systems (and eventually services), can be *balanced* with each other based on this link. Currently, this link is based on the PR numbers and milepoints used to define our modal networks. In the future, this will probably move to a simpler *latitude/longitude* coordinate model. Either way, the decision maker can now access any or all data, regardless of mode, for a specified study area.

The impact of this balance of various issues was generally positive:

Database Design: Minimizing restrictions in data access minimizes the security chores of database managers and programmer/developers. In addition, it allows unrestricted use of the supporting database, even if the user does not have access through the TMS/IMS interface.

Commonality: A TMS user who accesses IMS most often and is familiar with the way in which the data is used, will find the same patterns in data managed in other areas of responsibility.

Data Accessibility: Users access is restricted only by existing legal constraints.

Training: Users need only learn one part of TMS to understand the way in which data is accessed in all parts of the application.

Performance Measures: Not only is data readily available to all users, the measures used to justify projects and measure success are also documented and available for reference or use.

Tactical Decision Making: Planners, engineers and analysts have access to the same data as their managers.

Strategic Assessments: Without additional burdens on planners, engineers and analysts, managers have access to all of the data, not just that for which they are responsible.

Interface: Common vs. Specialized

The way in which the ISTEA legislation was written led many transportation professionals, including many at MDOT, to believe that individual applications relating to Bridge, Congestion, Intermodal, Pavement, Public Transit and Safety should be developed independent of each other. In Michigan, the state/metropolitan planning agency planning processes were already so integrated that six separate applications would not have effectively supported what existed, let alone the improvements ISTEA envisioned. As such, separate development was never seriously considered.

For similar reasons of decision support, MDOT also chose to develop a common interface for all six sections of an integrated TMS. This was deemed necessary in order to maximize the ability of all users to access pertinent information.

It should be noted that a *common* interface is not the same as an *identical* interface. In MDOT's common TMS interface, elements of any given display function the same in IMS, or any of the other five parts of the application. Standard features such as pull down menus, text fields and indicator boxes operate in a manner which most *Windows* computer users consider *normal*. In addition, tabular displays and organizational tools operate the same across all sections of TMS. However, as the data shown in IMS will be different from that displayed in other parts of the tool, the actual screen displays will also differ. Nonetheless, the behavior of elements in each part of the overall application are the same.

The impact of this balance of various issues was generally positive:

Database Design: The design of the user interface should never drive the design of the relational database it accesses. That type of *applicational* database design limits future flexibility.

Commonality: A user trained to use IMS will have little difficulty operating another part of TMS. The MDOT training regime starts with basic navigation which teaches the concept of using common parts of the interface. This saves time in teaching the six parts of the overall TMS.

Training: A user trained to use IMS will have little difficulty operating another part of TMS.

Tactical/Strategic Assessments: Users familiar with analytical tools used to support tactical or strategic decisions, can easily use those designed to support the other type of decision.

Decisions: Strategic vs. Tactical

The *balance* most important to IMS is between support for strategic and tactical decisions. The ability to assess a how a project meets long term goals, is *balanced* against the day to day tasks of personnel who manage such projects. As the data necessary for decision making at any level consists of the same basic variables, the balance struck by TMS/IMS was to standardize basic analytical tools required to turn raw data into information usable at all levels of the organization. This allows MDOT to meet both the needs of management and their subordinates.

However, to assure this would work, IMS needed to assure user acceptance of the tool as the means of performing their tasks. To do this, an easy to use interface was developed which structures and eases many time consuming data management functions. Using these interfaces, modal specialists enter the data only once. IMS then places it in the appropriate areas of the relational database, ready for use by standard analytical tools.

Those analytical tools can range from the simplest data display to complicated analyses of facility access. However, the key is that, with no additional work on their part, the person responsible for the provision and quality of necessary data, has made their work available in an appropriate format to all levels of MDOT, as well as to its federal and local partners.

At the tactical end of the spectrum, IMS is used to answer the most commonly asked questions received by planners, engineers and analysts. These include those related to the physical inventory and usage of Michigan's intermodal facilities. Users can access current and historical data on all modes, filter out what is not pertinent to their request/analysis, and display the results in tabular or graphic form. Most data can also be exported to various specialty software packages for further analysis. To give a context to the information they are seeing, users also have access to any maps, sketches, photographs (known collectively as *Images*) or notes and comments (*Supplemental Comment*) linked to the facility by modal specialists.

As any user can access this information, in the long run the time savings this will create for modal specialists will probably never be fully measurable. However, as IMS is used by greater numbers of people, there may be a period of time during which users have questions on what they are accessing. As such, during this learning curve, additional efforts may be required.

Planners, engineers and analysts also use IMS to ascertain deficiencies and define needs. The analytical tools used are performance measures. It is important to discern the distinction between performance *measures* and *indicators*. Both measure the same aspect of the transportation infrastructure. However, indicators lack standards against which effectiveness can be judged. It is these identifiable and measurable levels of achievement, surveyed over time, that allow IMS users to evaluate deficiencies in the flows of people and goods.

IMS performance measures are currently far from being absolute rules. Until such time as modal systems plans and experience allow federal, state and local organizations to jointly establish appropriate standards, they are used as planning aids. An IMS defined deficiency is not a reason to dispatch a construction crew. It is a reminder to the planners, engineers and analysts to look more closely at what might be a problem. Conversely, it is understood that transportation professionals will need to identify deficiencies not caught by the application. Even when standards are established for IMS performance measures, they will not be static values. Instead, they will reflect the best current assessment of deficiency in *general* situations.

Solutions to these deficiencies are documented by planners, engineers and analysts in a standard tool known as the *Transportation Analysis Notebook* (TAN). The TAN is the link between the project oriented tactical work of transportation professionals, and the program/budget work of department management. From the documentation provided by a TAN, managers and budget personnel are able to *package* various individual projects into logical groupings for the letting of bids. More importantly, MDOT personnel are able to do this regardless of mode or funding source.

This does not mean the abolition of discrete monies for specific modes (though that could eventually happen). It does, however, mean that overhead costs associated with construction and maintenance of transportation systems and facilities, can be leveraged over a wider retirement of needs. This will result in more high quality infrastructure for the dollar. And after a period of reshaping the traditional single-mode thinking of management, this should also lead to planning for smoother connections between modes.

The same performance measures that allow planners, engineers and analysts to identify deficiencies, allow management (and any other user so inclined) to quantify the effectiveness of chosen strategies in meeting those defined needs. Traditionally this required additional staff time to reanalyze, or at least reformat, the required data. By agreeing to standards of performance, IMS is able to provide the necessary analysis, in the required format for all levels of user. Still, there is no additional workload placed upon staff.

The impact of this balance of various issues was generally positive:

<u>Database Design</u>: Defined relationships must take into account the processes by which decisions are made. However, these relationships must reflect, not define the organization.

<u>Commonality</u>: Commonality between the tools used by planner, engineers and analysts to define needs, and those used by managers to assess priorities and define groups of projects need not be the same. A common interface has benefits in the training of personnel for advancement, or allows easier checking of a subordinate’s work.

<u>Data Accessibility</u>: All levels of the organization access the same data. Only the application developed to turn that data into useful information needs to change.

<u>Performance Measures</u>: The use of similar and/or identical performance measures to define needs and assess success in meeting those needs has several advantages. These include fewer points of required agreement amongst agencies and overall acceptance of goals by the whole organization.

<u>Tactical/Strategic Decision Making</u>: In TMS/ IMS, the only difference between these types of decisions is the developed analytical tool. As many of these will be the same, much of the cost of

this effort can be leveraged over multiple functions. However, the data remains the same.

Technical Support: Full vs. None

There was a time when federal requirements for an automated TMS were dropped, that MDOT considered returning to a less integrated, computer based scheme. The political climate of down-sizing in the state aside, MDOT and our governmental partners chose to improve the quality of decision making by integrating as much information as possible. This required much improved access by those responsible for the planning process. And that, in turn, required us to continue development of an automated TMS/IMS.

As such, MDOT found that in the area of technical support, only one possible balance can be struck: Technical support must receive the highest possible management commitment if an automated and integrated TMS/IMS is to work. This does not only mean the purchase of the computers and communications equipment required to run the applications. That is the easiest part. It also includes the trained personnel required to support the hard/software needed to keep users from being idled, and the training necessary to allow them to use the application to its fullest potential.

Conclusions

The process of developing MDOT's automated TMS application was a difficult balancing act. In particular, the balancing of intermodal issues to produce a cohesive intermodal decision support tool posed many problems not previously addressed by the department. Nonetheless, without introducing negative changes into any one mode, MDOT was able to produce an IMS which allows all users full access to data on modal facilities, systems and services which affect their work. This was achieved by striking a balances in each of the following areas:

<u>Systems</u>: The optimal solution, and that which MDOT hopes to implement in 1998, is to fully integrate the nonmotorized, rail, road and waterway networks under a single linear reference model. However, the department was forced to balance the desire to fully integrate across all modes, with the ability to develop and release our tools in a timely manner. The balance achieved was to fully utilize the highway reference example, but *temporarily* maintain the modes separately. When referencing of the roadway system is complete (February, 1998), full integration of the separate modal networks will begin. For planning and decision making purposes, this will effectively make the transportation system an homogenous unit.

<u>Facilities</u>: Even without ISTEA requirements, Michigan chose to include airports, border crossings, carpool parking lots, intermodal passenger facilities, pipeline terminals, ports, container/trailer terminals, rail freight stations and weigh stations in the IMS. The functions of the department made it clear that failure to include any of these components would be detrimental to the overall decision making process. As it was not deemed feasible or appropriate for MDOT alone to set a threshold level for inclusion, and as such a threshold would still require monitoring of the facility, all facilities except privately owned and used airports were included. Each facility type is required to maintain a minimum level of physical inventory and modal access data. Beyond that, each mode maintains the level of data appropriate to its needs.

<u>Services</u>: Due to the high cost of tracking the provision of freight services, MDOT struck a balance by monitoring only the supply of scheduled intercity air, bus, marine and rail passenger services. Data on passenger services was needed to justify state expenditures on guarantee, subsidy and equipment loan programs. To promote provision of seamlessly integrated intercity passenger

services required the department to change our focus from *what cities can a mode serve*, to *which service(s) provide the best customer service or utility to a community*? With properly developed utility measures in place, MDOT can work with providers of scheduled passenger services to achieve a service provision balance that meets the needs of a community on a cost effective basis. Where that service balance cannot be achieved, the documentation of why service support is not feasible can be used to prevent expenditure of funds due to political pressure.

Data Access: As we are aiming for optimal *transportation* solutions, the proper balance of data accessibility is for *all* personnel to have access to *all* data. In the long term, what is accessible through our tool is limited only by legal restrictions related to privacy and/or collection of proprietary information. To allow access to data under existing legal restrictions, it is aggregated in a way which does not allow a user to see privileged information, yet still allows its use in planning and decision making.

Interface: As TMS is intended to be an integrated decision support tool, MDOT chose to develop a common interface for all six sections of its integrated TMS. This was necessary to maximize the ability of all users to access pertinent information. Standard features, such as pull down menus, text fields and indicator boxes, operate in a manner which most *Windows* computer users consider *normal*. However, as the data shown in IMS will be different from that displayed in other parts of the tool, the actual screen displays will also differ. Nonetheless, the behavior of elements in each part of the overall application are the same.

Decisions: The *balance* most important to IMS is between support for strategic and tactical decisions. The ability to assess a how a project meets long term goals, is *balanced* against the day to day tasks of personnel who manage such projects. As the data necessary for decision making at any level consists of the same basic variables, the balance struck by TMS/IMS was to standardize basic analytical tools required to turn raw data into information usable at all levels of the organization. This allows MDOT to meet both the needs of management and their subordinates. Nonetheless, to assure this works requires: user acceptance of the tool as the means of performing their tasks, professional confidence in the person(s) responsible for the provision and quality of necessary data, flexibility in the application of performance standards, an understanding that performance measures reflect the best current assessment of deficiency in *general* situations, and the ability of management to access information required to monitor the quality of their actions with no additional workload placed upon their staff.

Technical Support: Technical support must receive the highest possible management commitment if an automated and integrated TMS/IMS is to work. This must include more than the purchase of the computers and communications equipment required to run the applications. It requires commitment to the trained personnel necessary to support the hard/software needed to keep users from being idled, and the training necessary to allow them to use the application to its fullest potential.

Notes

1. American Heritage Dictionary (The); 2nd Ed., Houghton Mifflin Company, 1976

2. Ibid.

3. In theory, a community will have an arrival for each departure. However, as only scheduled

services, not nonrevenue movements, are measured, it is possible for these numbers to differ; particularly with air service. Given the minimal number of services where this was a problem, MDOT chose to assume that arrivals and departures were always equal.

For Additional Information

If you have any questions or need additional information on the way in which MDOT has developed and/or instituted its IMS, feel free to contact:

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