Which roads should be repaired first? Which road repairs should be delayed in order to make other repairs? How often should we do routine maintenance on our roads? What is the most economical way to spend our maintenance budget? How can we make the selection of maintenance projects less biased and more objectively accurate? How can we communicate our maintenance project priorities to receive support from elected officials and the public? These are questions every road supervisor, city/county engineer, or public works director faces in the effort to manage local road networks.

The best answers to these questions come from a good pavement management system (PMS). A PMS is a set of steps used to collect, store, and retrieve information about a road or network. The system helps the user make repair and maintenance decisions that are more informed, organized, and consistent. It makes these decisions easier to communicate and substantiate. It is a tool for the decision-maker that enhances professional judgement.

The purpose of this publication is to promote PMS education, stimulate and facilitate discussion of PMSs, and encourage coordinated PMS development at the local government level throughout Florida. On the following pages, a PMS is defined, the benefits of using a PMS are discussed, and a report is given on national, state, and local PMS efforts. A case study of the City of Port Orange, Florida, is included to relate the experience of a typical local government in search of a system for managing its pavement. A list of resources for help and information is also offered.
WHAT IS A PAVEMENT MANAGEMENT SYSTEM?

The American Public Works Association (APWA) defines a pavement management system as:

A systematic method for routinely collecting, storing, and retrieving the kind of decision-making information needed to make maximum use of limited maintenance dollars. And it is a set of "steps," or computer routines, for quickly using the information and making the calculations necessary to arrive at these decisions. A PMS is a tool to help the engineer, the budget director, and the city manager or mayor do the job better in much the same way X-ray equipment aids the doctor. In both instances, professional judgment is enhanced, not replaced.

The Transportation Research Board commented in its introduction of the pavement management concept:

Pavement management is not a new concept; management decisions are made as a part of normal operations every day. The idea behind a pavement management system is to improve the efficiency of this decision-making process, expand its scope, provide feedback as to the consequences of decisions, and ensure consistency of decisions made at different levels within the same organization.

The Washington State Department of Transportation's Guide for Local Agency Pavement Managers reminds us that all agencies manage their pavements in some way. A formalized PMS is not entirely new, but it is an improvement on an agency's existing practices. It aids, not replaces, what a jurisdiction is already doing.

Pavement management can be conducted manually or by computer. A microcomputer-based PMS will make it much easier to store and retrieve data and prepare reports. The availability, low cost, and increased simplicity of microcomputers have been major factors in the proliferation of PMSs in local agencies.
**WHY USE A PAVEMENT MANAGEMENT SYSTEM?**

**A PMS Saves Money**

It is expensive to repair only a city's worst roads. While funds are being spent to repair "failed" roads, those needing slight or no immediate improvements continue to deteriorate. Studies show that if streets are properly maintained in a perpetual "good" to "excellent" condition, the total annual maintenance investment is four to five times less than if the pavement is rehabilitated after it reaches "poor" or "failed" status. Simply said, it costs more to repair roads once they have deteriorated significantly. This is because only the top portion of the pavement is replaced when repairing a surface in "good" condition, whereas the entire base, and sometimes the subbase, must be addressed when repairing a "poor" or "failed" road.

![Pavement Life Cycle Diagram](image)

*Source: Pavement (Maintenance) Management Systems, American Public Works Association*

This "worst first" approach can be avoided with the help of a good PMS. A good PMS can generate reports that show where resources should be spent now to avoid higher costs later. Reports showing the long-term effects of budget changes, or changes in how funds are allocated to projects, can also be produced in advance of the change. A PMS may recommend deferring improvement to "poor" or "failed" roads in favor of improving good roads before they fail. This is the kind of cost-saving advice that makes a PMS worthwhile.
A PMS Improves Communication

Having a PMS makes it easier to validate a maintenance budget. It is difficult to dispute the need for road maintenance dollars when that need is backed up by the computations of an efficient PMS.

A PMS makes it easier to communicate budget needs and other network information. All the components of pavement management are at your fingertips, making it easy to quickly give information to the public, elected officials, decision-makers, and others.

Other Benefits of Using a PMS

▼ Allows the user to quickly obtain information on the pavement condition of any road in the network.

▼ Allows the user to prioritize projects more objectively, alleviating the influence of politics on project selection.

▼ Allows the user to be more consistent in the practice of managing pavements.

A PMS Should Include:

▼ An inventory of physical pavement features

▼ A history of pavement construction, reconstruction, rehabilitation, and maintenance

▼ A pavement condition survey and performance analysis

▼ Traffic volumes and classification

▼ An investment cost analysis

▼ A data base that links all PMS-related data in accordance with the information reported for the Highway Performance Monitoring System (HPMS), a state data base that reports to the federal government the inventory and condition of all roadway infrastructure in the state.

Source: Guidelines for Pavement Management Systems, American Association of State Highway and Transportation Officials (AASHTO, July 1990)
HOW DOES A PMS WORK?

The Steps
The steps involved in pavement management include:

▼ Creating an Inventory
This consists of creating an inventory of all the streets in the network. During inventory, some of the road characteristics noted include location, width, length, surface type, drainage, and sidewalks.

▼ Data Collection
During this stage, pavement distress information is gathered in the field on the specific streets in the inventory and will form the heart of the PMS -- the data base. This is the most critical step in the pavement management process. Data must be collected in a timely manner so that they are not outdated by the time they are utilized by the PMS. Consistency in the way this procedure is conducted is also important, so training data collectors and documenting procedures are recommended.

▼ Analyzing Data
This step consists of retrieving and analyzing the data collected. The data can be used to make decisions at the network and project level. Data analysis can also test the consequences of "what if" scenarios such as changes in budget or postponement of repairs or maintenance.

▼ Updating Data
This involves conducting regular updates of the information in the data base. It could include adding new roads to the network, entering new pavement condition ratings, adjusting the cost of materials, or allowing for policy changes in maintenance and rehabilitation treatments.
management-related topics. The Institute, headquartered in Lexington, Kentucky, operates one of its seven Eastern region offices in Panama City, Florida.

**State Efforts**

The state of Florida’s PMS work plan was approved by FHWA in January 1995. The Florida Department of Transportation (FDOT) already has in place many of the specific PMS components required by ISTEA. Three additional requirements must still be met:

- Assurance that all federal-aid highways in the state are covered by a PMS
- An estimation of the remaining service life of all NHS roads in the State
- A project level investment analysis (current cost of required maintenance and rehabilitation) for NHS miles in Florida.

*The State of Florida encourages local governments to use a PMS and promotes creation of a PMS that is tailored to meet local government needs.*

> Pavement management systems can be used to forecast future pavement conditions and resurfacing needs. They provide an organized way to store and analyze historical pavement information, which allows the forecasts to be made in a logical fashion. I encourage local governments to consider using a pavement management system that best fits the needs of their local road system.

*Bruce Dietrich, FDOT State Pavement Design Engineer*

**State Sources of PMS Training and Information**

**FDOT**

FDOT has prepared two manuals as guides for local governments: *Pavement Condition Survey Manual-1994* and *Pavement Design Standards Manual-1993*. Both publications are available from FDOT’s Department of Maps and Publications. A computerized version of the survey and condition rating procedure has also been developed. Most importantly, the information contained in the Pavement Condition Survey Manual defines methods for conducting a visual evaluation and determining the riding quality of the pavement. From this evaluation, local governments will be able to:

- Determine the present condition of the pavement
- Compare present pavement condition with past condition to predict deterioration rates (or impacts of deferred treatment)
- Determine maintenance needs in terms of materials, labor, and funding
- Establish priorities for roadway maintenance based upon available resources
- Identify those maintenance and/or rehabilitation treatments that provide the greatest return for the investment.

**CUTR**

The Center for Urban Transportation Research (CUTR) in the College of Engineering at the University of South Florida in Tampa has gained experience in customizing PMSs. CUTR also continues to work with the Florida Association of Counties and Florida League of Cities to promote PMS for local governments.

**McTrans**

The McTrans Center at the University of Florida in Gainesville provides PMS technical guidance to local governments. A number of PC-based PMS software packages are available for purchase from the Center and range in price from $5 to $2,500. Some of the packages feature a Geographic Information System (GIS) interface.

**Local Efforts**

A random informal survey of Florida's local governments showed that pavement management efforts at the local level vary in degree of sophistication. Most cities and counties contacted reported using some type of system or indicated that current efforts were being made to establish a system. Some systems are manual but most are computerized or are in the process of becoming computerized.

Support for local governments interested in establishing a PMS or in need of assistance with their current system is available from several national and state organizations. If the FHWA proposal to require a PMS is enacted, the State of Florida expects to provide technical assistance and pavement condition data on roads under local jurisdiction but will leave the selection of a PMS up to each local government. This will provide valuable technical assistance to local governments establishing a PMS for the first time. It also gives flexibility to local governments with systems already in place, allowing them to continue using the same system.
PMS AT THE LOCAL LEVEL—A SAMPLE

City of Tampa

Population: 282,848  
Road Network: 520 lane miles  
System: MicroPAVER, for collector arterials only

"The City of Tampa was one of the test sites for MicroPAVER. The new version (version 4.0) is incredibly user friendly. It is window driven, offers a great degree of flexibility and is tied into GIS. Our biggest problem is getting inspectors to survey the roads, and this is due to a budget crunch. Right now we use the pavement condition index and maintenance records." - Sabine Stakes, Technical Service Supervisor

Broward County

Population: 1,317,512  
Road Network: 1,786 lane miles  
System: Broward County Pavement Management System (BCPMS)

"Our PMS was the first operational Geographic Information System (GIS) application in Broward County. We developed the system ourselves using funds secured through a research contract between the Office of Planning and the Florida Department of Transportation. In return for funding, our commitment was to match funds and share the technology with other local governments. Prior to establishing this system, pavement management was an informal process. The bottom line is inventory; this system provides the first complete inventory of roadway conditions and characteristics for Broward County maintained roadways." - Bob Wilson, Pavement Management Engineer

City of Dunedin

Population: 34,765  
Road Network: 212 lane miles  
System: MicroPAVER

"We got the system two years ago and taught ourselves how to use it. We used three two-person teams to collect data, each team surveying the same roads, but this process has been slow. We will probably hire a consultant to conduct surveys on our roads and provide us with the data." - Jay Cooper, Public Works Designer
IF FLORIDA'S LOCAL GOVERNMENT EFFORTS

**City of Ormond Beach**

Population: 30,063  
Road Network: 145 lane miles  
System: Manual

"We are not computerized. We have just begun a pavement condition survey that is also used by the City of Port Orange, and we have surveyed about one-eighth of our streets. We plan to use the information gathered in the survey to help create our priority list of projects. We are just beginning to get into a detailed pavement management program." - Judy Grim, City Engineer

**City of Altamonte Springs**

Population: 36,770  
Road Network: 129 lane miles  
System: MicroPAVER

"In 1979, we presented a program to our City Commission detailing the high cost of deferring maintenance, and the Commission approved funding for an annual street-resurfacing program. We then developed a pavement maintenance management system. First, we rated our streets and then began resurfacing streets in the fair range. In six years, we resurfaced more than 100,000 linear feet of streets at an average cost of $6 per linear foot. Average reconstruction cost is about $35 per foot, so we saved $3 million. We moved from our original system to PAVE, believing its detail would enable us to do a better job. Now we use MicroPAVER for the PC. We are happy with the system. You can take it to different levels, but we haven't yet utilized it to the fullest extent." - L.M. Richter, Engineering Technician

**City of Boynton Beach**

Population: 48,428  
Road Network: 238 lane miles  
System: MicroPAVER

"We are currently updating our system and this year have computerized it using MicroPAVER. We have been able to change the system to meet our needs. For instance, we eliminated the multiple categories of cracking and have only one category for noting cracks. We also added a category to record utility cuts and repairs. We learned the system from books provided by the Asphalt Institute. The biggest advantage is that it takes the politics out of the maintenance and repair schedule." - Bob Gibson, Supervisor of Roads and Streets
PORT ORANGE, FLORIDA: A CASE STUDY

Like the majority of municipal governments, the City of Port Orange, Florida, faced the dilemma of having more roads to repair than the maintenance and repair budget could handle. To generate funds for improvements to the deteriorating road network, the City sought to implement a transportation utility fee (TUF). However, the key to getting the TUF passed by the public and City decision-makers was a clear and convincing presentation of the need.

Port Orange learned that a PMS could create reports that would help validate the need. In addition, a PMS would greatly improve the City’s pavement management function and save money over the long term. In 1991, Port Orange asked the Center for Urban Transportation Research (CUTR) at USF to develop a customized pavement management system.

Four key steps were involved in the development of the Port Orange Pavement Management System:

▼ Network sampling

▼ Pre-survey training and pavement condition surveys

▼ Development of the customized micro-computer based pavement assessment model

▼ Summary of the results of the assessment model

Sample sections of three primary street categories were surveyed: subdivision locals, non-subdivision locals, and collectors. These sample sections were broken down further and sub-grouped according to pavement age and subbase type (limerock or soil-cement).
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Generally, more heavily traveled roads received heavier sampling. In addition, if pavement inventory records were poor, more extensive sampling was required; if records were good, less sampling was needed. In the Port Orange study, collectors received the highest sampling rate, followed by non-subdivision locals and then subdivision locals.

Consistency in the way pavement is surveyed for distress is critical to the success of a PMS. In Port Orange, CUTR conducted a pre-survey training session at the City offices. A two-person crew with 30 years of combined experience in roadway construction management and inspection conducted the Port Orange survey. To further ensure consistency, this two-person team was taken into the field for practice surveys on three sample segments. Each surveyor's data were checked for accuracy, completeness, and inconsistencies, significantly reducing subjectivity. The survey form recorded four types of cracking and also provided space to record other roadway-related conditions such as poor drainage or inadequate utility cuts.
After reviewing numerous pavement management software packages, a model used by Carson City, Nevada, was selected and modified for use in Port Orange. It was chosen because it is relatively simple, menu-driven, suitable for the visual survey data designed for a street network size comparable to Port Orange, and capable of producing the types of evaluation reports most appropriate for Port Orange. Mathematically, the model calculates the overall severity of distress, factors in the traffic load on that section, and assigns a project priority score. In this way, a list of projects is prioritized in ascending order beginning with the sections needing the most attention. The model then follows a decision tree of recommended treatments. This decision tree can be refined over time to better reflect historical trends, specific treatment triggers, and proven alternative treatment options in the Port Orange area.

For Port Orange, the assessment model within the PMS was developed to determine the costs associated with City pavement maintenance and rehabilitation needs. Because the priority was to determine what magnitude of funding would have to be generated to bring the entire city's street system up to acceptable conditions, the initial run of the model was compiled without financial constraints or budget limitations.
SUMMARY

Every agency has a process by which it manages the maintenance and rehabilitation of its road network. A PMS is a systematic, formalized process that can enhance the existing process. The PMS steers the process toward the goal of a network of roads in perpetual "good" to "excellent" condition. The result is:

▼ More efficient spending over the long term
▼ Increased ability to communicate details about the network
▼ The ability to present a more objective rationale for project decisions

Although a PMS can be achieved manually, computerized systems offer greater ease and efficiency. Incorporating computers into the process, and even customizing systems, is easier than ever with computer software systems designed to work on basic office microcomputers.
PMS SUCCESS

With a major portion of the Arizona interstate system completed in the mid-1970s, the state of Arizona shifted its emphasis from construction to maintenance. During that same period, maintenance costs escalated at an alarming rate (from $25 million in 1975 to $52 million in 1978), and revenues were very tight. In response, the Arizona Department of Transportation (ADOT) contracted with a private consultant in 1978 to design a “decision-making tool” for the department, know today as a PMS. As a result of following the recommendations developed from the PMS, during the first year of implementation only $32 million of the $46 million budgeted for pavement preservation was used. The following year, preservation costs were only $28 million. Combined, the total savings or “surplus” to the state of Arizona over a five-year period was $101.4 million.

In an evaluation of the PAVER PMS for potential approval for use on all Army bases, the U.S. Army Corps of Construction Engineers Research Laboratory (CERL) evaluated the management time required to carry out six management functions typically associated with pavement maintenance for a network of about 200 lane miles. The staffing required to carry out these activities under the old pavement maintenance approach was estimated to be about 1,200 hours per year at a cost of about $17,000. A prototype test implementation estimated that the level of effort required to perform the same tasks using the PAVER PMS was 480 hours at a cost of about $6,800. After allowing for the cost of an additional computer ($3,000) and technical assistance ($1,700), the total cost using a PMS was $11,500, a savings of more than 30 percent.
An initial street inventory in the city of Sanford, North Carolina, revealed that the 37-mile road network was in need of repairs estimated to cost $326,955, an average of $9,641 per mile. These results were presented to the Sanford City Council and compared with other municipalities. The comparisons showed that for more than 23 years, the street system in Sanford had not received adequate funding for maintenance and repair. At the time, the five-year budget was presented by staff. Following good pavement management philosophy, the budget was divided into five-year increments based on the rating system of the incremental improvement of the roadways. The staff further estimated that improvements would be completed in the next five years. The City Council approved a $370,000 proposal budget and asked that the work be completed by the City in two years instead of five. Eighteen months after the first inventory and after completion of 10 miles of the road work in the five-year plan, another inventory was conducted. Even with the growth of the network to 100 miles, there was a considerable decrease in the total maintenance requirements. The street mileage not needing repairs had increased to 78.3 percent of the total, and the total estimated cost for maintenance activities decreased to $225,380, or an average of $11,460 per mile.

In 1985, the city of San Leandro, California, received $1.5 million for road and street maintenance over a five-year period. However, only $7.5 million in revenues were available over that time period. Using this general information, the city's public works office made a formal presentation to the City Council on the $1.5 million road. Based on the presentation, the City Council agreed that in a reasonable forearm to increase the monthly sales tax passed, a portion of the revenues would go to public works for road and street maintenance. The referendum passed, and the $1.5 million budget was met.
PMS ADVICE FROM OTHER AGENCIES

Don't be afraid to get started.”

“Keep it simple.”

“Don't accept computer analysis without field verification.”

“Plan for an ongoing effort.”

“Customize your system.”

Hire or develop dedicated PMS personnel.”

“Don't skimp on the database or the integrity of the data.”

“Include a geographical information system (GIS).”

“Find a department already using a similar PMS to mentor you.”
WHERE TO GET HELP AND INFORMATION ON PMS

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