SUMMARY

In early 2005, AgileAssets, Inc signed a contract with the Federal Highway Administration to study the potential use of pavement management data for calibration of the New Mechanistic/Empirical Pavement Design Guide (MEPDG). In the initial effort a background document describing the project was sent to approximately 15 state DOTs selected by the project team and the FHWA. Based on the review by potential states, 12 states responded indicating their strong interest in participating. The states of Mississippi, Washington, Kansas, and Florida were initially selected for inclusion and state visits. For each state visit, a project visit report was written documenting the information and findings in that state.

Because of these meaningful findings and since there was strong interest in several other states; the Federal Highway Administration expanded the project to include a total of eight states. At that time, Pennsylvania, Minnesota, New Mexico, and North Carolina were added to the study. A complete trip report was prepared for each of these state visits. This included in every case a summary of the answers to the general questions presented about the state’s pavement management system and the states efforts to calibrate the Guide. A commentary of visit discussions was also included. The details of each state visit are presented in the detailed reports published in Volume 2 of the final report and available by email or from FHWA on request.

In general every state DOT indicated they were capable of using their pavement management system to calibrate the MEPDG at one level or another. A great deal of information about the plans that each state was undertaking to calibrate the MEPDG was also obtained. These ranged widely from “wait and see” to already having a consultant onboard.

The project team also worked closely with Mr. Harold Von Quintus of ARA who had been conducting a major research project, NCHRP Project 1-40, to do additional calibration of the MEPDG. Harold was very supportive and helpful in his interactions with us. There are clearly many problems remaining with the Guide. However, it is not
the purpose of this project to evaluate the MEPDG itself but to deal with the calibration of the MEPDG using long-term pavement management data. The fact that the MEPDG has problems is mentioned, because this has major impact on the efforts and attitudes of the states and has thus impacted this project.

As part of the project there was an opportunity to interact with the FHWA DGIT (Design Guide Implementation Team). The project team attended a DGIT Traffic Workshop in Biloxi, Mississippi in May 3-4, 2005, and also participated in a web cast workshop in Connecticut with the title “Material Inputs for M-E Pavement Design” carried out by DGIT on March 30-31, 2005. More recently the project team presented the main results of this study during a web cast workshop in Connecticut on September 20, 2006 with the title “Use of PMS Data to Calibrate the new MEPDG”. Together these workshops were helpful in understanding more about what DGIT and FHWA are doing to help the states implement the MEPDG.

Prior to visiting the states a series of questions and requirements for each state to participate in the study were formulated. A response was requested, including a detailed write up of their active pavement management system be provided prior to our visits. Two states had undertaken major research projects but have slowed down or stopped these projects pending receipt of an improved version of the MEPDG.

The information obtained for eight state DOTs was quite detailed. In order to compare this information and consolidate the findings, a Matrix was defined for data elements required to use or calibrate the MEPDG. In this matrix the information from all of the states visited was tabulated. While this is of necessity a summary of the details found, it provides an excellent method for comparing findings among the eight states visited. The findings in that Matrix are also summarized in Chapter 3, column by column. Careful study of the Matrix results will provide the reader with a great deal of detail about each state and a meaningful comparison among the states. The summaries serve well to synthesize the overall findings of the project and provide the state DOTs a way to compare their own activities.

Shell Oil Company introduced the world’s first mechanistic pavement design in the 1970’s. A description of that method and a discussion of its history and calibration are included in the final report. This history of the Shell Method provides good background information for state implementation and calibration.

The findings of the project are promising. There were differences among the states visited as would be expected among eight states from a variety of locations and sizes across the United States. Nevertheless, there is a general consensus that all eight of these states could undertake a pavement management calibration of the MEPDG and it seems likely that many other states could do the same. Clearly, additional work is needed and there are a number of problems to be resolved. Nevertheless, there are many benefits that can accrue to a state DOT by undertaking the use of its pavement management system to calibrate the MEPDG. Not the least of these is the fact that this provides an excellent opportunity to re-strengthen the coordination between pavement management and pavement design in the state DOT. This is discussed below in terms
of Satellite Database development which could and should be keyed to the existing pavement management system database.

States also need to undertake preliminary analysis of the data in their database to test pavement predictions based on the as-built data as compared to the initial performance predictions obtained in the design process.

This study shows that each state DOT should develop a Satellite Pavement Management/Pavement Design Database. This database would include the regular pavement management data but for each project being designed and constructed using the MEPDG. The data used in the design phase would be tabulated in electronic format, transferred, and stored in a Satellite Database compatible with the PMS database. As soon as the pavement is constructed, the as-constructed material properties and construction data should also be stored in this Satellite Database. In particular good traffic, load data and climate data as predicted and as measured each year should be collected and stored in the database, together with all performance, distress and deflection data. The Desired Data Level (DLL) as indicated in the Matrix gives DOTs guidance as to the types of data that should be collected both for design and calibration. Such a Satellite PMS/PD Database will do several important things as indicated in the three points below:

1) It will provide a Methodology for Preserving the Design Information that is used with the MEPDG on a Project-by-Project Basis.

Currently most states have no mechanism for electronically preserving and storing data used in design and as a result four or five years after the design is completed it is impossible to trace back and determine the exact information that was used in the design. That may or may not have been a major problem historically but it will be a major problem in the calibration and implementation of the new MEPDG. There are more than 150 data items that must be used for each design with the MEPDG. For calibration purposes even more data are required since measurements are needed over several years. Unless these data are stored and retained for future reference it will be practically impossible to follow-up and keep track of how the MEPDG is working. Likewise, currently no state makes a practice of storing as-built constructed data for new pavement projects in electronic form. In several states some of this information is available in material records and in construction files such as Site Manager. However, in all of the visits to DOTs no case was found where all required information is stored electronically for easy access and follow-up.

2) It provides a More Formal Interface for Pavement Management and Pavement Design

Secondly, such a Satellite Database will provide an opportunity to better coordinate and tie together pavement design and pavement management. The original development of pavement management was as a Pavement Design System and although pavement management has become generally a planning tool, this is a great opportunity to pull the two back together for future benefits.
Of particular importance in this effort is the necessity to keep track of the very complicated load spectrum information that is required for pavement design with the new MEPDG. Not only must the initial design values be input; but each year of the pavement’s life, the traffic section should either measure or make a concerted effort to coordinate the data available and calculate with reasonable accuracy the actual number of loads that are carried in the load spectrum by each of the newly designed pavements. Without this information it will be impossible to truly calibrate the MEPDG and to determine whether or not the actual performance for each pavement section is as-predicted.

3) It provides a Mechanism for Storing Electronically Materials and Construction Data with Annual Follow-Up as Appropriate.

It is equally important to keep track of the as-constructed materials data. The new MEPDG calls on the states to develop very complex materials characterization for many of the materials used in the pavement design. Only by keeping track of the as-constructed values and storing those values for follow-up can a state and indeed states can as a group determine whether or not the MEPDG is predicting pavement performance accurately and whether or not the extra effort and cost associated with this complex material testing is providing the desired improved performance.

From February 2005 to June 2006, this project has involved close coordination with the eight states visited in the project. In addition, discussions were held with many other state representatives at conferences, workshops and by phone calls or personal contacts by the project team. A bright spot in this effort has been the work done by the FHWA DGIT team to help states understand the requirements for traffic, materials and other inputs. Some revisions have been made to the MEPDG and others might be due. Three state DOTs stated that they planned no calibration efforts or further familiarization with the MEPDG until they were assured that correct workable software was made available to them. This is an unfortunate turn of events and may affect calibration efforts.

On the other hand, it is clear from working with the MEPDG and from coordination with Harold Von Quintus and others who have detailed experience and knowledge of the MEPDG that each state will need to validate and calibrate the MEPDG for their own conditions. Therefore, it is recommended that as soon as possible each state continue their familiarization with the newest release of the MEPDG and that they avail themselves of help from this Project staff, the DGIT team, NCHRP or others to assist them.

It is also recommended that they undertake short-term calibration efforts, in house or with researchers from their universities, other research institutions or consultants. In general, a rather intensive effort is needed over the next two to three years which suggests that it will be difficult to accomplish this within a short time frame with in-house personnel only. It is possible that two or more states in the same region can combine their resources to do joint calibration. This requires additional time to set up and manage the project and that must be taken into account.
Finally, the findings in this project are that every state can begin to use their pavement management system to calibrate new MEPDG. However, this will not be a short-term effort and is not intended to replace the aforementioned short-term calibration/validation activity. It will supplement that effort but in the long run will be more valuable to the state than the intensive early effort.

Key to this PMS effort will be the establishment of a Satellite PMS/Pavement Design Database which will contain not only the pavement management data but the design data and follow up as-built and actual data for each individual pavement section designed and constructed based on results of the MEPDG. This intensive data, listed in the various Matrix columns, will not be required for the entire pavement management system, only for those sections built based on the design from the MEPDG.

What are the next steps in the process of realizing the benefits of using pavement management data in calibrating the new MEPDG? The first step would be to demonstrate the potential by working closely with two states, potentially two states of the eight already visited. With minimum funding, a team of experts knowledgeable in this area can work with the states to set up the Satellite PMS/PD Database and illustrate the benefits of taking as-built and other required data and putting it into that satellite database for future analysis.

At the same time, it would be ideal to broaden the education aspects of the process by conducting four regional workshops across the United States involving all 50 state DOTs and preferably as many as three persons from each DOT in order that a team spirit can be built at the workshop. These workshops would provide hands-on break-out sessions where the staff and possibly members DGIT team can participate in sharing ideas on how to move forward.

Thirdly, it is important that FHWA encourage multi-state efforts at pavement management calibration of the Guide. If data from five or more states is collated into a common database with similar data elements, the number of sections available for calibration can be increased from 5 – 10 to 30 – 50 or more. It is important that state DOTs begin the process of testing their pavement management data for use and calibration. This requires the application of statistical-analytical capability to the data collected in the Satellite PMS/PD database.

If this type of integration can be fomented then perhaps continuity of pavement design guides can be established. Too often in the past, a new pavement design guide has been initiated (there have been four major modifications to the guide since 1962). Each time that Guide is considered to be the final version, but after five to ten years it becomes clear that the results are not adequate for accurate pavement design nationwide and a totally new effort at design guide development begins, as in this case in 1995 when work for the current MEPDG was started. If continuity can be reestablished between pavement management and pavement design and if a long-term database can be established, then gradual improvements can be made building toward a common goal for solid mechanistic empirical pavement performance predictions and design.
Each state will need to undertake some research associated with the guides. This may range from in-house familiarization studies to follow up studies with FHWA, materials calibration studies at the state university or full fledged major research efforts with a consultant. One thing that each state should consider is the use of an expert team to go through the list of extensive input variables as a group to try to establish the hierarchical importance of each variable. For example Poisson’s ratio is an input requirement for the guide for certain pavement types. It is a well known fact that the Poisson’s ratio can vary widely yet only has a minimal effect on the calculated stresses and strains. Therefore, the expert team might choose to set Poisson’s ratio at a fixed 0.4 rather than spend money and energy on further refinements. On the other hand, the modulus of elasticity of important pavement layers has a major effect on pavement stress and strain. Therefore, efforts are needed to measure the complex modulus or to find an effective way of determining it in the laboratory for design. It is estimated that this approach of classifying critical variable could result in categorizing the 150 input variables into three groups. About a third of the variables could be fixed such as (Level 3) Poisson’s ratio. Another third could be obtained through correlation or expert estimates (Level 2) leaving perhaps 25 to 30% which require detailed measurement and input into the process for improved design (Level 1).

It is clear from visits and discussions with eight states that a state DOT can undertake the use of their pavement management system data to calibrate the new MEPDG on a long-term basis. It is equally clear that the development of a Satellite PMS/Pavement Design Database used for a long-term calibration will also provide needed electronic storage for design data inputs used in designing new projects with the guide and thus provide a mechanism for effective storage of that data which has not before been available.


Prior reports cover the use of PMS data to validate Superpave performance as follows:

