
Final Report—State Study 191
Feasibility Study for the Redesign of
MDOT's Pavement Management System Software



applied pavement
TECHNOLOGY

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<p>16. Abstract</p> <p>In August of 2006 the Mississippi Department of Transportation (MDOT) initiated State Study No. 191, entitled "Feasibility Study for the Redesign of MDOT's Pavement Management System (PMS) Software." At the initiation of this study, the Department identified some of the deficiencies of the current tools:</p> <ul style="list-style-type: none"> • The data integration tools envisioned with the current software, Transportation Management Information System (TMIS), such as ad hoc querying and dynamic segmentation, were not developed fully. • TMIS was developed using a software program that is now outdated. As a result, the Department is limited in its ability to upgrade certain programs (such as Sybase, MGE, and GeoMedia) because upgrades to these programs render TMIS useless. • The Department is moving towards the Oracle database platform and web enablement for all applications, which are not possible with TMIS. • Processes for updating linear referencing changes in base maps are cumbersome and labor-intensive. • The pavement maintenance treatments in TMIS do not fully reflect the Department's current business processes. • The pavement management database and optimization tools are not fully integrated. <p>In order to address these deficiencies, the current research study has focused on finalizing the list of desired pavement management capabilities and evaluating the feasible software strategies in order to develop this implementation plan and associated cost estimate. In summary, this study provides a needs assessment, evaluation of software strategies, and a Request for Proposal (RFP) draft.</p>			
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Notice and Acknowledgments

This report was first written in 2008 when the feasibility study for MDOT ended. However, the software request for proposal (RFP) was not let until fall of 2010. This time delay caused some of the originally written report to require changes, notably the implementation time line, some of the information technology (IT) requirements, and the vendors' software capabilities. Also, some software requirements moved from important or desirable to mandatory. Therefore, MDOT has updated this report to reflect those changes.

The authors wish to thank all MDOT personnel who participated in the lengthy interviews during the needs assessment phase of this study.

At the time of the original study, MDOT's Executive Director was Mr. Larry ("Butch") Brown. At the time of the revision, the Executive Director was Ms. Melinda McGrath.

Introduction

In 2006, the Mississippi Department of Transportation (MDOT) initiated a research study with Applied Pavement Technology, Inc. (APTech) to develop recommendations for the redesign of its pavement management system. The current pavement management system was initially developed approximately 12 years ago. As a subsystem to the Department's Transportation Management Information System (TMIS), the pavement management data storage system became operational after a 5-year development period. In addition to the data subsystem, which stores pavement condition and construction history data and provides mapping capabilities using GeoMedia, the Pavement Analysis Package (PAP), an analysis tool, was developed to use TMIS data and traffic records for pavement rehabilitation and reconstruction project recommendations.

While MDOT has these pavement management tools, significant changes in technology and agency practices has rendered them inadequate at addressing the Department's business requirements. At the initiation of this study, the Department identified some of the deficiencies of the current tools:

- The data integration tools envisioned with TMIS, such as ad hoc querying and dynamic segmentation, were not developed fully.
- TMIS was developed using software programs that are now outdated. As a result, the Department is limited in its ability to upgrade certain programs (such as Sybase, MGE, and GeoMedia) because upgrades to these programs render TMIS useless.
- The Department is moving towards the Oracle database platform and web enablement for all applications, which are not possible with TMIS.
- Processes for updating linear referencing changes in base maps are cumbersome and labor-intensive.
- The models incorporated into PAP do not reflect the Department's current business processes.
- The pavement management database and analysis tools are not fully integrated.

In order to address these deficiencies, the current research study has focused on finalizing the list of desired pavement management capabilities and evaluating the feasible software strategies in order to develop this implementation plan and associated cost estimate. The remainder of this document provides discussion of the needed capabilities for the pavement management system, evaluation of feasible software strategies, and an implementation plan.

Pavement Management Capabilities

Based on a series of correspondence with the MDOT pavement management personnel, a list of capabilities required by the redesigned pavement management system (PMS) was created. The capabilities, or features, were classified into three groups in terms of importance: *critical*, *important*, and *desirable*.

A *critical* feature is an absolute necessity to provide MDOT with the pavement management capabilities required by the agency. Software that does not provide a designated *critical* feature is considered inadequate at meeting MDOT's needs. The *important* features are capabilities that are high on the priority list of needs but could potentially be compromised if the feature is not available or would be too costly to incorporate into the pavement management software. The *desirable* features are capabilities that MDOT hopes to have in its pavement management software. However, their decision regarding which software best matches MDOT's needs does not rest heavily on these *desirable* features. The *critical*, *important*, and *desirable* features were further divided into five categories: general, inventory, condition data, analysis, and results/outputs according to their use in the pavement management system. Summary lists of the *critical*, *important*, and *desirable* features as provided below:

Critical Features

The essential features, without which the implementation of the redesigned PMS software would not meet the required needs of MDOT, were identified as critical. They are listed below:

General Features

- Utilize the Oracle spatial platform.
- Allow MDOT personnel to have administrative privileges to update code tables.
- Provide a Graphical User Interface (GUI) for PMS personnel to update the decision trees, performance models, life-cycle cost data, user costs, and remaining service life (RSL).
- Validate the reasonableness of data entered into the pavement management database to ensure it meets certain criteria (treatment used on correct pavement type, milling depth does not exceed layer thickness, and so on).
- Enter and store data in English with capability to report in metric.
- Track the type of change and which user makes a change to information in the database.
- Take MDOT's existing GIS from TMIS and update it to work in new software. This may require the purchase of shape files for use by MDOT in new software.

Inventory

- Update linear reference system (LRS) automatically with re-alignment.
- Update data storage tables with attributes for inventory items.
- Store data and run analysis efficiently on more than 5,400 analysis sections.
- Enter rehabilitation project/construction project information that is checked versus validation coding.
- Designations for roadways such as Interstate, Intrastate, 1987 Four Lane, Vision 21 and Two-Lane. As programs are added, the department will require a field to enter this information. These designations may overlap each other.

Condition Data

- Preserve the historical condition data.

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- Use a combined index, individual distress data, IRI, fault, or rut data in the decision trees.
 - Store detailed FWD, coring, and skid test results.
 - Develop performance models and modify how indexes are calculated using stored data.
 - Provide an interface to easily import various vendor-collected pavement condition survey data and accompanying condition attributes.
 - Provide an interface or report that details how sample and distress data have changed when analysis sections are split, combined, or adjusted.

Optimization/Analysis Features

- Provide customizable decision trees used for work plan recommendations for virtually an unlimited number of treatments.
- Dynamically segment the network based upon database information for use in the analysis.
- Calculate and report RSL values for individual pavement sections and average network conditions.
- Conduct a separate analysis to identify safety needs (using rut and friction data) and correlate dollars spent to improvements in pavement condition.
- Provide a tool to facilitate grouping sections into logical projects after analysis.
- Check the budgeting cycle to see how designed components (models, unit cost, decision trees, and life-cycle cost) will behave in a real world budget cycle.
- Generate output from the optimization program to a map for reporting purposes.

Results/Outputs

- Export data and query results into multiple data formats (e.g. Excel, *.dbf, and Word).
- Provide customizable ad hoc tables and figures.
- Provide map displays of information (while GIS is being developed).
- Provide customizable queries and reports with template/bookshelf capability, such as Crystal Reports or a similar tool.

Important Features

Several features were designated as being important components of the pavement management setup that MDOT would like to see included in its PMS. However, these items were not critical. The capabilities identified as important in the redesigned PMS software are listed below.

General Features

- Provide Web-enabled features for viewing, editing, and conducting optimization.

Inventory

- Facilitate remote access (in the field) for districts to enter construction history data and perform QA/QC checks of the data on a laptop.

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- Archive deleted, rerouted, or reconstructed pavement sections and accompanying information.

Condition Data

- Add distress types to the existing rating procedure in the future.

Optimization/Analysis Features

- Split funding for the development of work plans across districts within the State.
- Trigger optimized preventive maintenance treatments.
- Optimize recommendations based on incremental benefit/cost or multiple ranking schemes.
- Force at least one project in each county or district (to balance workloads among contractors).
- Provide data to conduct a life-cycle cost analysis (LCCA) and analysis of user costs.
- Calculate Structural Number (SN) for a section, even after a treatment is recommended.
- Take traffic into consideration in treatment recommendations and optimization.

Results/Output

- View section-specific rates of deterioration compared to family rates.
- Plot PCR and individual distress data over time.
- View “dashboard” results which are customizable for each user.

Desirable Features

Some capabilities were identified as desirable, but not critical for the successful implementation of the PMS software. They are presented below:

General Features

- Interface with contractor-provided digital images via GPS and GIS information (video log).
- Track the changes that District users make to the list of optimized projects provided to them by the Pavement Management Group.

Inventory

- Store a variety of very detailed data for research studies (e.g., layer properties, etc.)
- Differentiate data stored for research activities (e.g. research project ID & data, calibration sites, and warranty projects) from network-level analysis data.
- Produce a strip diagram of the pavement cross section.
- Provide links to Maintenance Division’s AMMO, Accountability in Maintenance Management Operations, software, accident data and safety data from the Safety Management System.

Condition Data

- Provide self-calibrating performance models for each section.
- Use database to calibrate MEPDG performance models, as well as have MEPDG pavement types (conventional, deep strength, etc.).
- Use transaction log to modify collected condition data between download for survey and upload of collected survey data.

Optimization/Analysis Features

- Provide assistance developing treatment rules for PCC pavements.

As summarized in this section of the report, the features that MDOT would like to see incorporated into its pavement management software are well defined and will serve as the basis for decisions regarding feasible software strategies.

Evaluation of Feasible Software Strategies

Various options for software that would address the needed capabilities were evaluated. Two primary approaches were considered: licensing customizable software program from pavement management vendors and, alternatively, developing an agency-specific pavement management program through collaborative efforts with consultants, university faculty, or in-house personnel. The feasibility of each option was evaluated. The two aforementioned approaches are discussed in the following sections.

Licensing Customizable Pavement Management Software from Vendors

To begin the evaluation of feasible software strategies, APTECH's research team converted the list of needed features into a questionnaire that was distributed to pavement management vendors with past state pavement management implementation experience. The following vendors were initially contacted: Agile Assets, Axiom Decision Systems, Deighton, Dynatest, and Stantec, and Applied Research Associates (ARA).

System Capabilities

Each of the vendors was asked to identify those features that were currently available in their software, were expected to be added to the software in the near future, or could be added to the software for a fee. In addition, the vendors were asked to estimate the cost of the PMS software implementation. A copy of the questionnaire is provided in appendix A.

The questionnaire was used as a talking point document to direct meetings with Agile Assets, Axiom Decision Systems, Deighton, Dynatest, and Stantec during the Transportation Research Board (TRB) Annual Meeting in Washington, DC in January 2007. Immediately prior to the meetings, Dynatest withdrew from consideration since they did not feel their software could

provide the needed capabilities. In August of 2007, ARA demonstrated their software to the Mississippi DOT and completed the vendor questionnaire.

Based upon the discussions and input from the vendors it was determined in 2007 that currently 15 of the 17 critical capabilities could be provided with proprietary software from the majority of the vendors surveyed. A summary of the critical features needed for a successful implementation in the redesigned PMS software relative to each vendor is provided in table 1. It should be noted that the listing of critical features was revised and expanded since the solicitation of these responses from the vendors. Therefore, the vendors did not have a chance to respond directly to all of the critical software needs but they would have the opportunity to do so with the release of the RFP.

Those features that are not readily available were indicated by the vendors as features that can be added for a fee. Of the features that were unavailable in 2007 when this study was originally done, the Oracle Spatial platform with web-enabled features for data viewing, adding, editing and optimization was the critical feature that would require some enhancements to the half of the investigated software. Table 1 summarizes the various vendors' software capabilities in 2007 following meetings with the vendors.

Table 1. Feasibility of critical PMS features as of 2007.

Desired Features	Vendor				
	Agile Assets	Deighton	Stantec	Axiom Decision Systems	ARA
Utilizes an Oracle Spatial platform provides web-enabled features for viewing all data.	Only reads Oracle spatial data	Web enabled features being added. Oracle Spatial is available.	Can be added	Yes	Yes, some web enabled features available.
Ability to allow MS personnel to have administrative privileges to update code tables.	Yes	Yes	Yes	Yes	Yes
Optimization software that is web-enabled and uses an Oracle Spatial platform.	Only reads Oracle spatial data	Can be added	Planned for 2007	Yes	Yes
Ability to update data storage tables with attributes for inventory items.	Yes	Yes	Yes	Yes	Yes
Ability to store data and run analysis efficiently on more than 5,400 analysis sections.	Yes	Yes	Yes	Yes	Yes

Desired Features	Vendor				
	Agile Assets	Deighton	Stantec	Axiom Decision Systems	ARA
Ability to use a combined index, individual distress data, IRI, or rut data in the decision trees.	Yes	Yes	Yes	Yes	Yes
Ability to store detailed FWD, coring, and skid test results.	Yes	Yes	Yes	Yes	Yes
Ability to develop performance models and deduct curves for combined index or raw distress data within the software.	Yes	Can be added	Yes	Yes	Yes
Customizable decision trees used for work plan recommendations for either treatment categories or up to 21 treatments.	Yes	Yes	Yes	Yes	Yes
Ability to automatically cluster analysis sections into projects based upon database information.	Yes	Yes	Yes	Yes	Yes
Ability to calculate and report RSL values for pavement sections and average network conditions.	Yes	Yes	Yes	Yes	Yes
Ability to conduct a separate analysis to identify safety needs and the ability to correlate dollars spent to improved pavement conditions.	Yes	Yes	Yes	Can be added	Yes
Ability to export data and query results into multiple data formats (e.g. Excel, *.dbf, and Word).	Yes	Yes	Yes	Yes	Yes
Customizable ad hoc tables and figures.	Yes	Tables-Yes Figures-No	Yes	Planned	Yes
Map displays of information (while GIS is being developed).	Yes	No	Yes	Yes	Yes
Customizable queries and reports with template/bookshelf capability, such as Crystal Reports or a similar tool.	Yes	Yes	Yes	Yes	Yes

System Cost

Based upon the rough estimates of costs provided by the software vendors, the implementation, licensing, and maintenance costs of acquiring a new system for MDOT could range from approximately \$300,000 to \$1,000,000. The expectation is for the implementation

cost to be at the high end of this range given the list of capabilities that MDOT would like to see incorporated into the new system and the extensive nature of the data that they collect.

Feasibility of Developing New PMS Software

As a second step of evaluating feasible software strategies, the option of developing new pavement management software that would be customized to the specific needs of MDOT was assessed. Given that the majority of software capabilities desired by MDOT are captured by existing software, the option of developing new independent software is not necessary. Instead, the APTech team recommends evaluating the existing software packages for the most cost-effective package that provides all critical features and the majority of important and desirable features.

Implementation Plan

To guide the planning of the implementation process, a draft implementation plan was developed. The plan includes details regarding the project phases, deliverables and schedule, and the work to be conducted by MDOT to support the selected consultant. The proposed project structure includes four phases, each of which is subdivided into separate tasks in the following section. The timelines given in the implementation plan are estimates, and the RFP progress schedule time frames will supersede this document.

Project Phases

The four phases of the project are described below.

- **Phase I: System Design**
During this phase of the project, the consultant will evaluate the available data and develop an implementation plan that expands on the objectives and pavement management capabilities/features preferred by MDOT. The implementation plan will include, at a minimum, schedules, deliverables, and milestone events. It also provides recommendations for the initial customization of the pavement management software.
- **Phase II: System Implementation and Data and Model Testing**
During the second phase of the project, the consultant will design and populate the database and load/develop the initial models for the analysis using data provided by MDOT. Throughout this process ample time must be allowed for MDOT to examine various components of the system. Initial training for select MDOT pavement management staff is needed during this phase to prepare them for system checks.
- **Phase III: System Analysis Testing**
Using the database and models developed during phase 2, MDOT will continue to test components of the system. Upon completion of the review, the consultant will conduct an analysis at the state level to determine, at a minimum, the initial project recommendations for 2 or 3 funding levels and the projected network conditions under

these funding levels. MDOT will review the results of the analysis and based on the findings, the consultant will make revisions to the models to improve the overall results.

- Phase IV: System Documentation and Training

An important part of this project is documenting the capabilities of the new pavement management system and providing training to representatives from MDOT. During this phase, the consultant will train MDOT Executives on the capabilities of the new system, install the software on MDOT computers, train MDOT personnel on the operation of the software, and provide technical support during the first year of operation.

The specific tasks that will be conducted under each phase of the project are outlined in this section of the implementation plan. It will be the Consultant's responsibility when responding to the request for proposals (RFP) to clearly explain in the proposal how each task will be completed. Consultants will be asked to provide a detailed description of the approach that will be used to address each task, the qualifications of the individuals who will be responsible for the work, the project schedule, and the respondent's experience on similar projects. Consultants responding to the RFP will be asked to recommend adding or deleting tasks or system capabilities/features, as appropriate, to better ensure the success of the project to meet the needs of MDOT.

Phase I: System Design

Task 1: Review existing records to become familiar with existing data sources, typical maintenance and rehabilitation activities, TMIS documentation, and other information related to MDOT's pavement management practices.

Task 2: Meet with the State's staff to familiarize team members with MDOT's operating environment and pavement management needs.

Task 3: Develop an implementation plan that outlines the data currently available to support pavement management and how the data will be used in the pavement management system. Prepare documents that detail data sources, data maintenance responsibilities (for keeping the data current), and the proposed flow of data into and out of the pavement management system. The implementation plan shall address the schedules, milestone events, and deliverables for the project. If there are any perceived difficulties in the use of the existing data, the Consultant should outline the difficulties and provide recommendations for overcoming these problems. Allow MDOT 15 calendar days to review the implementation plan.

Task 4: Present the recommendations contained in the implementation plan to MDOT. Based on the feedback received during the meeting, make final adjustments to the implementation plan and submit a final version.

Phase II: System Implementation and Data and Model Testing

Task 5: Load pavement inventory and condition information into the pavement management database. Structure the pavement management database to address both the initial and

longer-term needs. Import existing data into the pavement management database, after MDOT has performed any necessary data conversions to prepare data for loading. Allow MDOT 30 calendar days to review the database to verify that the data are accurate, complete, and loaded correctly. The ability to link inventory and condition information to the GIS should also be demonstrated during this task.

Task 6: Develop and/or load the pavement management analysis models, including pavement performance models for selected condition indices, treatment rules, treatment impact rules, treatment cost models, and a construction history interface that provides checks of data (treatment type and thickness) as it is input. The Consultant will work with MDOT to create new individual condition indices and family performance models for each of the surface types detailed below:

- Flexible/Composite
 - Pavement Condition Rating (PCR)
 - Roughness Index
 - Fatigue Cracking
 - Other Cracking
 - Rutting
- Continuously Reinforced Concrete Pavement (CRCP)
 - Punchouts
 - Cracking
 - Roughness
- Jointed Reinforced Concrete Pavement (JRCP)
 - Cracking
 - Roughness
 - Faulting
 - Spalling

In addition to the creating performance models for each pavement surface type, MDOT is also considering creating separate models for each functional classification (interstate, 4-lane, and 2-lane roadways). The Consultant will also work with MDOT to create treatment rules for approximately 30 treatments. The treatment rules should consider a full range of treatments, including preventive maintenance, rehabilitation, and reconstruction options. The creation of the rules for rehabilitation and reconstruction projects will be based upon the treatment rules that are currently in place for 21 of the treatments while new rules will be created for preventive maintenance treatments. The Consultant should allow 30 calendar days for MDOT to review all the analysis models and checking of individual indexes before proceeding to Phase III. Prior to the review of the analysis models, the Consultant should provide at least 2 days of

training for the MDOT pavement management staff who will later serve as the software trainers. The training should be sufficient to provide MDOT staff with the information needed to conduct the review of the pavement management performance models and treatment rules and handle the system testing in Phase III.

Phase III: System Analysis Testing

Task 7: Provide 60 days for MDOT to review the various components of the pavement management system including distress density calculations, structural number (SN) calculations, pavement type determination, the linear referencing system, and construction history input process. Thirty days into the testing, MDOT will provide the Consultant with initial findings of the system testing to allow for work to begin on revisions to the system. At the end of the 60 day testing period, MDOT will provide additional comments to the Consultant regarding the other changes that are needed to the models. Models should be finalized within 30 calendar days of receipt of final comments from MDOT.

Task 8: Allow an additional 30 days for MDOT to review the final version of the pavement management system. After approval of the system, the Consultant should run a multi-year analysis that generates the current and projected needs as well as recommended maintenance and rehabilitation projects for up to 3 different funding scenarios. The results of the analysis should be provided to MDOT and the Consultant should allow 60 calendar days for MDOT to review the reasonableness of the recommendations. Based on the findings, make any changes to the models. Models should be finalized within 30 calendar days of receipt of comments from MDOT.

Phase IV: System Documentation and Training

Task 9: Provide documentation for the pavement management system, including data dictionaries, User's Guides, data models, and documentation of the analysis models. Provide recommendations for maintaining the system and updating the models on a regular basis.

Task 10: Install software on MDOT computers and provide training on the capabilities and operation of the pavement management system. The training should include a 2-hour Executive overview of the system capabilities for those who will be using information from the pavement management system. Additionally, provide a minimum of 3 days of training to individuals who will be editing and operating the pavement management system. Also provide train-the-trainer course materials so MDOT can continue to train its staff.

Task 11: Provide maintenance support on the operation of the software for 1 year following the completion of task 10. Technical assistance should be included in the maintenance agreement. Any features provided in the cost of maintenance support, such as software updates or 24-hour help lines, should be identified in the proposal.

Deliverables and Schedule

Deliverables shall be considered those tangible work products that are delivered to MDOT as a result of the completion of tasks during this study. Deliverables may include reports, draft

documents, data, interim findings, schematics, training, meeting presentations, and/or software.

The deliverables and schedule for this project are expected to include the following:

Phase I: System Design

This phase is estimated to take approximately 3 months to complete.

Deliverables for this phase include the following:

- A meeting with key stakeholders at MDOT to familiarize members of the Consultant's team with MDOT's operating environment and pavement management needs.
- A draft version of an implementation plan outlining the data currently available to support pavement management, its expected use within the pavement management system, and the proposed project timeline. The implementation plan should document the proposed flow of information into and out of the pavement management system and assign responsibilities for keeping data current. Any discrepancies in the existing data that will cause problems in the pavement management system should be identified and proposed resolutions provided.
- A meeting with key MDOT stakeholders to present the recommendations contained in the draft implementation plan.
- A final implementation plan that incorporates any changes discussed at the meeting.

Phase II: System Implementation and Data and Model Testing

This phase is estimated to take approximately 10 months to complete. The Consultant should allow a minimum of 30 calendar days for MDOT to review the content of the database and 30 calendar days for MDOT to review the analysis models.

Deliverables for this phase include the following:

- A demonstrated ability to export information from the pavement management system to MDOT's GIS.
- A complete and accurate pavement management database containing the information needed to generate a pavement management analysis.
- Criteria for calculating individual distress indices to support the selection of feasible treatment options.
- Customized pavement management models, including pavement performance models for selected condition indices, treatment rules, treatment impact rules, and cost models for a range of treatment options and performance families.
- Up to 2 days of training in the operation and use of the pavement management system for the MDOT Pavement Management staff.

Phase III: System Analysis Testing

This phase is estimated to take approximately 8 months to complete. The Consultant should allow a minimum of 60 calendar days for MDOT to review the initial version of the pavement management system, 30 days for MDOT to review the revised version, and an additional 60 calendar days for MDOT to review the results of the network analysis.

Deliverables for this phase include the following:

- A complete and accurate pavement management database containing the components needed to review the complete pavement management system.
- Sample reports generated from the pavement management system showing current and projected pavement needs and recommended maintenance and rehabilitation projects under 2 or 3 different funding scenarios.
- Updated models to reflect any concerns identified by MDOT.
- An operational pavement management system including a GIS and optimization that provides the capabilities outlined in this RFP.

Phase IV: System Documentation and Training

This phase is estimated to take approximately 3 months to complete tasks 8 and 9. Task 10 will be completed 1 year following the completion of task 9.

Deliverables for this phase include the following:

- Complete documentation for the pavement management system, including data dictionaries, User's Guides, and documentation of the analysis models.
- Recommendations for keeping the pavement management system updated.
- Pavement management software installed on MDOT servers with access for up to 25 simultaneous users. Any updates to the software issued within the 1 year of maintenance should be provided at no additional charge.
- A 2-hour overview of the system capabilities.
- Up to 3 days of training in the operation and use of the pavement management system along with copies of Train-the-trainer materials.
- One year of technical support on the use and operation of the pavement management system. The Consultant should clearly outline any restrictions on the amount of assistance provided during this period.

Project Timeline

The proposed project timeline for the project was originally the following:

September 1 – 30, 2007: APTech assembles draft RFP. MDOT PMS reviews and provides comments regarding draft RFP to APTech for creation of final draft version of the RFP.

October 1, 2007 – January 31, 2008: MDOT and Information Technology Services (ITS) Review of final draft RFP and final revisions by APTech and MDOT PMS.

February 1 – 29, 2008: RFP release by MDOT.

March 1 – 31, 2008: Review of proposals and shortlist of Consultants determined.

April 1 – 30, 2008: Interviews of Consultants and final Consultant selection by MDOT and APTech.

May 1 – June 30, 2008: Contracting between MDOT and Consultant.

July 1 – September 30, 2009: Project Phase I – System Design.

October 1, 2009 – July 31, 2010: Project Phase II – System Implementation.

August 1 – March 30, 2010: Project Phase III – System Testing.

April 1 – June 30, 2010: Project Phase IV – System Documentation and Training.

However, for many reasons the RFP was not released until fall of 2010. Responses were received in early 2011, with a vendor selected in April 2011. The contract between MDOT and APTech ended before MDOT could finalize the RFP and begin vendor selection. MDOT anticipates that contracting will be completed in July 2011, at which time the agency will commence with the design, implementation, testing, and training activities with the selected vendor.

Work Performed By MDOT to Support Selected Software Vendor

In support of the project, MDOT will provide a project manager to oversee the successful Consultant's work and to provide support as needed. Additional duties that MDOT will perform include the following:

1. MDOT will provide sufficient hours of staff resources as is required to meet with the Consultant and to provide information that may be required.
2. MDOT will have staff available to handle data conversions from the previous pavement management database for input into the new pavement management system.
3. MDOT will provide the successful Consultant with available technical and administrative documentation of existing systems and practices as needed to assist in customizing the pavement management software.
4. MDOT will provide access to data needed to support the pavement management analysis.
5. MDOT will review all deliverables and perform all data checks within the proposed schedule.

In addition to the work performed by MDOT during the conduct of the project, there is work that should be addressed by MDOT prior to the initiation of the implementation.

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1. Incorporate preservation treatments into the treatment rules. This may require coordination with the Maintenance Group.
 2. Sort through any data issues by cleaning up and filling in missing data.
 3. Obtain feedback from Districts on how well District work plans matched those obtained from the PMS based upon the decision trees and use this to guide the development of new treatment triggers.
 4. Add a database field designating which sections are part of research studies.
 5. Assemble data sample files and data dictionaries for posting on the FTP site for download by Consultants at the time of RFP posting. Past reports regarding the MDOT pavement management system should also be posted on the FTP site.
 6. Determine how FWD testing information, core information, and skid data will be incorporated into the pavement management system sample database prior to release of the RFP to the vendors.
 7. Determine the number of pavement sections for each combination of pavement type and functional classification (interstate, 4-lane, and 2-lane roadway). This information will help determine if functional classifications will be used in the development of performance models during the implementation.
 9. Consider creating a committee that includes several Districts to aid in the RFP creation and vendor selection process.
 10. Post a data file on the MDOT ftp site that includes a subset of all database tables for use in the demo by vendors. Provide a data dictionary to explain included data.
 11. Assemble the technical requirements for the RFP, including the associated coding that will be included as part of the RFP. APTech will create the base RFP with placeholders for the technical requirements assembled by MDOT. MDOT should provide coding for:
 - The checking of rehabilitation/construction history information input.
 - The update of pavement type based upon the changes made to construction history.
 - The calculation of SN for a section.
 - The selection of treatments.
 - The transaction log.
 - The re-mileposting of sections.
 12. Several database issues should be examined by MDOT before the pavement management implementation. Specifically, MDOT needs to decide what new attributes

they wish to track that TMIS does not have: for example, dowels or lack thereof on jointed concrete, MEPDG attributes, and/or more material properties.

The completion of these work items will help aid in the successful implementation of the pavement management system. Several decisions that will aid in the pavement management implementation have already been made as described in the following:

1. Construction history information will continue to be entered by the Districts. The District will not be allowed to handle the deletion of sections or changes to the LRS. The Pavement Management Group will continue to provide support and help fill in any gaps in the data that exist.
2. The distresses within the current rating system are going to remain the same for the pavement management implementation. They will not be simplified for use in automated distress interpretation; instead, 100-percent surveys instead of sampling are now be used. The reason for not simplifying the distresses is that pavement preservation triggers require a certain level of detail in distress data.
3. Functional class may be used in the optimization process instead of network-level traffic data, but traffic may still be used if desired.
4. Safety will be incorporated into the pavement management analysis through the link of the pavement management data to SAMS to retrieve fatal accident and crash data.
5. MDOT will continue to collect the data that is currently part of the data that is stored for use in the MEPDG implementation. A note will be made in the RFP that drop boxes to enter the specific data the pavement management database is desired.
6. The vendor will be responsible for linking the PMS to the following: MMS, accident data, signs, and landmarks/station numbers.
7. Dynamic segmentation will be used for sectioning. Since dynamic segmentation is used instead of the current construction sections, the vendors should be asked in the RFP how the old data will be tied to the new approach.
8. The vendor will be asked to assist in creating performance curves and treatment rules for the concrete pavement sections.
9. The vendor will be asked to create routines to ensure that warranty, MEPDG, and research condition survey results are not incorporated into the index calculations, performance models, and the GIS maps.
10. The vendor will be asked to provide a way of explaining “black-box” optimization to those in the Districts. Also MDOT would like a flowchart that will explain the new analysis procedure in a simple method to the legislature and upper management.
11. The vendor will be asked to add a field to the database to track the “overlay number” for each placed overlay.

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12. The vendors will be informed that patching and pothole repair information will be available from the maintenance management system and will need to be linked to the pavement management data. A note will be made in the RFP so the vendor knows this information will soon be available.

Summary

Based upon information collected from MDOT, this implementation guide highlights the features that the organization needs in the agency's pavement management system. The details of these capabilities can be used in the RFP that MDOT releases to solicit bids from pavement management software vendors in the state agency market.

The project phases for pavement management implementation and associated tasks are detailed in this implementation guide and a proposed schedule for the project is provided. Details of MDOT's assistance with the implementation and issues to address prior to the implementation are also provided in the document.

Conclusions

Off-the-shelf (OTS) PMS software is a feasible option for replacement of TMIS. TMIS was custom-designed by a consultant and at time it was built, MDOT intended to TMIS to be an enterprise GIS data warehouse application. However, much of that intention was not realized. It became obsolete not long after it went into production, and due to the platforms upon which it was built, updates to TMIS were not possible without breaking existing code and functions. Also, PAP, the optimization package never went to production because it too became obsolete. Current OTS packages offer data maintenance with optimization in one environment. MDOT's business practices continue to change with increasing asset management and reporting requirements, and available OTS software offers the flexibility for MDOT to adapt. Further, having a maintenance agreement with the chosen vendor will allow for upgrades and accommodation of network infrastructure and underlying technology, such as database and mapping/GIS platforms.

MDOT was not able to follow the proposed timeline completely. Mississippi law requires that all software purchases over \$50,000 be released to RFP and that the State of Mississippi's Information Technology Services (ITS) agency must approve the RFP and author the contract. The RFP was released in the fall of 2010. This study provided a firm foundation for writing the RFP requirements, succeeded in delivering a needs assessment, identification of critical, important, and desirable software functions, and provided an outline for implementation planning.

APPENDIX A: VENDOR SURVEY

REDESIGN OF THE PAVEMENT MANAGEMENT SYSTEM (PMS) FOR THE MISSISSIPPI DEPARTMENT OF TRANSPORTATION (MDOT)

The table below highlights some of the features that the Mississippi DOT desires to have included in its new PMS. We are trying to help the MDOT set a budget for its implementation by determine which capabilities can be implemented with most software packages and which ones will require some customized programming. Please take the time to review these questions prior to our scheduled meeting at TRB. We look forward to meeting with you to discuss the capabilities of your system.

Desired Features	Does your system currently provide this feature? (Yes/No)	Is this feature a planned addition? (Yes/No)	Can the feature be added to your system? (Yes/No/NA)	What state currently uses this feature?
General				
1. Utilizes an Oracle Spatial platform and has web-enabled features for viewing all data.				
2. Ability to interface with contractor-provided digital images via GPS and GIS information (road log). Ability to link other media (e.g. pictures and word files to pavement section data).				
3. Ability to automatically update linear referencing system (LRS) (e.g., remileposting) based upon updates to the agency's planned GIS.				
4. Ability to use English and metric units interchangeably. Ability to store both units.				
5. Ability to allow MS personnel to have administrative privileges to update code tables.				
6. Optimization software that is web-enabled and uses an Oracle Spatial platform. GUI for PMS personnel to update the decision trees, performance models, life-cycle cost data, user costs, and remaining service life (RSL).				

Desired Features	Does your system currently provide this feature? (Yes/No)	Is this feature a planned addition? (Yes/No)	Can the feature be added to your system? (Yes/No/NA)	What state currently uses this feature?
7. Tracking of user changes to construction data and district changes to optimized clustered projects.				
Inventory				
8. Ability to store a variety of very detailed data for research studies (e.g. asphalt mix design details for each pavement layer to include asphalt grade, polymer modification, contractor, subgrade stabilization type, drainage layer, and detailed project costs).				
9. Ability to differentiate data stored for research activities (e.g. research project ID & data, calibration sites, and warranty projects) from network-level analysis. Note: condition surveys on warranty projects may be collected twice a year on 500 ft samples.				
10. Ability to update data storage tables with attributes for inventory items such as stabilized layers and subgrades, drainage layer type, overlay number, type of concrete under asphalt for composite pavements, and functional classification.				
11. Ability to store data and run analysis efficiently on more than 5400 analysis sections.				
12. Ability to view a strip diagram of the pavement cross section				

Desired Features	Does your system currently provide this feature? (Yes/No)	Is this feature a planned addition? (Yes/No)	Can the feature be added to your system? (Yes/No/NA)	What state currently uses this feature?
13. Ability to archive deleted, rerouted, or reconstructed pavement sections and accompanying information.				
14. Ability to store accident data, sign locations, pipe locations, nondestructive testing results, coring information, construction history, and air temperature at time of construction.				
15. Links to MMS (when selected), accident data and safety data from Safety Management System, and materials data from Site Manager (may not be possible since data is stored using stationing).				
16. Remote access (in the field) for districts to enter construction history data. Will need a data entry screen to be used with a PDA and a QA/QC check on the data before loading into the PMS.				
Condition data				
17. Interface to easily import various vendor-collected pavement condition survey data and accompanying condition attributes.				
18. Ability to use a combined index, individual distress data, IRI, or rut data in the decision trees.				
19. Ability to add distress to their rating procedure in the future.				
20. Ability to preserve historical condition information if changes are made to the condition rating survey (use ratings since 1991).				

Desired Features	Does your system currently provide this feature? (Yes/No)	Is this feature a planned addition? (Yes/No)	Can the feature be added to your system? (Yes/No/NA)	What state currently uses this feature?
21. Ability to store detailed FWD, coring, and skid test results.				
22. Ability to develop performance models and deduct curves for combined index or raw distress data within the software (may want to link to contractor).				
23. Would like self-calibrating performance models for each section. If your software does this, does it use mostly linear, exponential, or polynomial curve fits, or a combination of these?				
24. Ability to use database to calibrate MEPDG performance models, as well as have MEPDG pavetypes (conventional, deep strength, etc.)				
Analysis				
25. Customizable decision trees used for work plan recommendations for either treatment categories or up to 21 treatments with rules differing for various functional classifications for asphalt pavements alone (and will add treatments for PCC and preventive maintenance).				
26. Assistance developing treatment rules for PCC pavements.				
27. Ability to calculate Structural Number for a section, even after a treatment is recommended.				
28. Ability to split funding for development of work plans across districts within the State.				

Desired Features	Does your system currently provide this feature? (Yes/No)	Is this feature a planned addition? (Yes/No)	Can the feature be added to your system? (Yes/No/NA)	What state currently uses this feature?
29. Ability to automatically cluster analysis sections into projects based upon database information including condition indices, as well as remaining service life (RSL), route class, federal functional class, and contractor locations, thickness, and accident data.				
30. Ability to trigger optimized preventive maintenance treatments.				
31. Ability to optimize recommendations based on incremental benefit/cost or multiple ranking schemes.				
32. The ability to take traffic into consideration in optimizing recommendations.				
33. Ability to force at least one project in each county or district (to balance workloads among contractors).				
34. Ability to calculate and report RSL values for pavement sections and average network conditions.				
35. Ability to conduct a full-scale LCCA analysis and user costs to compare two or more recommended treatments on the same pavement section.				
36. Ability to conduct a separate analysis to identify safety needs and the ability to correlate dollars spent to improved pavement conditions.				

Desired Features	Does your system currently provide this feature? (Yes/No)	Is this feature a planned addition? (Yes/No)	Can the feature be added to your system? (Yes/No/NA)	What state currently uses this feature?
Results				
37. Ability to view section specific rates of deterioration compared to family rates (for combined index and raw distress data).				
38. Ability to export data and query results into multiple data formats (e.g. Excel, *.dbf, and Word).				
39. Ability to plot PCR and individual distress data over time graphically.				
40. Customizable ad hoc tables and figures.				
41. Map displays of information (while GIS is being developed).				
42. Ability to view “dashboard” results which are customizable for each user.				
43. Customizable queries and reports with template/bookshelf capability, such as Crystal Reports or a similar tool.				

For all above referenced states, please provide contact information.

State: _____
 Contact Name: _____
 Contact Phone Number: _____
 Contact Email: _____

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 Contact Email: _____

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Additional questions to be discussed with the vendor in person.

1. Currently MDOT stores data based on analysis sections that are roughly based on construction history and paints the section limits on the road in the field. When projects extend beyond the analysis section limits, they modify the project limit to eliminate the occurrence of too many

small sections. MDOT's Transportation Management Information System (TMIS) is designed to be project-driven, resulting in a many-to-many data relationship with the analysis section data. How does your software handle data modeling of projects vs. analysis sections? Is GPS the determining factor for this?

2. How do you recommend the sectioning be done in the future? How will old data be tied to the new sections if changes are recommended?
3. We currently use construction history data in analysis. We have heard that some software puts construction history in a repository where it is not used for analysis and optimization. How does your software handle this?
4. Currently TMIS is able to limit user input of rehabilitation/overlay projects based on existing pavement structure, including pavement type and layer thicknesses. For example, on a composite pavement, the maximum milling thickness cannot exceed the thickness of the asphalt portion. Also, a user cannot, for a pavement with an asphalt surface, choose slab replacement or grinding. How does your software control input of project data?
5. Currently TMIS calculates pavement type and structure number on the fly (e.g., when a project is entered. Does your software do this? How?
6. Currently MDOT stores raw distress data on two 500-ft samples per mile. How does your software integrate this data? Does it use GPS?
7. TMIS calculates distress densities nightly. How does your software handle this?
8. Does your software integrated contractor-collected pavement condition video using GPS?
9. Based upon the above mentioned desired features, are there any cost saving measures you can identify?
10. What experience have you had linking to MMS?
11. How does your software handle map/LRS changes, such as bypasses, remileposting, change of route ID etc? Are these processes manual, automatic, or a combination? Is your map primarily ESRI, Intergraph, or other? Can you pull in an existing base map and accompanying data? Is GPS the common denominator on which the GIS data is modeled?
12. During your implementation in state DOTs, what issues have you encountered in data integration and conversion? How did you solve these issues?
13. What do you feel are the advantages and disadvantages to the use of raw distress data for selecting treatments versus the use of distress indices?
14. How user friendly is your software? Is your software used by people in District/Region offices? Is it used full-time by people in Central Office? Do they need special skills to run the software?

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15. MDOT would like to have the system fully operational by spring 2009. This means that the software should be installed during the summer of 2008 so they can use the condition data collected in 2007 to develop performance models, test the software, and so on. How long does a typical installation of your software take? When will this project need to be started to meet these deadlines?

 16. We are trying to estimate the total cost for this implementation. To assist us, please provide us with the cost of the three most recent implementations you completed and identify any significant differences between this implementation and the completed implementation. Include licensing costs separately. MDOT may need 100 copies of a viewer and 10 licenses for the analysis, but would like to see different pricing options. They would also like to get a feel for annual maintenance costs.