Pooled Fund Study Project TPF-5(054)
SDDOT Project SD2002 – 18
Development of Maintenance Decision Support System
Phase III
THIRD QUARTERLY PROGRESS REPORT
July – September, 2005

Overview

This quarterly progress report covers activities that occurred during the third quarter of Phase III of this pooled fund study. The effort represents activities planned and specified within the Phase III Detailed Research Plan and Budget Proposal of the Development of a Maintenance Decision Support System (MDSS) - SD2002-18 project. The work during this third quarter represents a transition period between the evaluation of lessons learned from Demonstration Field Test for Year 1 (DFT-1) done during quarter 2 and preparations for Demonstration Field Test for Year 2 (DFT-2) beginning in quarter 4. Much of the effort focused on the integration of recommendations derived from the first year demonstration test into the graphical user interface and processing techniques of the MDSS.

Develop and integrate new technologies into MDSS (Task 2)

Blowing snow remains a critical maintenance issue for all member states although its effects vary as a function of geography, vegetative cover, type of snow, pavement temperature ranges, and winter climatology. Meridian through its relationship with the University of North Dakota (UND) worked on the design and development of a blowing snow algorithm to integrate into the MDSS. The UND blowing snow algorithm research is part of a multi-year research program that complements the work of the PFS MDSS. This algorithm will provide route-specific estimates of duration and intensity of blowing snow conditions within the roadway environment. The algorithm will be evaluated during DFT-2. The algorithm development is nearing completion and is undergoing controlled tests.

Recognizing the need for additional information on the risk of frost, a depiction of the hour-by-hour frost probability was added to the MDSS Route View as well as to the Alert Panel. This probability is calculated by evaluating the overlap between ‘error envelopes’ surrounding the forecasted pavement temperature and dew point temperature curves. This technique represents over four years of research and testing at Meridian.

Modify the graphical user interface and internal MDSS processing to support DFT-2 based upon feedback from DFT-1 (Task 3)

Meridian received extensive feedback from the Department of Transportation (DOT) participants of the eight state Pooled Fund Study (PFS) regarding the performance and presentation of MDSS information during DFT-1 and the evaluations performed at the completion of the DFT-1 winter test. These evaluations were done during the second quarter and the DFT-1 Evaluation Report was distributed during the Technical Panel meeting in June 2005. The assessment of the first year test indicated that the fundamental features of the MDSS were well received by DOT participants. However, the MDSS participants had numerous recommendations of modifications that would make the PFS solution a more useful tool. In addition, several minor software bugs were located and rectified during the DFT-1 validation effort, and the entire process was instrumental in calibrating parameterizations within the software for application during DFT-2.

Meridian composed an extensive list of modifications from this DFT-1 input and expanded this list based upon input from MDSS participants during the post-test visits and the technical panel meetings. This list of requirements laid the foundation for a revamp of the graphical user interface (GUI) and some of the internal processing. The Meridian development team met during May and defined several major modifications to the GUI. These modifications were adjusted to incorporate further participant guidance received from the end-of-test evaluations. By the beginning of the third quarter development had started on a substantial redesign of the GUI. The modifications included major improvements in the Route view, a modification of the Alert panel, a significant adjustment to the time control mechanism, and the implementation of new icons to provide a crisper presentation in all views. Several GUI modifications completed during the period include (but are not limited to):

- the introduction of regional MDSS domains and other bandwidth saving measures,
- the incorporation of a web browser into the interface,
- a redesign of the RWIS data displays, including more parameters and the provision of data from all sensors at each site,
- the introduction of graphical presentations of time-series data within the interface as a complement to the tabular presentations already in existence,
- addition of performance tuning mechanisms to optimize bandwidth and CPU usage on a per-computer basis,
- a redesign of the GUI Alert Panel to include more informative color bars, and more graphical (as opposed to textual) conveyance of alert information,
- the introduction of frost probability and conditional precipitation probability forecasts in the forecast displays,
- time slider modifications to make controlling the start and end time of Map View loops more straightforward,

- a rearrangement of the controls for the Route View to make advanced features more user-friendly and accessible, and
- the replacement of textual presentations on the Map View with more concise icons.

An interim release of the PFS MDSS software was issued on July 17, 2005 for participants to test and evaluate. This was followed by a second interim version released on August 26. Meridian supported this second release with forecasts for all eight states so users could test all facets of the interim software. These interim software releases contained a number of bug fixes and refined processing calibrations. Several structural modifications were made to the MDSS processing scheme, including provision for rapid report turnaround (<30 sec), longer forecast and history windows, bridge deck forecasting, and a breakup of data distribution allotments into regional domains as a bandwidth saving measure. In addition, the third quarter saw the development of the 'Standard' response module for MDSS. This module is intended to serve a dual purpose with MDSS. The first purpose is to act as an analogue or 'Rules of Practice' means of recommending maintenance actions. When used in this manner the appropriate maintenance responses are derived from a complex lookup table relating weather and road conditions to appropriate maintenance responses. The second purpose is to act as an alternative technique for reporting maintenance activities. For those locations where maintenance action reporting is impractical using existing procedures, the 'Rules of Practice' technique may be used to simulate expected maintenance actions based solely on forecasted and observed weather and road conditions. Finally, Meridian incorporated the output from its redesigned weather forecast system into the MDSS. The new forecast system permits Meridian to provide one contiguous forecast over the entire MDSS domain and generate a completely new forecast every hour or less. This weather forecast cycle coupled with the reprocessing of route segment pavement conditions every 30 minutes and the immediate integration of maintenance field reports creates a much more sophisticated dynamic tactical planning tool.

All participating PFS states indicated at the end of DFT-1 the desire to expand the number of routes leading into DFT-2. Some states desired broader participation throughout the state while others wanted complete coverage of routes within a specified maintenance area. This expansion of the program from a handful of test routes to a statewide program had been the intent of the member states from the inception of the MDSS project so this gradual expansion was a reasonable step. However, the addition of nearly 100 additional routes required considerable planning. Meridian initiated the process of getting thorough route definitions and collecting the detailed information needed to support these new routes in August and worked with the state coordinators and their field representatives to assure that the necessary input data was received by Meridian so it could be integrated into the MDSS to permit the proper display of the information in the GUI.

By the end of September Meridian had pre-release versions of MDSS version 2.0 set up for internal testing and debugging.

In preparation for the second year field test (DFT-2) the Meridian training staff prepared a DFT-2 training manual and user's field observation guide. Dates for the fall training sessions were coordinated with all eight PFS state DOT's and solidified during the second half of September with training sessions scheduled to commence early in October. The expanded use of DOT field observers to validate and verify both weather and pavement conditions have become a crucial piece of the DFT-2. The preparation of the PowerPoint presentations were done as the final v1.99 'training' version of the MDSS software came together near the end of September.

Validation Program (Task 4)

Meridian prepared complete documentation on the proper procedures to maintain the Geonor precision precipitation gauge and NovaLynx ultra-sonic snow depth instruments. The Geonor requires maintenance at least twice a year so it is vitally important that DOT personnel monitor the fluid level in the Geonor on a regular basis. The antifreeze agents and evaporation suppressant need to be replaced both in the fall and spring; therefore, Meridian proceeded to write documentation on this process with items to consider during this semiannual maintenance procedure. Meridian visited each of the sites and demonstrated the correct procedures to the DOT personnel in charge of validation equipment maintenance at the respective sites. Meridian also worked with Indiana, Minnesota, and North Dakota to complete the installation process of their equipment.

Meridian also completed many of the remaining DFT-1 validation efforts during the quarter. Whereas second quarter efforts had focused upon the evaluation of weather inputs, agreement between verifying observations, and the accuracy of the DFT-1 pavement temperature forecasts, the emphasis of third quarter validation efforts was placed upon evaluation of the MDSS' ability to accurately simulate the combined effects of weather, maintenance activities, and traffic using selected case studies from the DFT-1 field test. The findings of this study were encouraging and were presented at the August Technical Panel meeting. However, the limited sample size and the extent of uncertainties in most of case study datasets highlighted the need for more thorough case study analyses during DFT-2.

Develop a Strategy to Extend MDSS Participation (Task 5)

Meridian prepared information on the various options associated with the design of the pooled fund study MDSS and the issues involved with intellectual property.

As part of this effort Meridian prepared a listing of the various modules being used within the PFS MDSS framework, including an identification of ownership. This information was presented to the PFS MDSS Technical Panel at the August 31-September 1, 2005 meeting for discussion. It was determined at this meeting that further discussion should be held on intellectual property ownership at the subsequent Technical Panel meeting. Meridian was instructed to work with the Technical Panel to construct a recommended business plan and a recommendation on ways to proceed with assigning intellectual property ownership.