Deighton Total Infrastructure Management System (dTIMS)

Introduction

dTIMS BA is a software tool that acts as a manager, integrator, and analyzer of asset information enabling the department to make more objective and consistent decisions by providing quality information and forecasts to all decision levels.

In its simplest form dTIMS BA comprises a 'database' component and an 'analysis' component. The 'database' component allows the department to input infrastructure data and analysis parameter data. The 'analysis' component determines the best preservation and improvement actions for each pavement segment based on the budgetary and technical constraints. This enables the department to create outputs such as forecasted long term impacts and a recommended construction program optimized to preserve the existing pavements and make the most progress toward system performance goals.

Currently there are two investment classes within dTIMS BA: Pavement Preservation and Freight and Personal Mobility (also referred to as Functional Capacity). Each investment class is set up individually within dTIMS BA and is analyzed separately of each other. Each investment class also has its own set of triggers, resets, deterioration rates, and treatments that are used for project recommendations. Each investment class is assigned its own budget(s) when the analyses are run. Pavement preservation focuses on pavement condition and keeping the overall network in as good a physical condition as possible with the treatments that are recommended from the analysis. The pavement preservation analysis focuses strongly on picking preservation treatments to keep the network in good condition rather than waiting and letting the network segments deteriorate to a condition of needing a much higher cost treatment like reconstruction. Freight and Personal Mobility focuses on what the system is intended to do by monitoring the operational restrictions of the roadway and removing as many of them as possible with the treatments that are recommended. Therefore, this investment class improves the services delivered by the transportation system.

dTIMS BA Data

All data used by dTIMS BA is housed in a main table. The table contains all the data used to run the analysis in dTIMS BA. Most of the NDDOT data that is imported into the table is stored in the mainframe database called RIMS. This database is external to dTIMS BA. It is within the mainframe database that the aggregating and transforming of data to segments is completed to arrive at a final file that is uploaded to dTIMS BA. Other data is imported from excel spreadsheets. The table is used for both investment classes. Every year once the pavement condition data, traffic data and construction data is updated in RIMS, the data is updated in dTIMS BA. This is usually done in early spring.

Each data item in dTIMS BA used for the analysis has its own analysis variable. Examples of an analysis variable is IRI (roughness), rut, AADT (traffic volume), distress, roadway width, etc.

Some analysis variables can have deterioration rates, meaning dTIMS BA will systematically change that analysis variable at a set rate over the analysis time period. Numerous analysis variables in dTIMS BA also have resets. This sets the value of the analysis variable to a specified condition after a treatment is performed. Resets are assigned to each treatment. The resets are used during the cost benefit analysis to help determine the benefit of each treatment.

Treatments for pavement preservation are actions an agency takes on a network element either to slow the deterioration of a road or to repair the effects of deterioration. Treatments for the freight and personal mobility investment class reduce roadway restrictions. A treatment can be defined to be time dependent or as a response to a certain set of conditions. Treatments in the pavement preservation analysis include: Major Reconstruction, Structural Improvement, Minor Rehabilitation with Sliver Grading, Minor Rehabilitation and Preventive Maintenance. Currently dTIMS BA does not include seals. Treatments in the freight and personal mobility analysis include: Major Reconstruction, 8-Lane, 6-Lane, 4-Lane, Super Two, Structural Improvement, Minor Rehabilitation with Sliver Grading, Structure Widening, and Structure Replacement. All of the non-structure treatments for freight and personal mobility can include a structure widening or replacement. dTIMS BA examines the effects of applying treatments over a period of time.

During the network analysis, dTIMS BA uses triggers to determine when to apply a treatment on a roadway segment. Triggers are analysis variables within dTIMS BA (example: IRI, rut, AADT, TAADT, roadway width, etc.). The triggers make up the decision trees. Once a trigger reaches a certain value, it is used to determine the treatment.

An expression is needed for each action performed by dTIMS BA. The actions could include selection of a treatment, deterioration of a variable and resetting a variable.

dTIMS BA projects the future values for various traffic factors in order to use realistic traffic volumes and traffic loading. In the current dTIMS BA setup the AADT is used as the weighting factor for the cost benefit analysis for completing optimization. The growth of the AADT values is facilitated by supplying expressions for the AADT analysis variable. In the expression, the traffic growth rate is used to increase the AADT value over time.

Different budgets are used by dTIMS BA. Each budget amount has a budget scenario that holds the information to assign different budget amounts to budget categories. The current dTIMS BA setup uses one budget category – Capital. This allows the budget to be applied to the entire network as the optimization determines best. The current budget scenarios are set to maximize benefits.

dTIMS BA Analysis

dTIMS BA runs a 20 year analysis on each investment class. When the analysis is run, dTIMS BA follows decision trees to generate multiple possible treatments (projects) for each segment of roadway based on budget scenarios. Once all possible treatments are selected for the specific budget scenario being analyzed, then dTIMS BA runs a cost benefit analysis on each treatment and determines the final treatment recommendation. This is referred to as optimization.

dTIMS BA calculates the cost benefit of a strategy by using the "Area Under the Curve" method. The IRI index curve is used in the current setup as the benefit indicator for pavement preservation and a restriction score is used for freight and personal mobility. The basic method is to calculate the difference in pavement condition or restriction score between doing nothing and applying a strategy. The difference is calculated as the integrated area between the IRI or restriction score curve for the strategy and the do-nothing IRI or restriction score curve.

The benefit calculation uses the AADT raised to a power to determine the effect of the traffic volume on the optimization results. The road sections with high traffic volumes are given greater priority over low traffic volume sections of the same roadway classification because these pavements serve more people.

There are three main budget scenarios used within dTIMS BA: Committed, Constrained, Unconstrained. For the committed budget, the projects listed in the 4-year Statewide Transportation Improvement Program (STIP) are committed into dTIMS BA, meaning the model must do those projects in the year they are programmed for funding in the STIP. There is no budget given to dTIMS BA in the committed years. dTIMS BA then recommends projects after the committed years using a constrained budget given to it. For the constrained budget, dTIMS BA is given a specified budget for all 20 years of the analysis. dTIMS BA recommends projects for all 20 years using the constrained budget. The constrained budget is obtained from the Distribution of Obligational Authority chart supplied by the Programming Division, based on the estimated federal funding and state match to be received, for the first 4 years of the analysis and then the budget is projected to increase by a set percentage after those years. For the unconstrained budget, dTIMS BA is allowed to spend an unlimited budget for all 20 years of the analysis. This last scenario provides a list of the optimal projects to be completed on every segment, which is the easiest treatment for an experienced system manager to identify, thus providing a continual human calibration check of the model and a method to verify the desired project-selection philosophy is being followed during the priority submission process detailed later in this document.

It is critical to note that the optimized project-level recommendations are dependent on the available funding. Therefore, predictable funding facilitates optimizing the investments. If the funding changes significantly (up or down) from the predicted levels used in the model analysis, the best mix of treatments (or projects) across the system will change.

dTIMS results are analyzed annually to see if any further calibration or edits need to be made to the analysis components. Projects selected by dTIMS BA are compared to the projects in the State Transportation Improvement Program (STIP) to see how closely the projects "match". The triggers within dTIMS BA that are used in treatment selection are periodically reviewed along with the resets for each treatment. The deterioration rate of the analysis variables are also reviewed.

dTIMS BA Results

Results from dTIMS BA are used for varies recommendations and analyses both at the segment level and the network level. Long term and short term analysis results are presented at the draft

and final State Transportation Improvement Program (STIP) meetings. An estimated dollar amount needed to keep the network condition in its current condition for each biennium is presented during these meetings. The long term results show how the network condition will decline over the next 20 years based on current projected funding. Results such as what condition the overall network will be in at the end of the STIP years based on the committed budget is compared to the constrained budget run where dTIMS BA would recommend the projects instead. The comparison between the projects in the STIP and the projects that dTIMS BA recommends for the STIP years is presented. On average the projects match 80-90% for the STIP years. The current and projected miles in good/excellent condition are presented along with the vehicle miles traveled (VMT) on good/excellent pavements. dTIMS BA also predicts the percentage of deficient miles based on IRI (Ride) and Distress (cracking, rutting, faulting, etc). The percent of unrestricted miles is presented for the freight and personal mobility analysis along with how many miles will be unrestricted after the STIP projects are completed. The future projections are also used to determine funding needs to meet specific system performance expectations, which assist in developing the NDDOT budget request.

dTIMS BA results are used by NDDOT's Programming Division for scoping reports and reviews. The dTIMS BA recommendations for a constrained and unconstrained budget is presented in scoping results to inform executive management when signing the scoping reports. On the Interstate and Interregional review, the dTIMS BA recommendations are used as a guide by the team on the reviews when making their recommendations.

A printout of dTIMS BA results are given to each district office for use as a "tool" to help set district priorities (i.e. project requests to be considered in STIP development). The full recommendations from the committed and unconstrained budget runs are given to the districts. The unconstrained is provided as a check to the district on projects that may not be recommended by dTIMS BA. If a project the district is recommending is not recommended in the committed budget run it does not necessarily mean that dTIMS BA does not think it's a reasonable project, it just may not recommend it based on the cost benefit analysis and available funding for a given year. If that is the case, then a project of some type would be recommended with the unconstrained budget. Currently, the districts use the dTIMS BA recommendations as a tool and are not required to follow the recommendations, because, as with any model, there may be information that is not available for the computer model to consider but is known to the District Engineers (e.g. a planned expansion of a large private freight generator, extensive maintenance work routinely being completed on a pavement segment, etc.).