PennDOT's Pavement Management System

Foresight Pays Off

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The Pennsylvania Department of Transportation's (PennDOT) Pavement Management System (PMS) was implemented in October 1986 and has continually grown and evolved since that time. More than just a pavement management system, it is also a Roadway Management System (RMS) composed of several data bases and integrated systems that are incorporated into various other management systems through a common location reference system. Some current management systems that are integrated with RMS are

- Bridge Management System
- Project Management System
- Maintenance Operations Resource Information System
- Accident Records System
- Financial Management Information System
- Construction Management System
- Construction and Materials Management System
- Geographic Information System

At PennDOT, RMS contains, or can access through integrated systems, the following types of information:

- Roadway inventory including number of lanes, length, width, surface type, functional classification, shoulder, and intersection information;
- Pavement conditions such as ride, distress, rutting, and surface friction;
- Pavement history that includes layer thickness and material type with dates and type of construction;
- Inventory and condition of drainage pipes and guide rail;
- Railroad crossing;
- Highway performance monitoring data;
- Bridge inventory and condition;
- Highway maintenance activities and costs;
- Political subdivisions; and
- Traffic information including volumes, classification, and load data.

This type of information covers the entire state-owned network of 41,000 miles and is stored for each half-mile segment of highway. It is the common location-referencing system with individual management segments that facilitates the integration of data.

Since RMS implementation in 1986, more than 200 enhancements to the system have taken place. Most of these changes were made at the suggestion of PennDOT's user community. Currently the largest enhancement under development is a PC-based subsystem for modeling pavement performance and a network optimization scheme based on the modeling of each individual pavement section.

The subsystem is composed of four major modules: Database, Grouping, Modeling, and Application. The Database module is used for importing and exporting data to and from PennDOT's main RMS data bases. The Grouping module defines groups of pavements that will deteriorate in a similar way. The Modeling module is used to apply mathematical modeling techniques to build performance models based on the available data in a group. The Application module applies the performance models developed to a life-cycle cost analysis and an optimization process for maintenance and rehabilitation planning. This subsystem will provide PennDOT managers with the latest tools for the development of projects and network planning.

How PMS is Used at PennDOT

PMS helps PennDOT managers to answer the question: what is the most effective use of its available construction and maintenance dollars? Pennsylvania's annual construction and maintenance program is very

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large ($1.75 billion). Nevertheless, transportation needs always outweigh transportation funds. To improve its effectiveness, PennDOT has launched a major effort and integrated its PMS with various other management systems throughout the department. This effort will also include all management systems specified by ISTEA legislation. Several examples of how PennDOT uses its PMS to conduct business are the following.

State-of-the-Interstate Report

The annual State-of-the Interstate Report uses pavement condition data, roughness data, and detailed traffic-count data from RMS to analyze the current and projected rehabilitation needs of Pennsylvania's Interstate system. Information is analyzed on each half-mile segment and expanded into hypothetical projects of various levels. This detailed analysis provides decision makers with a decision tree and the tools to select the most critical projects and make the best use of pavement restoration funds on a statewide basis.

Allocation of Maintenance Funds

Every year Pennsylvania distributes maintenance funds (about $750 million) among its 67 counties using the Maintenance Allocation formula. The formula consists of two parts: (a) a fixed-base allocation and (b) a variable additional allocation, which is based on pavement conditions, roughness data, traffic count data, mileage, bridge deck area, climate data (snowfall), and percentage of trucks. This detailed information is tabulated and each county receives a relative index. The relative index is used to distribute the funds that exceed the fixed-base allocation. By using the Roadway Management System and the Maintenance Allocation Formula, Pennsylvania can distribute available maintenance funds to those counties with the greater needs.

Maintenance Annual Work Plan

Every fall each County Maintenance Organization puts together its annual work plan based on available maintenance funds and information contained in the RMS data base. Information such as pavement, drainage, and guide-rail conditions are used to establish their program. Every quarter these annual work plans are modified with new up-to-date field data and RMS information.

Automated Permit Routing Analysis System

The Automated Permit Routing Analysis System (APRAS) is currently in the final

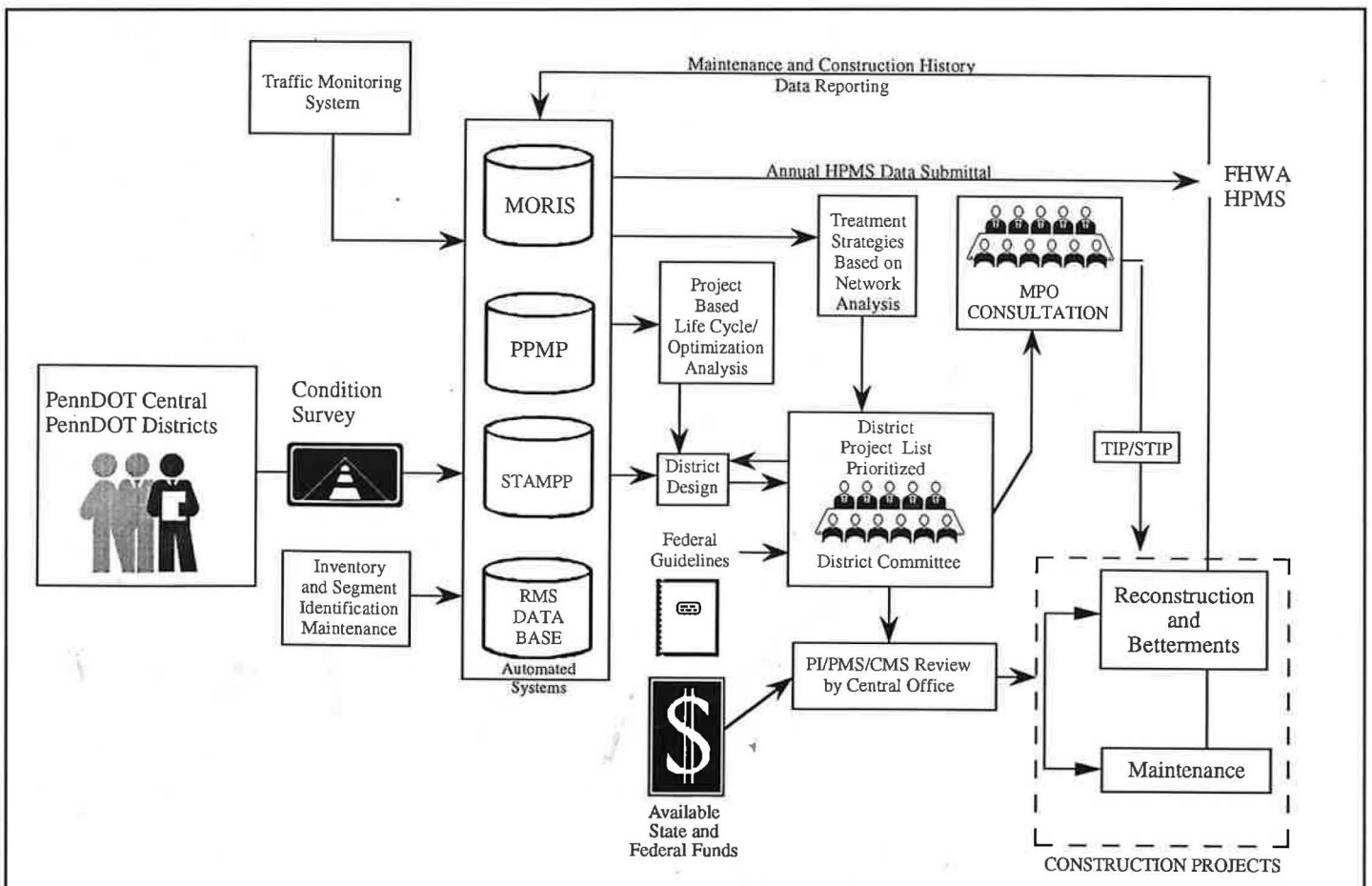

FIGURE 1 Pennsylvania Department of Transportation's Pavement Management System.

stages of development and application. It is designed to provide the safest and most practical route for specialized truck-hauling needs. APRAS uses roadway geometry, location (latitude and longitude) data, roadway and shoulder widths, intersection locations (junctions), load capacities and restrictions, and overhead structure clearances from RMS to determine the permit route. This information is analyzed and a permit containing the recommended sequence of routes from the truck's origin to its final destination is issued. Eventually it is planned that this system will be expanded to provide online permit appli-

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TRB Sponsors Third International Pavement Management Conference

The 3rd International Pavement Management Conference held in San Antonio, Texas, in May 1994 attracted 540 participants from 40 countries. The conference assessed the state of the art, identified problems, and examined the potential for expanding pavement management into total roadway management systems.

The program addressed six major themes: appropriate systems, implementation issues, institutional issues, managing information, analytical issues, and new frontiers. Pavement management experts attending included consultants and researchers and representatives from industry and federal, state, and local agencies.

The conference was funded by FHWA, Ontario Ministry of Transportation, International Society for Asphalt Pavements, American Concrete Pavement Association, as well as from conference registration fees. A National Research Council-appointed steering committee was formed, drawing from eight TRB standing committees and interested organizations.

Two volumes of the three-volume proceedings have been issued (*TRB Conference Proceedings 1*) containing the research papers. The third volume, to be issued at a later date, will summarize the conference discussion.

SHRP Products Increase Usefulness of Pavement Management Systems

Pavement management systems (PMS) are valuable management tools. The products of the Strategic Highway Research Program's (SHRP) Long-Term Pavement Performance (LTPP) program will make them even more valuable. For example, SHRP products will provide new equations for predicting pavement performance, better pavement data for accurate predictions of pavement deterioration rates, more standardized recording of distress, and the ability to rely more on objective measures of pavement condition.

Although falling weight deflectometers (FWDs) have been used by highway agencies for at least 10 years, they have not been a routine component of most pavement management systems. SHRP researchers have developed procedures for the calibration of FWDs, software programs to ensure data quality, and operational guides adaptable to operating agency needs. These tools will permit pavement managers to employ FWDs with greater confidence that the data are reliable and comparable when more than one FWD is used in a survey.

The heart and soul of SHRP's FWD standardization research are four software programs, FWDREFCL, FWDCAL, FWDCHECK, and FWDSCAN. The first two ensure that deflectometers are functioning properly and are calibrated. FWDSCAN and FWDCHECK ensure that collected data are properly recorded and are reasonable. The Federal Highway Administration is currently sponsoring reconfiguration of these programs for standard, instead of research, practice.

To discover how well a pavement is meeting the public's desire for a smooth ride, the pavement's profile is measured over time. As is true for FWDs, profile measurement devices must be properly calibrated. SHRP developed PROFCAL, PROSCAN, and PROFCHK software modules to ensure proper equipment calibration and quality control of profile data. SHRP also developed *Manual for Profile Measurement: Operational Field Guidelines,* that can be used as a standard reference for the use of profile measuring equipment and the proper handling of data collected. Although the FWD and profile quality assurance software programs were originally developed to meet the needs of SHRP's LTPP program, they hold great promise as pavement monitoring and management tools for highway agencies.

To provide a simple and effective way to consistently observe pavement distress, SHRP has developed the *Distress Identification Manual for the Long-Term Pavement Project,* building on previous versions used in the U.S. and overseas.

Another product, which was developed by the Georgia Department of Transportation and then modified by SHRP researchers, is the Georgia Digital Faultmeter. This device provides a low-cost, consistent means of electronically measuring joint faults and edge drop-offs in concrete pavements.

A SHRP-IDEA project has effectively answered the question of how to determine pavement layer thickness through the development of a computer program to analyze ground-penetrating radar (GPR) signals. The analysis of the GPR signals quickly computes pavement layer thicknesses at specific intervals for use in pavement management. This program, from Infrasense, Inc., reduces reliance on "ground truth" cores.

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cation and approval from centers accessible by drivers across the entire state.

MPO Development of TIP and STIP

Pennsylvania's metropolitan planning organizations (MPOs) use pavement management data to develop their transportation improvement programs (TIP). TIP are staged, multiyear, intermodal programs of transportation projects that are consistent with MPO transportation plans. These plans are used to develop the Statewide Transportation Improvement Program (STIP), a staged, multiyear, statewide, intermodal program of transportation projects that is consistent with the statewide transportation plan. Pennsylvania's long-range transportation plan, the Twelve Year Plan, incorporates both TIP and STIP to provide a comprehensive program that facilitates the efficient and economic movement of people and goods in all areas of the state.

GIS Applications

The application of a geographic information system (GIS) in Pennsylvania is nearing completion. Until now, the placement or plotting of RMS roadway information on various statewide maps has been a slow and time-consuming effort. As GIS develops, RMS information required by Pennsylvania's decision makers will be easily displayed in graphic or picture form. This will increase the use and demand of RMS data in project and network planning.

Reporting

Highway information and statistics are used by many federal, state, and local government agencies. The Pennsylvania PMS has a built-in query language that facilitates customized reports. Pennsylvania reports some of its roadway data to the Federal Highway Administration using the Highway Performance Monitoring System (HPMS).

HPMS is a standard nationwide inventory system that includes a variety of sample roadways on an assortment of different highway networks. Most of the sample data are extracted directly from RMS and converted into a standard form that is the same for every state. These data are used to assess the potential impacts of alternate and proposed legislative programs and policies that affect transportation. The type and amount of data collected is continually monitored and adjusted on the basis of economic changes and technological advances in the transportation field. Pennsylvania's RMS is continually adapting and growing to meet these needs.

The RMS data base is also periodically analyzed to provide safety and tort liability information. Examples of some items that might be considered for investigation include shoulder drop off; pavement frictional (skidding) characteristics; guiderail repair, replacement, and removal; inadequate drainage; pavement rutting; excessive pavement roughness; profile distortions; and pavement geometry. All reportable accidents and the roadway inventory data are used to identify potential safety problems as they occur.

The ability to monitor and record trends in pavement conditions and performance relies quite extensively on accurate pavement layer construction history, maintenance history, and historical traffic-count data. The analysis of these trends is an important step in the progression of any pavement management system.

PennDOT's PMS Versus ISTEA Requirements

The Pennsylvania PMS, as presented here, essentially satisfies ISTEA requirements for all Federal-aid highways under the direct jurisdiction of PennDOT: 4,300 miles on the National Highway System (NHS) and 21,000 miles on highways other than the NHS. However, in Pennsylvania there are about 512 miles of toll and bridge facilities and 3,057 miles of Federal-aid highways owned by local municipalities that do not come under the direct jurisdiction of PennDOT. This situation is not unique to Pennsylvania as all states are faced with having to address this requirement. In fact, most states will have to address more local mileage than is the case in Pennsylvania. At this time Pennsylvania has not developed a strategy to satisfy the requirement of a PMS tailored to meet the needs of these local Federal-aid highways.

In summary, the ISTEA requirements of a PMS have had minimal impact on the way PennDOT is currently doing business. PennDOT had the foresight to recognize the many advantages of a good PMS and proceeded with its development more than a decade ago. Today that decision has paid off.