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TxDOT's Pavement Management Information System: Current Status and Future Directions

Project Summary Report 1420-S

Cooperative Research Program

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COLLEGE STATION, TEXAS

TEXAS DEPARTMENT OF TRANSPORTATION

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16. Abstract

The Texas Pavement Management Information System (PMIS) was planned in the early 1990s as a two phase implementation effort. In Phase 1, the focus was on providing information on network pavement conditions and funding requirements to TxDOT's administrative level in Austin. This phase is now complete; researchers have summarized the PMIS data into annual reports showing condition trends and the impact of varying funding levels. The PMIS data are also used increasingly for maintenance and rehabilitation fund allocation.

Phase 2 focuses on improving PMIS implementation at the district level, the goal being to provide sufficient information to move from network to project level decision making. Phase 2 implementation cannot be achieved until key components are developed, such as the Pavement Layer Data Base, the ability to move to management sections and implementation of improved automation technology to facilitate data base integration and map-based reporting.

This report provides a review of the current PMIS from a district perspective. Despite the limitations of the current system, over 70% of the districts view PMIS as both an Austin and district tool and most use it to assist with their project selection. This report describes Phase 1 system limitations together with a list of district supplied action items.

The feedback from the district interviews and questionnaire survey was sufficiently positive to recommend full implementation of Phase 2.

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TxDOT'S PAVEMENT MANAGEMENT INFORMATION SYSTEM: CURRENT STATUS AND FUTURE DIRECTIONS

by

Tom Scullion
Associate Research Engineer
Texas Transportation Institute

and

Roger Smith
Associate Research Engineer
Texas Transportation Institute

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The Texas A&M University System
College Station, TX 77843-3135

IMPLEMENTATION STATEMENT

To implement the findings of this study TxDOT should re-establish the Pavement Management Steering Committee which was active in the early 1990s developing the Phase 1 implementation plan. This team should be charged with the following:

1) Prioritize the action items described in this report aimed at improving the existing PMIS system. Develop an implementation schedule starting with the top priority items.

2) Develop an implementation plan for Phase 2 implementation, addressing the key issues described in this report, namely: a) developing an integrated District level system, preferably on a microcomputer platform, including a District level condition reporting, needs estimation, and prioritization scheme based on either 0.8 km inspection units or District supplied section limits; b) developing an integrated pavement layer data base initially on the Highways of National Significance and then on the rest of the network; c) as soon as possible, implementing a prototype map based reporting system.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the official view or policies of the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. The engineer in charge of the project was Tom Scullion, P.E. #62683.

There is no invention or discovery conceived or reduced to practice in the course of or under this contract, including any art, method, process, machine, manufacture, design, or composition of matter, or any new and useful improvement thereof, or any variety of plant which is or may be patentable under the patent law of the United States of America or any foreign country.

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SUMMARY

The Texas Pavement Management Information System was planned in the early 1990s as a two phase implementation effort. In Phase 1, the focus was on providing information on network pavement conditions and funding requirements to TxDOT's administrative level in Austin. This phase is now complete; researchers have summarized the PMIS data into annual reports showing condition trends and the impact of varying funding levels. The PMIS data are also used increasingly for maintenance and rehabilitation fund allocation.

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CHAPTER 1
INTRODUCTION

The Texas Department of Transportation (TxDOT) has operated a network level Pavement Management System since the early 1980s. The initial system was known as the Pavement Evaluation System (PES). Around 1990, a Pavement Management Steering Committee was assembled to plan the next steps in improving and expanding PES. That committee recommended a two phase approach to system development. Phase 1 was to focus primarily on the needs of the Austin administrative level, to assist with their need to follow network level trends in condition, to conduct impact analysis, and to assist with fund allocation. The Phase 1 system would be available for District use in documenting pavement condition and identifying potential maintenance and rehabilitation candidates, but many of the features thought essential to complete implementation at the District level were scheduled for development in a Phase 2 implementation effort. Phase 1 implementation is essentially complete, and the Pavement Management Information System (PMIS) is increasing being integrated into all levels of decision making within TxDOT. The purpose of this study is twofold: firstly, to conduct a District and division survey of the value of PMIS and identify problem areas within the current Phase 1 system; and secondly, to lay the ground work for the Phase 2 implementation by identifying District requirements. This project involved developing a questionnaire which was distributed to all districts. It also involved visiting eight districts to discuss the strengths and weaknesses of the current system and to obtain their ideas on how to proceed with system development.

In the next section of this report, a brief description of the existing PMIS system will be presented. In Chapter 2, the key concerns from the District interviews about the current PMIS are summarized together with a list of action items. Chapter 3 provides more insights into the Phase 2 development effort. The Appendix to this report provides each District's response to the questionnaire.

DESCRIPTION OF THE KEY ELEMENTS WITHIN PMIS

PMIS is described in detail in TTI report 1989-1 entitled "Pavement Management Information System Concepts, Equations and Analysis Pavements" (1). A summary of the key components is included here to help in understanding the problem areas described in Chapter 2.

Pavement Types

Within PMIS, the Texas highway network is broken into 10 pavement types as shown in Table 1. This is essentially the only pavement layer information currently available to PMIS.

Table 1: Proposed PMIS Pavement Types.

Pavement Type		
Broad	Detail	Description
CRCP	1	Continuously-Reinforced Concrete Pavement
JCP	2	Jointed Concrete Pavement — reinforced
	3	Jointed Concrete Pavement — unreinforced ("plain")
ACP	4	Thick Asphalt Concrete Pavement (greater than 14.0 cm thick; [5.5"])
	5	Intermediate Asphalt Concrete Pavement (6.4-14.0 cm thick; [2.5-5.5"])
	6	Thin Asphalt Concrete Pavement (less than 6.4 cm thick; [2.5"])
	7	Composite Pavement (asphalt surfaced concrete pavement)
	8	Overlaid or Widened Old Concrete Pavement
	9	Overlaid or Widened Old Flexible Pavement
	10	Thin-surfaced Flexible Base Pavement (surface treatment or seal coat)

Condition Evaluation

In the fall of each year, a sample of the highway network is visually inspected and pavement roughness measurements are made. The basic sample unit is a 0.8 km (0.5 mi) section. Currently, the minimum sample is 100% of the Interstate pavements and 50% of the remainder. PMIS uses the pavement distress types and rating methods shown in Table 2 for Continuously Reinforced Concrete Pavements (CRCP).

Table 2. Proposed PMIS CRCP Distress Types and Rating Methods.

CRCP Distress Type	Rating Method
Spalled Cracks	total number (0 to 999)
Punchouts	total number (0 to 999)
Asphalt Patches	total number (0 to 999)
Concrete Patches	total number (0 to 999)
Average Crack Spacing	spacing (1 to 75), to the nearest 0.1 m (foot)

PMIS uses the pavement distress types and rating methods shown in Table 3 for Jointed Concrete Pavements (JCP).

Table 3. Proposed PMIS JCP Distress Types and Rating Methods.

JCP Distress Type	Rating Method
Failed Joints and Transverse Cracks	Total number (0 to 999)
Corner Breaks	Total number (0 to 999)
Failures	Total number (0 to 999)
Shattered (Failed) Slabs	Total number (0 to 999)
Slabs With Longitudinal Cracks	Total number (0 to 999)
Concrete Patches	Total number (0 to 999)
Apparent Joint Spacing	Spacing (15 to 75), to the nearest 0.1 m (foot)

PMIS uses the pavement distress types and rating methods shown in Table 4 for Asphalt Concrete Pavement (ACP).

Table 4. Proposed PMIS ACP Distress Types and Rating Methods.

ACP Distress Type	Rating Method
Shallow (13 to 25 mm [(½" to 1"] depth) Rutting	percent of wheelpath length (0 to 100)
Deep (25 to 76 mm [1" to 3"] depth) Rutting	percent of wheelpath length (0 to 100)
Patching	percent of lane area (0 to 100)
Failures	total number (0 to 99)
Block Cracking	percent of lane area (0 to 100)
Alligator Cracking	percent of wheelpath length (0 to 100)
Longitudinal Cracking	length per 100' station (0 to 999)
Transverse Cracking	number per 100' station (0 to 99)
Raveling (optional)	none, low, medium, or high
Flushing (optional)	none, low, medium, or high

Pavement Score Calculation Process

A multiplicitive utility analysis approach is used to calculate the score for every inspection section. Each distress value is converted into a utility value between 0 and 1 using a utility curve. The basic shape of a pavement's utility curve is sigmoidal (S-shaped). Most of the PMIS distress types have a utility curve, with the exception of Raveling, Flushing, Average Crack Spacing, and Apparent Joint Spacing. This curve may be represented by the following equation:

$$U_i = 1 - \alpha e^{-\left(\frac{\rho}{L}\right)^{\beta}}$$

where:

U = utility value;

i = a PMIS distress type (e.g., deep rutting or punchouts);

α = alpha, a horizontal asymptote factor that controls the maximum amount of utility that can be lost;

e = base of the natural logarithms (e ≈ 2.71828...);

ρ = rho, a prolongation factor that controls "how long" the utility curve will "last" above a certain value; and

L = level of distress (for distress types) or ride quality lost (for ride quality).

β = beta, a slope factor that controls how steeply utility is lost in the middle of the curve;

The PMIS Distress Score is calculated from the pavement utility curves. PMIS uses the equations listed below, one for each broad pavement type (CRCP, JCP, and ACP), to calculate the Distress Score.

Equation for CRCP (Pavement Type = 1)

For CRCP sections, the following equation is used:

$$DS = 100 \times \left[U_{Spall} * U_{Punch} * U_{ACPat} * U_{PCPat}\right]$$

where:

DS = Distress Score,

U = Utility Value,

Spall = Spalled Cracks,

Punch = Punchouts,

ACPat = Asphalt Patches, and

PCPat = Concrete Patches.

Equation for JCP (Pavement Type = 2-3)

For JCP sections, the following equation is used:

$$DS = 100 \times \left[U_{Flj} * U_{Fail} * U_{SS} * U_{Lng} * U_{PCPat}\right]$$

where:

DS = Distress Score,

U = Utility Value,

Flj = Failed Joints and Cracks,

Fail = Failures,

SS = Shattered (Failed) Slabs,

Lng = Slabs With Longitudinal Cracking, and

PCPat = Concrete Patches.

Equation for ACP (Pavement Type = 4-10)

For ACP sections, the following equation is used:

$$DS = 100 \times \left[U_{SRut} * U_{DRut} * U_{Patch} * U_{Fail} * U_{Blk} * U_{Alg} * U_{Lng} * U_{Trn}\right]$$

where:

DS = Distress Score,

U = Utility Value,

SRut = Shallow Rutting,

DRut = Deep Rutting,

Patch = Patching,

Fail = Failures,

Blk = Block Cracking,

Alg = Alligator Cracking,

Lng = Longitudinal Cracking, and

Trn = Transverse Cracking.

The ride values are measured automatically and reported on a scale from 0 to 5, which is the user perception correlated to the roughness of the highway. The ride value is of major significance to TxDOT, as it is one of the main indicators of the need for pavement rehabilitation; it is used extensively in the flexible pavement design process (FPS 11 and FPS 19). Within PMIS, the ride values are converted into a Ride Utility score from 0 to 1.

To arrive at a final PMIS Condition Score for each segment of highway, the Distress Utility and Ride Utility scores are combined as shown below.

$$CS = 100 \times U_{DS} \times U_{RS}$$

where:

CS	=	Condition Score,
U	=	Utility Value,
DS	=	Distress Score, and
RS	=	Ride Score.

Pavement Deterioration Curves

Within PMIS, in order to make predictions of trends in pavement condition over time, it is essential to be able to project condition over time and to evaluate the consequence of the four different maintenance and rehabilitation treatments available within PMIS. The basic shape of a pavement's performance curve is sigmoidal (S-shaped). Most of the PMIS distress types have a performance curve (Patching, Raveling, Flushing, Average Crack Spacing, and Apparent Joint Spacing do not). This curve may be represented by the following equation:

$$L_i = \alpha e^{-\left(\frac{\chi \epsilon \sigma \rho}{AGE_i}\right)^{\beta}}$$

where:

L	=	level of distress (for distress types) or ride quality lost (for ride quality);
i	=	a PMIS distress type (e.g., Deep Rutting or Punchouts) or Ride Score;
α	=	alpha, a horizontal asymptote factor that controls the maximum range of percentage distress growth or ride loss;
e	=	base of the natural logarithms (e ≈ 2.71828...);
χ	=	chi, a traffic weighting factor that controls the effect of 18-k ESAL on performance;
ϵ	=	epsilon, a climate weighting factor that controls the effect of rainfall and freeze-thaw cycles on performance;

σ	=	sigma, a subgrade weighting support factor that controls the effect of subgrade strength on performance;
ρ	=	rho, a prolongation factor, in years, that controls "how long" the pavement will "last" before significant increases in distress occur;
AGE	=	pavement section age, in years; and
β	=	beta, a slope factor that controls how steeply condition is lost in the middle of the curve.

The χ, ϵ, and σ factors are curve modifiers used only in the performance curve equations.

Treatment Types and Cost

To provide the greatest possible use to TxDOT pavement managers, PMIS identifies the type of treatment (if any) that each pavement section requires based on the current level of distress and ride. However, these treatment types are broad because PMIS does not have all of the information necessary to propose a specific project-level pavement design.

Within PMIS, only 4 treatment levels are specified: a) preventive maintenance, b) light rehabilitation, c) medium rehabilitation, and d) heavy rehabilitation or reconstruction. These are general cost categories, and, within each, several specific treatment types are possible. For the network level cost estimation, an average statewide treatment cost is assigned to each pavement type and treatment type. Examples of the typical specific treatments within each treatment type and the associated costs are shown in Table 5.

Selection of Treatment Types

Each section is then analyzed to determine if a treatment is needed to provide the desired level of service. PMIS uses the following seven factors to identify if treatments are required:

1. Pavement type,
2. Distress ratings,
3. Ride Score,
4. Average Daily Traffic (ADT) per lane,

Table 5. Examples of Proposed PMIS Treatment Types and Costs.

Pavement Type = 1-3

Treatment Type	Pavement Type		
	1 (CRCP)	2 (JCP, Reinforced)	3 (JCP, Unreinforced)
Preventive Maintenance (PM)	Crack (or Joint) Seal *$6,000 per lane mile* *$3,660 per lane kilometer*	Joint Seal *$6,000 per lane mile* *$3,660 per lane kilometer*	Joint Seal *$6,000 per lane mile* *$3,660 per lane kilometer*
Light Rehabilitation (LRhb)	CPR (Concrete Pavement Restoration) *$60,000 per lane mile* *$36,600 per lane kilometer*	CPR (Concrete Pavement Restoration) *$60,000 per lane mile* *$36,600 per lane kilometer*	CPR (Concrete Pavement Restoration) *$60,000 per lane mile* *$36,600 per lane kilometer*
Medium Rehabilitation (MRhb)	Patch and Asphalt Overlay *$125,000 per lane mile* *$76,250 per lane kilometer*	Patch and Asphalt Overlay *$125,000 per lane mile* *$76,250 per lane kilometer*	Patch and Asphalt Overlay *$125,000 per lane mile* *$76,250 per lane kilometer*
Heavy Rehabilitation or Reconstruction (HRhb)	Concrete Overlay *$400,000 per lane mile* *$244,000 per lane kilometer*	Concrete Overlay *$400,000 per lane mile* *$244,000 per lane kilometer*	Concrete Overlay *$400,000 per lane mile* *$244,000 per lane kilometer*

Note: Treatment costs for rigid pavements proposed by Design Division, Pavements Section.

Table 5 (Continued). Examples of Proposed PMIS Treatment Types and Costs.

Pavement Type = 4-6

Treatment Type	Pavement Type		
	4 (Thick Hot-Mix)	5 (Intermediate Hot-Mix)	6 (Thin Hot-Mix)
Preventive Maintenance (PM)	Crack Seal or Surface Seal *$10,000 per lane mile* *$6,100 per lane kilometer*	Crack Seal or Surface Seal *$10,000 per lane mile* *$6,100 per lane kilometer*	Crack Seal or Surface Seal *$8,000 per lane mile* *$4,880 lane kilometer*
Light Rehabilitation (LRhb)	Thin Asphalt Overlay *$35,000 per lane mile* *$21,350 lane kilometer*	Thin Asphalt Overlay *$35,000 per lane mile* *$21,350 lane kilometer*	Thin Asphalt Overlay *$35,000 per lane mile* *$21,350 per lane kilometer*
Medium Rehabilitation (MRhb)	Thick Asphalt Overlay *$75,000 per lane mile* *$45,750 lane kilometer*	Thick Asphalt Overlay *$75,000 per lane mile* *$45,750 per lane kilometer*	Mill and Asphalt Overlay *$60,000 per lane mile* *$36,600 per lane kilometer*
Heavy Rehabilitation or Reconstruction (HRhb)	Remove Asphalt Surface, Replace and Rework Base *$180,000 per lane mile* *$109,800 lane kilometer*	Remove Asphalt Surface, Replace and Rework Base *$180,000 per lane mile* *$109,800 per lane kilometer*	Reconstruct *$125,000 per lane mile* *$76,250 per lane kilometer*

Table 5 (Continued). Examples of Proposed PMIS Treatment Types and Costs.

Pavement Type = 7-8

Treatment Type	**Pavement Type**	
	7 (Composite, Unwidened)	**8 (Composite, Widened)**
Preventive Maintenance (PM)	Crack Seal or Surface Seal *$11,000 per lane mile* *$6,710 per lane kilometer*	Crack Seal or Surface Seal *$11,000 per lane mile* *$6,710 per lane kilometer*
Light Rehabilitation (LRhb)	Thin Asphalt Overlay *$40,000 per lane mile* *$24,400 per lane kilometer*	Thin Asphalt Overlay *$40,000 per lane mile* *$24,400 per lane kilometer*
Medium Rehabilitation (MRhb)	Mill and Asphalt Overlay *$62,000 per lane mile* *$37,820 per lane kilometer*	Mill and Asphalt Overlay *$62,000 per lane mile* *$37,820 per lane kilometer*
Heavy Rehabilitation or Reconstruction (HRhb)	Remove Asphalt Surface, Replace and Repair Concrete Base *$175,000 per lane mile* *$106,750 per lane kilometer*	Remove Asphalt Surface, Replace and Repair Concrete Base *$175,000 per lane mile* *$106,750 per lane kilometer*

Table 5 (Continued). Examples of Proposed PMIS Treatment Types and Costs.

Pavement Type = 9-10

Treatment Type	Pavement Type	
	9 (ACP, Overlaid and Widened)	**10 (Seal Coat)**
Preventive Maintenance (PM)	Crack Seal or Surface Seal *$11,000 per lane mile* *$6,710 per lane kilometer*	Surface Seal, No Patching *$6,000 per lane mile* *$3,660 per lane kilometer*
Light Rehabilitation (LRhb)	Thin Asphalt Overlay *$40,000 per lane mile* *$24,400 per lane kilometer*	Surface Seal, Light/Medium Patching *$11,000 per lane mile* *$6,710 per lane kilometer*
Medium Rehabilitation (MRhb)	Thick Asphalt Overlay *$62,000 per lane mile* *$37,820 per lane kilometer*	Surface Seal, Heavy Patching *$20,000 per lane mile* *$12,200 per lane kilometer*
Heavy Rehabilitation or Reconstruction (HRhb)	Remove Asphalt Surface, Replace and Rework Base *$175,000 per lane mile* *$106,750 per lane kilometer*	Rework Base and Surface Seal *$62,000 per lane mile* *$37,820 per lane kilometer*

5. Functional class,
6. Average County rainfall (in inches per year), and
7. Time since last surface (in years).

PMIS uses a series of "decision tree" statements to "pick" the treatment type for each pavement section. A decision tree statement might be:

ACP005 RECONST

TYPE OF TREATMENT: Heavy Rehabilitation or Reconstruction (HRhb).

CAUSE: ADT per lane greater than 5,000 **and**
Ride Score less than 2.5.

PMIS uses a "Reason Code" (**ACP005 RECONST** in the example) for each decision tree statement. The "Reason Code" helps the pavement manager identify why PMIS picked the treatment that it did. This is important because there are many combinations of factors which can require the same treatment — PMIS should be able to tell the pavement manager what the specific problem is. PMIS contains over 50 decision trees to assign the appropriate treatment to each pavement type.

Definition of Benefit

By applying a treatment, the pavement manager hopes to improve the section's overall condition (distress and ride quality), not just for the current fiscal year, but for many years to come. Each year that the newly-treated section's condition is better than its original "untreated" condition represents "Benefit" to the agency and its customers.

This concept of "Benefit" can be represented as the area between two performance curves, as shown in Figure 1. The bottom curve is the section's original "untreated" condition over time. This curve is based on the HRhb performance curve coefficients, which are the same as new construction coefficients. The upper curve is the section's "treated" condition over time. This curve is based on

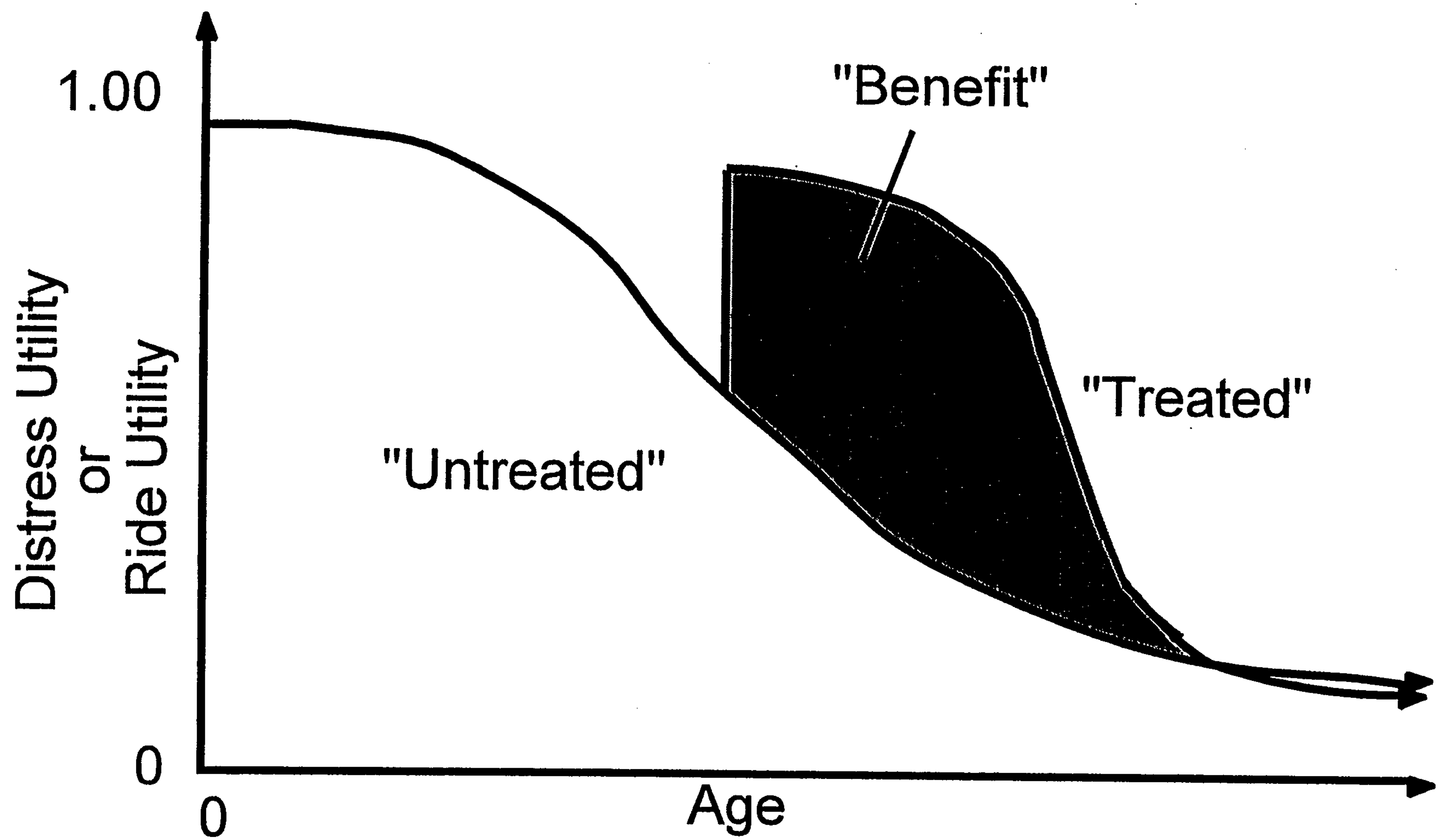


Figure 1. Proposed Definition of "Benefit" for PMIS Optimization Program.

the performance curve coefficients for the treatment recommended in the Needs Estimate routine. The Optimization program uses a trapezoidal approximation to calculate the area between the two curves.

The Benefit is defined as the sum of the distress and ride quality areas, each weighted equally, as shown in the equation below:

$$B = 2 \left[\frac{W_D}{100} A_D + \frac{W_R}{100} A_R \right]$$

where:

B = Benefit of the "needed" treatment (from the Needs Estimate routine);

A_D = Area between the "before" and "after" Distress Score performance curves; and

A_R = Area between the "before" and "after" Ride Score performance curves.

W_D and W_R are weighting factors for Distress and Ride areas, respectively. Currently, both are set to 50.

"Cost Effectiveness Ratio" for Each Section

The purpose of computing the Benefit and Effective Life for each section is to develop a measure which can be used to rank the sections in order of increasing "Effectiveness." The Needs Estimate program does not have such a measure because it does not consider available funding but considers what the engineers think should be done. The Optimization program, however, deals with the "reality" of limited funding, and, when funding is limited, the pavement manager needs a way to determine which sections will provide the greatest overall effectiveness.

To address this requirement, the PMIS Optimization program defines a "Cost-Effectiveness Ratio" for each section, as shown in the following equation:

$$CERatio = 10000 * \left[\frac{LM * B}{EffLife * UACost} \right] * \log_{10} VMT$$

where:

CERatio = Cost-Effectiveness Ratio

LM = Lane Miles

B = Benefit (distress and ride quality)

EffLife = Effective Life of the Needs Estimate treatment, in years

UACost = Uniform Annual Cost of the Needs Estimate treatment, in dollars

VMT = Vehicle Miles Traveled.

The "10000" term in the equation converts the Cost-Effectiveness Ratio values into one- to four-digit integers (instead of small decimal values) which can be easily printed in a report.

As shown above, the Cost-Effectiveness Ratio includes a weighting factor for Vehicle Miles Traveled. In cases where identically "Effective" sections are competing to be the last funded project, this factor gives preference to the section with the higher traffic.

The Cost-Effectiveness Ratio annualizes cost over the Effective Life of the Needs Estimate treatment, as shown in the equation below:

$$UACost = TCost * \left[\frac{DRate\ (1 + DRate)^{EffLife}}{(1 + DRate)^{EffLife} - 1} \right]$$

where:

UACost = Uniform Annual Cost of the Needs Estimate treatment, in dollars;

TCost = Treatment Cost (current or future) of the Needs Estimate treatment, in dollars;

DRate = Discount Rate, in percent per year; and

EffLife = Effective Life of the Needs Estimate treatment, in years.

The equation uses a Discount Rate, which is the expected return on investment if TxDOT chooses not to fund the Needs Estimate treatment.

CHAPTER 2

PROBLEMS IDENTIFIED WITH THE CURRENT SYSTEM

This chapter provides a summary of the District concerns about the current PMIS system. Details of each district's comments are shown in the Appendix to this report. Each concern is described, and an appropriate action item is proposed. It must be emphasized that the vast majority of the District viewed PMIS as a critical resource in their pavement management efforts. The comments and concerns expressed have been provided in the hope of making a good system even better.

PROBLEMS WITH DATA COLLECTION

Poor Quality Condition Data

One major concern expressed by several districts was the repeatability and consistency of the visual pavement condition data. Several Directors of Transportation and Plan Development (TP&D) commented that this was one of the main reasons for their lack of use of the system. Two major factors have recently impacted the perceived quality of the data. The first is the automation of rut data collection, which now means that the visual condition data can be collected without stopping and walking the section. In the past, the raters had to measure ruts manually every 0.8 Km (0.5 miles). They would also use this visual measurement to calibrate their other observations and check for fine cracking. As rutting is now automated, there is no mandatory requirement to stop.

The second factor is the use of consultants to collect the condition data. The fear is that they operate on a production basis, and there is a tendency to drive the sections too fast, missing some of the distress types.

<u>Action Item 1</u> *Develop a standardized auditing procedure to be implemented by district staff. This will include pre-rating of a set number of sections, comparison on ratings with pre-rated results and statistical criteria for acceptability. Contracts should be written to include this review and certification period.*

Need for Automation to Improve Pavement Assessment

Visual pavement data collection is costly and dangerous. The collection cost is running from $18 to $28 mile. As discussed above, there is also concern about the reliability of the manual rating procedures. All of the other data items (rutting, ride, skid, etc) are automated. The need for automation is greatest in the large urban districts. Several districts were concerned specifically about the rating of Continuously Reinforced Concrete Pavement (CRCP), particularly the difficulties of measuring crack spacing on tined pavements. Crack spacing has a big impact on the Needs Estimate calculation.

Action Item 2 *Provide funds to the development of automated distress equipment. Investigate other technologies, for example Infra Red, for crack detection. As soon as practical, implement a prototype system in the urban areas.*

Identification of Crack Sealing

Many districts requested that the visual inspection system be changed to include the state of crack sealing. Some thought that sealed longitudinal and transverse cracks are not themselves a problem. Also, the amount of unsealed cracks would be a very good item to estimate crack sealing contracts.

Action Item 3 *Evaluate what impact including an extra item in the inspection would have on the entire system. The raters should note whether the longitudinal and transverse cracks are a) sealed, b) unsealed, or c) partially sealed.*

Sections with Stabilized Bases

The current flexible pavement inspection system does not adequately define the condition of pavements with stabilized bases. These types of pavements are common in many districts, especially those in East Texas. The Houston District has used this design exclusively for the past 10 years. Stabilized base pavements are not considered as a pavement type within PMIS and there are no adequate inspection procedures or decision trees for needs estimation. On these pavements, the presence of base pumping is a critical item.

Action Item 4 *Make the Pavement Type 7 designation "Asphalt surfacing with heavily stabilized base." This will be restricted to bases designed under Item 276 of the Specifications Book. Develop a new inspection procedure which focuses on the extent and severity of longitudinal, transverse, and block cracking. Develop new decision trees for this new pavement type.*

Network Level FWD Testing for Calculating a Structural Strength Index (SSI)

The need for a structural strength index is still important, but most districts are concerned that the current Falling Weight Deflectometer (FWD) based procedure is not cost effective. The current procedure is expensive, dangerous and difficult to coordinate as the FWDs are generally busy with project level testing. Several districts have also reported that the current structural strength index is for information only and it has little impact on needs estimates.

Action Item 5 *Suspend network level FWD testing until a pavement layer data base is in place. Once a pilot data base is established, coordinate with the Design Level procedures to generate a SSI for each inspection section. Include the SSI information in pavement score calculation process, decision trees, and pavement deterioration model. Furthermore, network level FWD can only be cost effective if it is available in a convenient form to the District personnel for their initial pavement design estimates.*

Bridges Causing Problem with Ride Values

A recurring problem identified was the impact on bridges on the pavement ride value. This is particularly a problem in urban areas with many bridges close together.

Action Item 6 *Provide training to operators on how to exclude bridge roughness from pavement data.*

Problems with the Automated Rut Measuring System

The rut measuring system was thought to be a big improvement, particularly in terms of operator safety. However, several districts commented that measurements made with the rut bars were inconsistent and not representative of actual rut depths. Some of the problems were thought to be weather related. Testing narrow pavements with no paved shoulder also impacted the accuracy of the automated rut measurement equipment.

<u>*Action Item 7*</u> *Provide funds for the next generation of automated rut measuring equipment. Consider placing more sensors on the rubbars. Also develop calibration facilities for annual certification of automated equipment.*

DATA ANALYSIS SCORES, NEEDS ESTIMATE AND PRIORITIZATION

Transverse Cracking Utility Value

It was pointed out that the sigmoidal curve for transverse cracking may need to be adjusted. It takes 3 transverse cracks per station to reduce the score from 100 to 99. In the decision trees, preventive maintenance is recommended for 2 cracks per station. This does not seem to be consistent.

<u>*Action Item 8*</u> *Develop recommendations for adjusting the Rho and/or Beta values for transverse cracking.*

Utility Values for CRCP

The districts thought that light distresses in two categories sometimes produced a very low score; for example, a crack spacing of 10 ft with 2 good patches produced a score of 45. This was thought to be too severe.

<u>*Action Item 9*</u> *A review of the score calculation for CRCP pavements should be made, particularly the impact of crack spacing.*

Ride Utility Values

Most districts thought that the ride values were very reasonable. The only concerns were that, in some instances in urban areas, the rides score has too much impact on pavement scores. Recent research has indicated that the initial ride values on jointed concrete pavements in urban areas are not as high as initially thought. On top of this, in urban areas, curb and gutter drainage inlets and stop and go traffic often impact ride values.

<u>*Action Item 10*</u> *Expand Item 6 to include better training and/or improved capabilities to remove unrealistic ride values. These problem ride values on concrete pavements in urban areas also severely impact the needs estimation procedures. Recommendations should be developed to modify the decision trees to lessen this impact. For these pavements, the focus should be on the distress information, with the ride data being of secondary significance.*

PMIS Needs Estimation Routines

The districts in general thought that the needs estimates were one of the most useful features of PMIS. Over 75% of the districts reported that they have helped with project selection and prioritization.

District Specific Costs

One concern was the need for District specific costs. The current system uses statewide average costs; however, the urban districts pointed out that, if this system is to be used as part of the fund allocation system, then their treatment unit costs are substantially higher because of the additional traffic handling costs.

<u>*Action Item 11*</u> *Investigate the feasibility of switching to District or county specific treatment cost.*

District Specific Decision Trees

The districts thought that the current system worked well for Austin and most District operations; however, several districts wanted to build District specific decision trees for their own internal use.

Action Item 12 *In the next generation of PMIS, the goal will be to move to a microcomputer based system for districts; this feature of District specific decision trees should be included in the new system.*

CRCP Decision Trees

The major concern about the current system was the decision trees for CRCP pavements. Of particular concern was the CRC010, combining rainfall and crack spacing. This was thought to be too severe. It was reported that many pavements in the Houston area have short crack spacings and good performance. The narrow crack spacings are usually only a concern if the ride value starts to decrease. It was also thought that the punchouts and patching trees were too severe; again, if the pavement is stable with good ride and good quality patches, this should indicate reconstruction is not needed (CRC040).

Action Item 13 *A survey should be made of the major urban districts to determine what they feel are the major issues when selecting treatments for these pavements. The decision trees will need to be modified based on this review.*

Optimization and Impact Analysis Programs

The optimization/prioritization schemes depend on the pavement deterioration procedures described in Chapter 1, as well as the definition of benefits and cost effectiveness. In general, the districts view the concept as desirable, but few have tried to use the current system. The comments and action items below were drawn from discussions held with the PMIS support group in Austin. It was agreed that this was one of the areas where enhancements and training were needed to gain the same level of implementation as achieved with the Needs Estimation routines.

Definition of Benefit

The current scheme calculates benefit from an area under the curve concept for treatments ranging from preventative maintenance to reconstruction. However, in the higher level treatments, there are substantially more benefits than improved pavement condition, including upgrading to standards, bridge widenings, safety improvements, etc. The current definition of benefit appears to be only appropriate for level 1 and 2 treatments. The current system does not split budgets; so consequently, only lower level treatments are selected.

Action Item 14 *Review the definition of Benefit and cost effectiveness, particularly the arbitrary traffic weighting factor. (See action Item 15 below)*

Cost Effectiveness Ratios

A problem closely related to action item 14 is the definition of cost effectiveness ratio as essentially Benefit divided by cost, shown in Chapter 1. Figure 2 shows the consequences of the definition of Benefit and the use of the current cost effectiveness equation are shown. This is calculated Cost Effectiveness values for the projects identified in the Paris District. As can be seen, higher cost effectiveness ratios are calculated for the lower level treatments. The average values for the four treatment types are 811, 639, 413, and 204 respectively, with preventive maintenance being 811 and reconstruction being 204. With this definition, few of the reconstruction projects will ever be selected.

Action Item 15 Review the entire cost effectiveness calculation procedure. Consider splitting budgets between treatment types and funding categories, as districts operate in this manner. Consider prioritizing treatments 1 and 2 together and 3 and 4 together.

District Specific Prioritization System

The districts view the current optimization scheme as largely a system for Austin to look at statewide needs and impact analysis. Most districts do not see how the system as proposed will ever

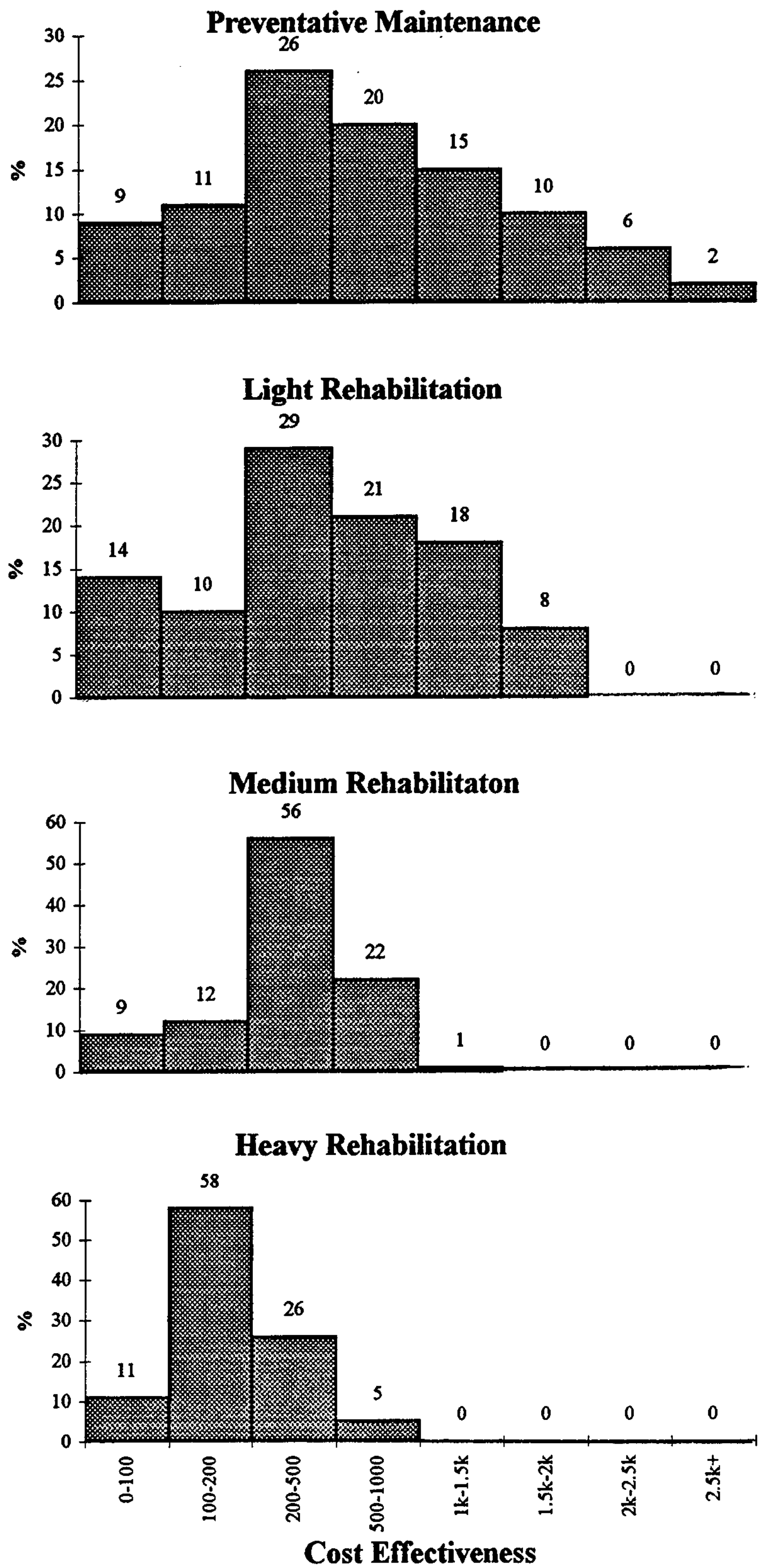


Figure 2. Calculate Distribution of Cost Effectiveness Values for Each Treatment Type for Paris District. This Demonstrates the Low Values of Cost Effectiveness for Higher Cost Treatments.

meet their needs or how it fits into the decision-making structure already in place. A typical District system usually involves the District PMIS coordinator providing the area offices with condition reports of the condition of their network. When a program call occurs the Area Engineers take input from PMIS and maintenance personnel. They often drive to each candidate section. They then decide on treatments and estimate costs. For unusual cases, they request help from the District lab or Pavement Engineer. The Area Engineer submits the request to the Director of TP&D, who reviews the strategy selections and prioritizes the projects, considering needs, state of project readiness, and workload balance. Sometimes, the Director of TP&D requests the help of the Pavement Engineer in evaluating the needs of the various proposed sections.

Selection of the projects and estimation of costs is a critical function of the Area Engineer. The cost estimation includes all patching and maintenance, traffic handling, safety improvements, treatment costs and costs, of other repairs. These cost estimates are hoped to be within 10% of the eventual total job cost. Once a project is approved by the Director of TP&D, it is programmed into the Design and Construction Information System (DCIS), funding is allocated, and plans are drawn up.

Most of the districts recognize that it is this decision process which needs help from improved strategy selection procedures and prioritization routines. Because of the delays in implementing Phase 2 of PMIS (District level PMIS applications), several of the districts have attempted to build automated prioritization schemes in-house. An example from the Corpus Christi District for prioritizing minor rehabilitation projects is shown in Table 6. The estimated cost and proposed treatment information was supplied by the Area Engineer. The final priority is based on maintenance cost, pavement score and the other factors discussed above.

<u>Action Item 16</u> *In the Phase 2 implementation, the concept of a District level prioritization scheme will need to be investigated. This will involve moving from the current 0.8 km (0.5 mi) sections to management sections. It should supply the Area Engineers with the PMIS needs estimate for the section but let the Area Engineer make the project and strategy selection and cost estimate. It should include the concept of workload balance between area offices in the prioritization scheme.*

Table 6. Spreadsheet Prioritization of Area Office Recommendations (Partial Listing) Developed by Corpus Christi District.

FY 97 Minor Rehabilitation Candidates

PRTY	PROJ TYPE	COUNTY	MGR NO	1997 Supplemental State Funded Program HWY	CONT	SEC	Length	MP Begin	MP End	Limits From:	Limits To:	Estimated	Comments	Exist Roadway Surface Width	RUT SH	RUT DP	PATCH	FAL	BLK	ALG	LNG	TRN	ADT RDBD	MAINT COST	DIST SCORE	RIDE SCORE	COND SCORE	TREAT CODE
4	3	Aransas	58	FM 3284	738	3	5.718 MI	3.189	8.907	FM 136	SP 202 In Gregory	$810,000	Rehabilitate Exist. Roadway		1	0	0	0	0	0	1	0	2400	1701	99	4.1	99	
5	3	Aransas	58	FM 2165	2023	1	2.421 MI	0	2.421	FM 1781	BS 35	$225,000	Rehabilitate Exist. Roadway		5	0	0	0	0	0	0	0	3550	33154	98	3.7	98	
6	3	Aransas	58	FM 2040	350	3	5.535 MI	0	5.535	FM 774	Aransas CO. Line	$505,000	Rehabilitate Exist. Roadway		20	0	0	1	0	0	2	0	327	2493	88	3	88	
7	3	Aransas	58	FM 774	447	5	10.455 MI	21.005	31.46	SH 35	SH 239	$950,000	Rehabilitate Exist. Roadway		11	1	1	1	0	1	6	0	593	23835	89	3.4	89	A705
8	3	Aransas	58	FM 1684	2025	1	3.413 MI	0	3.413	SH 35	FM 774	$315,000	Rehabilitate Exist. Roadway		6	0	0	0	1	22	1	0	28	64858	97	3.8	97	
9	3	Aransas	58	PR 13	585	1	2.890 MI	0	2.89	SH 35	Big Tree	$265,000	Rehabilitate Exist. Roadway		1	0	0	0	0	0	6	1	806	-	100	3.1	100	
10	3	Aransas	58	PR 13	585	1	1.280 MI	10	1.28	4-Way Stop	Goose Island Fishing Pier	$120,000	Rehabilitate Exist. Roadway		1	0	0	0	0	0	6	1	806	-	100	3.1	100	
1	3	Aransas	58	FM 1360	1423	1	13.265 MI	1	14.265	SPUR 1360	FM 136	$1,200,000	Rehabilitate Exist. Roadway	18 ft	5	0	1	0	0	1	26	0	820	103743	94	3	93	
2	3	Aransas	58	SH 202	447	4	7.100 MI	7.1	0	US 183	Bee CO. Line	$645,000	Rehabilitate Exist. Roadway		4	0	0	0	0	0	0	0	698	2318	98	3.2	97	
3	3	Aransas	58	FM 136	738	1	11.690 MI	1	12.69	WOODSBORO	FM 2678	$1,060,000	Rehabilitate Exist. Roadway		12	1	8	0	0	1	5	0	1252	81049	86	3.1	85	A705
4	3	Aransas	58	FM 2441	738	6	9.753 MI	9.753	0	US 77	Bee CO. Line	$885,000	Rehabilitate Exist. Roadway		17	6	1	0	0	0	6	0	256	73411	83	2.6	82	A705
5	3	Aransas	58	FM 2441	738	5	3.517 MI			REFUGIO CO. LINE	SH 202	$320,000	Rehabilitate Exist. Roadway		5	0	0	0	0	0	20	0	251	14283	96	2.5	92	
6	3	Aransas	58	FM 774	447	5	21.005 MI	0	21.005	US 77	SH 35	$1,900,000	Rehabilitate Exist. Roadway		11	1	1	1	0	1	6	0	593	29535	89	3.4	89	A705
7	3	Aransas	58	FM 3410	3393	1	1.020 MI	0	1.02	FM 2441	End of Roadway	$95,000	Rehabilitate Exist. Roadway		12	2	0	0	0	0	0	0	10	120	94	2.5	94	A705
1	3	San Patricio	58	FM 631	507	2	1.990 MI	6.994	8.934	FM 1074	FM 2512	$185,000	Rehabilitate Exist. Roadway		2	0	6	2	0	2	4	0	948	112318	92	3.2	91	
2	3	San Patricio	58	FM 1945	1208	2	2.596 MI	0	2.596	CO. ROAD 35	CO. Road 39	$240,000	Rehabilitate Exist. Roadway	18 ft	10	1	12	1	0	5	13	0	438	3322	76	2.7	74	A705
3	3	San Patricio	58	FM 631	507	2	1.988 MI	2.943	4.941	CO. ROAD 55	FM 2046	$185,000	Rehabilitate Exist. Roadway		2	0	6	2	0	2	4	0	948	112318	92	3.2	91	
4	3	San Patricio	58	FM 1068	2521	1	3.078 MI	3.487	0.409	PARK ROAD 25	CO. Road 4	$280,000	Rehabilitate Exist. Roadway		14	1	0	0	0	0	0	0	2901	333	93	3	91	A705
5	3	San Patricio	58	FM 893	1209	1	4.686 MI	5.611	10.297	FM 1074	Walker St. in Portland	$425,000	Rehabilitate Exist. Roadway		24	7	23	0	0	0	10	0	1378	32793	64	3	60	A705
6	3	San Patricio	58	FM 2046	371	5	4.62 MI	1.99	6.61	CO. ROAD 86A	FM 631	$425,000	Rehabilitate Exist. Roadway		23	14	5	0	0	3	9	0	1500	194	66	2.6	57	

It will be necessary to work with the Directors of TP&D to define possible prioritization schemes; this may be a system in which different schemes are available.

Improved Deterioration Curves

From discussion with the Austin PMIS group, researchers find the deterioration curves for flexible pavements appear to be reasonable. However, the rigid pavement curves could be improved.

Action Item 17 *None at this time as this is the subject of a current research study.*

PROBLEMS WITH PMIS OUTPUT REPORTS

The quality of the current reports and the lack of flexibility in presentation format are two of the major complaints about the PMIS system. Considerable summarization is required to get the data into the format required by decision makers. The "District Engineers do not want to wade through three-inch thick computer generated reports; they want charts, graphs and maps." The current problems are largely because the system is mainframe oriented and includes few microcomputer applications (links to spreadsheets, etc.) and no map-based outputs. The next chapter discusses this topic, a few examples of commonly heard complaints are presented below.

Improved Report Format for Optimization Reports

For the optimization/prioritization routines and impact analysis, the current reports were viewed as poor. The mainframe system does not have the flexibility to present the data in an acceptable format for decision makers. Specific complaints about the prioritization reports were that there were numerous pages of sections with "do nothing," and it was difficult to find the top 10 or 20 projects. It was also thought that most of this information would be better in graph and/or map-based format

Action Item 18 *Develop a prioritization report that ranks the projects, providing the ability to identify several sections in every treatment group.*

Map Based Reports

Every one of the districts takes the PMIS condition reports and transcribes the data onto maps. A few use the SAS Graph reports available in Austin, but most want to tie the system to a GIS based system such as Arc/Info. This need has been voiced for at least 10 years and the districts do not see any coordinated progress from Austin on this critical issue. This is very frustrating as most of the consultants and several cities and counties now have map-based pavement management systems. Because of the lack of progress in this area, several of the districts have initiated in-house map-based pilot studies.

<u>*Action Item 19*</u> *Map based reports have been the subject of continual study for the past decade within TxDOT. The technology has been in place for the past 10 years to develop a map-based interface for PMIS. Develop software that will facilitate interfacing PMIS data with GIS.*

PROBLEMS WITH DOCUMENTATION AND TRAINING

Executive Level Training

The district PMIS coordinators did not perceive any problems with the training, documentation and support they received from the Austin PMIS support group; they were very appreciative of the help. However, a common concern was that, even though they understood the strengths and weaknesses of PMIS, there was a lack of understanding at the senior district level. It was recommended that some type of training be developed for District Engineers and Directors of TP&D about what is the best way to use PMIS data. It was thought that this would best be achieved by some kind of video presentation.

<u>*Action Item 20*</u> *Prepare an executive level video no more than 30 minutes in length explaining what PMIS is and how it can best be used at the district level.*

CHAPTER 3

FUTURE DIRECTIONS PHASE 2 SYSTEM DEVELOPMENT

This chapter will present discussion on a range of topics which should be considered in the Phase 2 system development.

DECISION MAKING WITHIN TxDOT

In the broadest sense, pavement management covers all phases of planning, programming, budgeting, analysis, design, construction, and research. However, as currently practiced in the Texas Department of Transportation (TxDOT), the pavement management process includes planning, programming, budgeting, analysis, and design. It is generally described in two levels, network and project-level. These two levels differ in both management application and data collected.

Pavement Management Levels

Pavement management is generally described, developed and used in two levels, network and project-level (1, 2, 3). There are several differences between network-level and project-level management processes. Although the differences vary among agencies depending on the size, organization, and other factors in the agencies, some or all of the following differences are generally found:

1. Goals or purposes of the decisions;
2. Groups or levels within the organization making and reviewing the decisions;
3. Number of management segments considered in the analysis; and
4. Detail of the data and information needed to support the decisions.

The first three define the decision support needed at each level, and the fourth includes the data needed to support those decisions.

Within TxDOT the decentralized decision making has a major impact on PMIS requirements. In project selection a list of segments, generally with an initial recommendation on the treatment, will be submitted to the District Office. From all of those segments submitted by the Area Engineers, a final list is selected by the District, often by a committee, which is then approved by the District Engineer. This list generally has an initial treatment and cost calculated.

Purposes

The purposes of the network-level management process are normally related to the budget process and include:

1. Identifying pavement maintenance, reconstruction, and rehabilitation needs;
2. Determining funds needed to address these needs;
3. Selecting feasible funding options and strategies to be tested;
4. Determining the impact of these funding options on the health of the pavement system as well as the overall welfare of the public;
5. Developing a recommended funding option and funding strategy; and
6. Selecting sections to be recommended for funding within the selected funding option or strategy.

The portion that deals with selecting sections to be funded may also be described as project selection and programming. The primary results of network-level analysis include maintenance and rehabilitation needs, funding needs, forecasted future impacts for various funding options considered, recommendations for funding levels, allocation of funds, and prioritized listings of candidate projects needing repair for the selected option.

At the project-level, the purpose is to provide the most cost-effective, feasible, original design, maintenance, rehabilitation, or reconstruction strategy possible for a selected section of pavement for the available funds. This generally includes:

1. An assessment of the need for construction or cause of deterioration leading to the need for maintenance, reconstruction, or rehabilitation;

2. Identification of feasible design, maintenance, rehabilitation, and reconstruction strategies;
3. Analysis of the cost-effectiveness of the feasible alternatives or treatments;
4. Definition of imposed constraints; and
5. Selection of the most cost-effective strategy within imposed constraints.

Many agencies call this stage design, and, depending on the detail of the analysis, it can include the complete alternative selection and preparation of plans and specifications. Although some authors include construction and quality control/quality assurance in project-level management, TxDOT places those activities under different management systems.

Decision Makers

Those who make the final network-level decisions are generally relatively high within the organization, and they generally have some type of funding authority for the specific funds being managed. In Texas, the State Legislature makes the ultimate decisions about the level of funding for transportation; however, the State Transportation Commission is involved in making strategic level decisions about how the funding is distributed among different activities, usually based on the recommendations of the TxDOT staff. This includes allocation of funds for reconstruction, rehabilitation, preventive maintenance, and other funds that affect pavements. Although the Executive Director and staff are involved in making many of the decisions about which individual segments will be selected for new construction, they are primarily involved in allocating reconstruction, rehabilitation, and maintenance funds to the districts. The decisions about which segments to fund for reconstruction, rehabilitation, and preventive maintenance are generally made at district level. Maintenance funds are generally allocated by the districts to area or section levels.

In most TxDOT districts, the decisions about which segments of pavement to fund for reconstruction, rehabilitation, and preventive maintenance is made through a series of steps; although these steps will vary among the districts, they generally include most of the following. At the appropriate time, the district puts out a program call for the work to the Area Engineers. Those using the TxDOT Pavement Management Information System (PMIS) generally send a list of pavement segments that should be considered when they contact the Area Engineers based on PMIS. The Area

Engineers inspect each section and develop recommendations for treatment, a preliminary estimate of cost, and the program (or programs) from which the project will be funded.

At project-level, the decisions about which segments will receive work have been made; however, some adjustments are generally still made. The final plans, specifications, and contract documents must be prepared. Although the work may have been selected based on pavement maintenance, rehabilitation, or reconstruction, at the project-level it becomes a project that often includes additional work such as culvert replacement, drainage repair, sign replacement, signal installation, safety devices, etc. This additional work can sometimes cost more than the pavement work. In addition, the actual treatment applied to the pavement may change, particularly in the districts where the district laboratory completes a series of tests and develops recommended final treatments.

Number of Segments

In network-level management activities, agencies generally include all of the pavements under their jurisdiction. However, TxDOT, like most state transportation agencies, must actually manage subsets because of funding requirements. Although there is more flexibility in funds than previously, specific funds are still generally defined at district level, and those funds can only be spent on selected types of highways or for selected types of activities. Therefore, after the funds have been allocated to specific funding categories, the management is completed by those categories, probably meaning that the selection of segment will result in a less than optimum allocation of funds. For instance, only the Farm to Market (FM) System can be funded with FM funds, and only selected treatments can be funded with Preventive Maintenance funds.

The quantity of pavement considered in project-level management is normally a single management section, which also often corresponds to an original construction section or a part of an original construction section. However, in the analysis, some management sections may be combined into a single project for contracting purposes. Other sections may be subdivided into more than one segment so that different treatments can be applied to individual portions of the original management section.

Detail of Data and Information

Each purpose, decision level, and review level needs different amounts of information and detail. In general, as the purpose becomes broader, less detail is needed and more summarized information is used. Those making decisions at lower organizational levels make more detailed decisions requiring more complete data. Each level of review varies in data needed and summarization of information.

Data collection is expensive, and funds spent collecting data are not available to be spent on applying treatments to pavements. While many agencies talk about cost trade-offs for data collection, no definitive analysis is available at this time to guide decisions on how much data should be collected. However, we have learned some of the problems of data collection from the experiences of agencies that have used pavement management systems to this point.

We know that we must have the necessary data to support decisions being made at any given time at the appropriated level. In general, know that we will need relatively detailed data to make cost-effective project-level design decisions. If had that data for every section of pavement in the network we manage, we should certainly be able to also support network-level decisions. This has led to the assertion, by some people, that network and project-level management should be combined into a single management system based on the same data set. However, excessive data collection has created problems in implementing and continued use of PMS in the past (2). In general, it is not the initial data collection that has created the problems, but several agencies have not been able to keep the data current. This has led to a loss of confidence in the decision support by the PMS, and the decision support system has been discontinued or used at a minimal level. To avoid this problem, it is recommended that only the data needed be collected at the time it is needed. However, as that data are collected, appropriate data should be retained for future use.

Interfacing Network and Project-Level Elements

Ideally, the network-level pavement management elements should identify funding needs and prioritize sections needing work. They should show the impact of different funding strategies to justify fund requests. However, in an agency such as TxDOT, the funds are allocated among a series of different funding categories before they are allocated to pavement segments. We can think of this as a strategic level, which is normally completed at the departmental level, followed by an intermediate, or tactical, level at the district level where segments are selected. The actual design of treatments normally is completed at the district or area office level. To accommodate this type of management process, it is suggested that a third, intermediate management level needs to be identified in the process.

Project Selection Level

This intermediate level would operate between the network and project-level analysis to assist with project selection and developing more accurate funding estimates. Some of the problems encountered included inadequate time to develop reasonable cost estimates of the segments recommended for funding. As the pavement segment recommended for repair is converted into a project that includes much other work, the funds are often inadequate if the fund recommendations were based only on the pavement repair. In addition, in some cases, treatments were recommended without sufficient investigation, and when the treatments were applied, change orders had to be made or a structurally inadequate treatment was applied to keep within the fund limits.

The purpose of this intermediate level is to provide support at this level. This was identified as a "project selection level" in Reference 3, and would require more data than normally collected at network-level but less data than needed for full project-level analysis and design. The number of segments that would be included should be much fewer than all those in the network but could include more than what will finally be funded.

After completing the normal network-level analysis, those segments that are obviously not candidates for maintenance, rehabilitation, or reconstruction in the analysis period could be removed from further analysis. Those segments for which the appropriate levels of treatment and funding needed are accurate enough can be set for the analysis period, but additional funding for other activities could be added to the estimate. The remainder of the segments can then be identified for additional data collection and analysis; this could include coring and deflection testing for those asphalt pavement segments to determine if they can be repaired by patching and a seal coat or whether a structural improvement is needed. Others might need additional soil tests or field visits to determine if some unique problem, such as swelling soils, would lead to special repairs. It might include surveys of the drainage facilities or other cost items to determine if major corrections are needed that will lead to additional costs being added to the project.

Once the segments are selected, the final design, plans, and specifications can be completed. However, in trials of operating systems with both network and project-level elements, the using agencies ran their network-level analysis and then put the resulting information into the project-level analysis (4). If they didn't get similar results, they felt there was something wrong with the project-level system. Once the user becomes comfortable with a network-level system, the project-level system needs to give similar results, when the same data are used, for the project-level system to have any credibility. The same general analysis concepts used in the network-level decision support software need to be employed in the project-level elements, whenever appropriate. However, it should make full use of more complete data, cost information, and better life estimates.

HARDWARE AND SOFTWARE ARCHITECTURE

The Information Systems Division (ISD) of TxDOT has adopted an architecture for hardware and software use in TxDOT. The following recommendations are based on using that architecture.

Several of the problems encountered in use of the PMIS software were related to the limitations of the current PMIS hardware and software systems. The current PMIS software and data are on the TxDOT mainframe computer system. The data are stored in flat files in ADABASE, and the analysis routines are written in SAS. Data for an individual district can be moved to a microcomputer data base with a significant amount of effort, but not the analysis tools. A series of standard reports are provided, but they are difficult to change or modify.

To make the PMIS software useable to the engineers in the districts and area offices, a user-friendly interface to the analysis tools and data is needed. It is recommended that the PMIS data be stored in SYBASE to allow client server access to the data at district and area office levels. The analysis programs should be written in an object-oriented language compatible with Windows NT. The analysis package should include a group of standard reports, similar to those currently available. However, it should also provide a custom report generator, such as Crystal Reports, that would allow the districts and Area Offices to generate their own reports. All data analysis results should be stored in a data file so that they could be accessed with both the standard and custom reporting procedures.

The software should provide a data export capability so that the districts and Area Offices can export data to Excel or Access to generate tables and graphs as needed.

The data in the PMIS data base should be linked to a Geographic Information System (GIS) so that the Design Division, districts, and Area Offices can generate map based reports. This should also be used to help link the PMIS data to other data bases such as the maintenance, construction, traffic, and bridge data bases.

DATA STORAGE AND INTEGRATION

To determine the maintenance and rehabilitation needs of pavements, the TxDOT uses PMIS. However, there is considerable information in TxDOT that would be helpful for determining the maintenance and rehabilitation needs of the pavements.

MAINTENANCE RELATED DATA BASES

The maintenance crew collect data during the routine maintenance operations. This information could be used in pavement management activities to determine if excessive funds are being spent on pavement related activities. This could be used to identify candidates that should be included in the selection of projects.

The maintenance data are collected and stored in a series of data bases that are briefly described in the following.

Single Entry Screen System (SES)

There are four different mainframe computer systems within TxDOT used for highway maintenance support (MMIS, SLD, EOS, and MSMS). SES has been developed to allow input of data related to the maintenance activity through a single data entry system. SES then sends the appropriate data into each of the four data bases (MMIS, SLD, EOS, and MSMS) to simplify data input and update. Data on the routine and preventive maintenance activities performed on the highway system are recorded in these data bases. Each maintenance activity is identified using a three digit function code, and the amount of work performed is recorded using suitable units.

Maintenance Management Information System (MMIS)

Maintenance Management is divided into two parts, Maintenance Management Information System (MMIS) and Maintenance Efficiency Analysis Reporting System (MEARS). MMIS stores data on selected routine maintenance functions. It draws data from other computer systems (SLD, EOS, and MSMS) to generate reports relating maintenance costs to specific roadway segments. It provides reports to analyze maintenance activities, and it contains cost information, man hour information, and material usage information for a specific highway location and category of work called function code. Work activities are located by reference marker and centerline location for all highways that TxDOT maintains for up to a two-year period of time. The records include both contract maintenance work and non-contract maintenance work.

MEARS is a subsection of MMIS. It compares costs of state work to contractor work by function.

Salary and Labor Distribution System (SLD)

SLD is the primary system for assimilating and reconciling employee time sheet records and Equipment Operating System (EOS) repair order work records. This is done by an edit and compilation process which compares the hours worked, according to the payroll system work records, to SLD time sheet and EOS repair work order records. These hours worked are checked for totals and charge-reasons according to the Budget and Finance Division's (BUD) pre-determined charge numbers. If correct and in harmony with the various other Financial Information Management System (FIMS) information, SLD information is distributed to FIMS. SLD is also responsible for computing EOS repair order work costs to the department for EOS.

Equipment Operating System (EOS)

EOS was designed to establish and maintain inventory control for all the major equipment. Its files are read by Automated Receiving Report System (ARRS). EOS provides reports for all levels of management to properly control the major equipment assets of the department.

Materials Supply and Management System (MSMS)

MSMS is divided into two phases - Inventory Management and Purchasing. The Inventory Management phase provides the department with an on-line computerized inventory of all materials and supplies. Goods may be received by the warehouse and issued at a later date. Stock levels, locations, and asset values are maintained automatically through MSMS transactions. The Purchasing phase provides the department with an Automated Purchasing System (APS). This system reduces the procurement cycle by eliminating duplicated effort and by reducing clerical backlogs.

Effective inventory, control and management of equipment and materials used for maintenance can help the department use its resources in the most efficient manner. The data required for this purpose are available in EOS and MSMS. These data, along with the data on availability of labor (from SLD), can be used in planning the maintenance activities. The combination of labor, equipment, and materials which is most cost-effective for maintenance activities can be determined. The data from SLD, EOS and MSMS is also used by MMIS to generate cost reports on maintenance activities. Based on the labor, equipment and materials available, the treatment strategy which is more effective and economical can be determined.

Financial Information Management System (FIMS)

FIMS was designed to maintain and control financial data for the department. Its two primary functions are to aid the Budget and Finance Division (BUD) in preparing the legislative "100 Day" report and to help the districts track and budget funds. The data transactions of FIMS are controlled by the Master Data Controller (MDC). Information on the money spent on the various maintenance activities is stored under the appropriate maintenance function code. FIMS maintains information on more than a hundred maintenance related activities. It has data on the expenditures for labor, equipment, materials used, and all other costs involved for each individual maintenance activity. These data can be used in planning maintenance activities based on the allocated budget. Once the condition of the highway system and the required maintenance activities are determined, FIMS data can be used to calculate the total money required for the maintenance activities.

Bridge Data Base

The Bridge Inventory and Appraisal Program (BRINSAP) contains data about the "on" and "off" system structures within the state. The term on-system applies to a bridge on the State and the Federal Highway System. The term off-system applies to any other public highway, street or road in the state. The data include inventory, inspection, and rating information about the bridge deck, superstructure, substructure, approaches, and culverts. The file includes some information about the roadway and traffic.

The BRINSAP program is used in the bridge management process to help determine current needs and forecast future needs in funding for rehabilitation, replacement and general maintenance for structures.

Information about bridge needs could be used to coordinate work between pavement and bridge activities.

CONSTRUCTION RELATED DATA BASE

When work is being planned using PMIS, the PMIS software should be able to identify work in progress and work already planned so that those sections of pavement could be screened from the list when determining maintenance and rehabilitation needs. When work is completed, the information about the location of pavement related construction, changes in layer materials, addition of layers, removal of layers, thicknesses of actions, and results of quality control testing could be accessed by the PMIS. This information should be available in the construction related data bases.

Design and Construction Information System (DCIS)

The DCIS is an information system that helps manage highway project development. This system is used to communicate important highway related information between the districts and the Austin office. The letting system is also considered a part of DCIS and is used to enter bid information and to tabulate the bids for each contract, to ascertain a low bidder. The post-letting part of DCIS is used for getting contracts awarded, writing history files, and getting the data ready for entry into FIMS and Contract Information System (CIS). DCIS interfaces with Construction/Maintenance Contract System (CMCS), CIS and FIMS.

Construction Management System (CMS) or the Site Manager

CMS provides information about construction to TxDOT to record and track the status of construction and testing activities. CMS is a very large and complex computer system and is designed to encompass activities in almost every department in TxDOT at different levels.

The function of CMS includes:

- Daily work reports and contract records
- Materials management
- Contractor payments
- Civil rights monitoring
- Contract administration

Site Manager, a new system being developed by the American Association of State Highway and Transportation Officials (AASHTO), is being considered for adoption by TxDOT to replace the construction management system. It will provide the same support as described above. However, it is supposed to be more user friendly and provide better methods of tracking test results. It should be tested in the coming construction season. It is hoped that it will provide information that can be readily used by PMIS about treatments applied and results of tests completed.

The Need for Integration

The management information systems within TxDOT were developed separately, each at a different time. Each system tried to incorporate new ideas and the latest computer hardware and software available. Hence, the management systems available in the department are often incompatible with one another, impeding the efficient and timely flow of information among them.

PMIS should be able to access maintenance data to determine if excessive funds are being spent on pavement related activities. This could be used to identify candidates who should be included in the selection of projects. It should be able to access the BRINSAP program to help coordinate planned work on the pavement with planned work on the bridges and culverts. PMIS should be able to access construction data to identify work in progress and work already planned so that those sections of pavement could be screened from the list when determining maintenance and rehabilitation needs. It should also be able to retrieve information about work completed, including information about the location of pavement related construction, changes in layer materials, addition of layers, removal of layers, thicknesses of actions, and results of quality control testing accessed by the PMIS.

For this to be possible, the data bases need to be integrated in a way that would allow information management systems to access the databases used by the other information management systems.

Need for Using Geographic Information System (GIS)

GIS software is designed to store, retrieve and analyze data that are referenced to a geographic location. Due to the inherent geographic nature of most of the transportation data, GIS concepts can serve as bases for coherent organization of the information systems across the entire range of transportation applications. GIS provides the framework for moving from stand-alone, isolated data bases and applications to truly integrated information systems. The capabilities of GIS in the transportation field will permit the assimilation, integration, and coherent display of data collected and stored by the separate divisions within the department. GIS offers the potential to assemble and process the data from different sources and to display them in a map-based graphical format. However, the most important part for data integration is using GIS to assist with the process of allowing different information management systems to access and use data from the other information management systems.

While integrating the data bases within the department, it is important to start with a core system that can stand alone and have other management systems attached to it. A location referencing system is ideal to start with. The true referencing system in a GIS is location in terms of coordinates. However, for this information to be useable to most engineers, the users of the information management systems must see the location in a form that they can readily understand. In TxDOT, the system developed for locating work on roadways is the Texas Reference Marker (TRM). TRM provides a common location key to link roadway-related data department wide. The current TRM software is supposed to contain information on physical roadway features, geometrics, traffic information, network mileage and administrative data. It also supports the Highway Performance Monitoring System (HPMS) as the department's instrument for certifying total public road mileage to the Federal Highway Administration.

Recommendation on GIS Implementation

Geomatic data and the data currently stored in TRM should be stored in a GIS. The GIS geomatic base data should be standard for all of TxDOT. Global positioning systems (GPS) can be used to locate physical points on the road in terms of coordinates; the GIS is needed to translate those into physical locations in terms of route numbers and TRM.

Other data, such as the condition data on the road surface, currently stored in the PMIS data bases should be stored in a GIS-compatible database, such as SYBASE; SYBASE is the client server architecture software adopted by the Information Systems Division (ISD) for TxDOT. Once the data in each information management system in stored in SYBASE, that data can be linked to physical locations using the TRM data in the GIS. This allows the transfer of data among the various information management systems. However, some data bases will need additional modifications. Currently, the maintenance data are stored only by road centerline, which does not provide adequate location information. Those data need to be stored by road bed location as the data in TRM and PMIS are stored.

MOVING TO MANAGEMENT SECTIONS

The next phase of PMIS development will focus on District level implementation. Currently, the data are stored and reported in 0.8 km (0.5 mile) inspection sections. It is thought that the half-mile sections are adequate for administrative level condition estimation and maintenance needs estimation, but they are very restrictive in the main function of District operations, that of project selection and prioritization. Projects are of any length and frequently contain many half-mile inspection sections.

As described earlier, it is envisioned that the District level system will eventually be used by the District Pavement Engineer to communicate network conditions to the Area Offices and to the Director of TP&D, who make the final project selection. Rather than send the Area Offices a list of 0.5 mile sections with varying conditions and needs, it would be beneficial to move to management sections and come up with a treatment to repair the entire section. The Pavement Engineer would send the Area Office a list of candidate sections and proposed treatments; the Area Engineer would then consider this list as well as input from the maintenance engineers in developing a final project list.

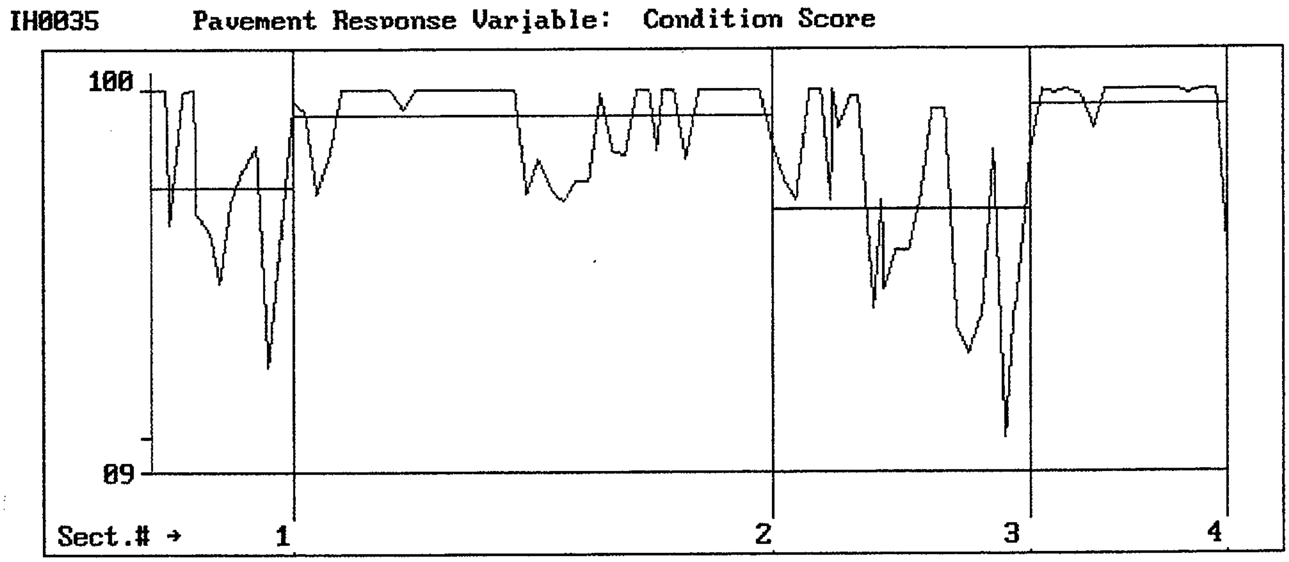
The final list from each Area Engineer would then be forwarded to the Director of TP&D who would then use a district-level prioritization scheme as part of the final project selection. Note: This district-level scheme does not currently exist, but it would be an extension of the current cost effectiveness procedure for network level prioritization.

To accomplish this, two issues need to be resolved, namely

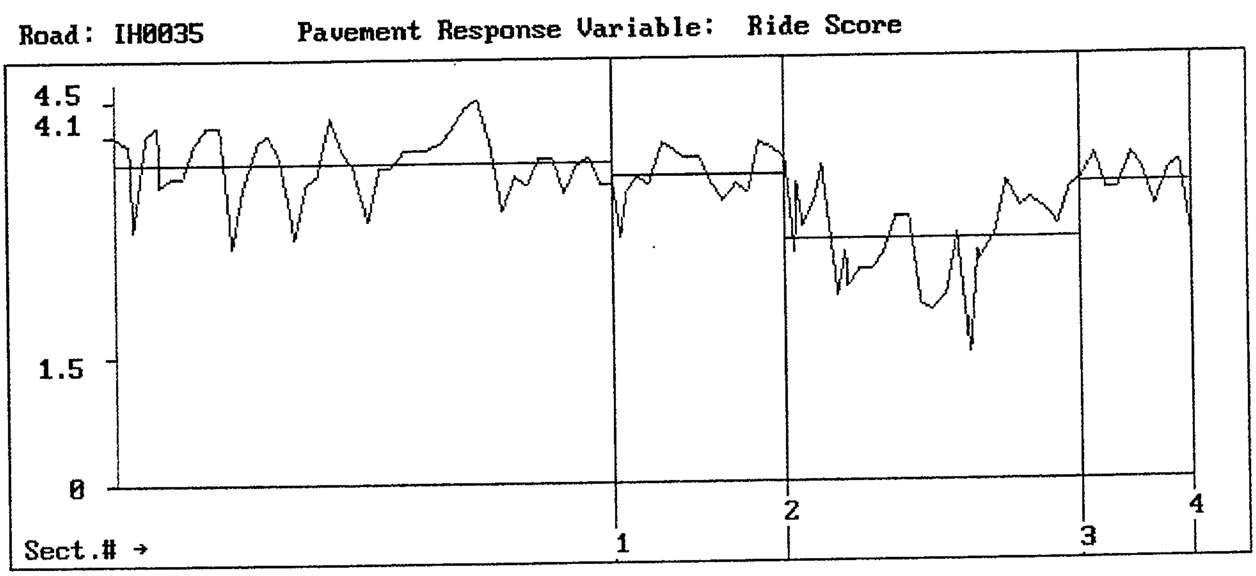
a) How to obtain the limits of management sections, and
b) How to obtain a realistic condition assessment and needs estimation of the selected management section containing several inspection sections.

Each will be described separately.

Three options are available for selecting candidate management section limits. Firstly, the default control section limits could be used. Secondly, the District Pavement Engineer could supply the limits for each proposed section. In the questionnaire responses, most of the districts replied that they could supply potential section limits. A third possibility would be to let the computer review the contiguous 0.5 mile data and automatically decide on section limits based on variations in the ride and condition scores. The Cumulative Difference method is ideal for this type of work; this method is embedded within the MODULUS system to assist is processing project level deflection data. In this study, prototype software was assembled and tested on almost 50 miles of PMIS data from the Laredo District. The results are shown in Figure 3. Four classifications are possible for the combination of ride and condition scores: good/good, good/bad, bad/good and bad/bad. In Figure 3, the section from Milepost 64 to 77 would be classified as bad/bad (bad ride/bad condition), and this would be a candidate management section. The details of how this could be implemented are yet to be worked out, but the concept of using the inspection data and the cumulative difference method to automatically identify candidate management sections is feasible.



Section #	From	To	Mean	S.Dev.
1	38.300	44.000	74.46	22.23
2	44.000	63.500	93.18	10.18
3	63.500	74.000	68.68	26.14



Section #	From	To	Mean	S.Dev.
1	38.300	58.500	3.77	0.39
2	58.500	65.500	3.60	0.30
3	65.500	77.500	2.84	0.55

Figure 3. Using the Cumulative Difference Method to Select Potential Management Section Limits from 0.5 Condition and Ride Data.

Note: For this section of IH 35 the worst condition is from MP 63 to 77 (bad ride and condition); however, a section with a low score and good ride is from MP 38 to 44.

The next issue is: Once a section is chosen, how can it be assigned a pavement condition so that a priority can be defined and the Needs Estimate can be run to define a potential treatment? An example of this is shown in Table 7. This 8.5 mile section of US 77 was considered to be a management section. However, on review of the score and condition data, the section from TRM 632 to 634 + 1.0 is in substantially worse condition than the rest of the section. This example demonstrates why using a simple average is not reasonable. The average score for the section is 69, the average ride is 3.2, and the average treatment is A600, which is a preventive maintenance. If the real goal of the district level PMIS is to come up with reasonable estimates of treatments and costs as the first step in planning project selection for the pavement rehabilitation process, then something other than simple averaging should be used. If the section limits are fixed, the Area Engineers will generally base their rehabilitation strategy on the condition of the worst section. This is because the section is showing variable performance, and the current undistressed sections will also probably start to deteriorate rapidly. Unless it is a very long section, it is unlikely that different strategies will be chosen for different sections within the project limits. Therefore, a scenario of treating the entire length based on the worst should be assumed. The first of two possible alternative for the data shown in Table 7 would be to average the worst mile only (average of any two 0.5 mile sections which would result is a distress score of 32, ride value of 1.9 and recommended treatment of reconstruct); a second alternative would be to use the average condition for the worst adjacent one mile section within the project. Clearly, for the management section concept to be viable, the best way to combine the condition and ride data for many 0.5 mile sections should be the topic of future studies.

IMPROVED OPTIMIZATION/PRIORITIZATION SCHEMES

For PMIS to be integrated within the TxDOT Districts to aid with the current project selection and treatment selection, it must be designed to work within their current decision making process. The key individuals in each district are the District Pavement Engineer, the Area Engineers and the Director of TP&D. The Pavement Engineer sends lists of pavement condition and candidate project information to the Area Engineers. Typically, the Area Engineers take input from other sources such as maintenance personnel. They then drive over each candidate project and develop a recommend

Table 7. Problems with Straight Averaging 0.5 Mile Section into Management Sections. The Middle Subsection has Significant Worse Condition.

PMIS.ADHOC
PMIS.SAS.CONTROL.SECTIONS

RESPONSIBLE DISTRICT: 16

TEXAS DEPARTMENT OF TRANSPORTATION
PAVEMENT MANAGEMENT INFORMATION SYSTEM (PMIS)
CONTROL SECTION RATINGS AND SCORES - DETAIL REPORT
*** ANALYSIS WORK FILE DATA ****

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PROTOTYPE TEST REPORT

COUNTY	MCT	FCLS	HIGHWAY	CONTROL SECTION	TRM MARKERS BEGIN	TRM MARKERS END	LENGTH	ROADBED	PAVTYPE	RBLANES	RUT SH	RUT DP	PAT	FAL	BLK	ALG	LNG	TRN	R	F	ADT (RDBD)	MAINT COST	DISTSCR	RIDESCR	CONDSCR	YR-PCT	TREAT CODE
137	7		BU0077V	0102-12	630.000	638.033	8.000																				
											ASPHALTIC CONCRETE PAVEMENT																
137	7	6	BU0077V	PMIS	630+00.5	630+01.0	0.5	K	6	4	0	0	0	0	0	0	7	0	.	.	7900	146	100	4.2	100	1997	
137	7	6	BU0077V	PMIS	630+01.0	630+01.5	0.5	K	6	4	0	0	0	0	0	1	7	0	.	.	7900	146	100	4.3	100	1997	
137	7	6	BU0077V	PMIS	630+01.5	632+00.0	0.5	K	6	4	1	0	0	0	0	2	6	0	.	.	6700	146	99	4.3	99	1997	
137	7	6	BU0077V	PMIS	632+00.0	632+00.5	0.5	K	5	4	1	0	0	0	0	0	4	0	.	.	4400	4116	100	3.2	99	1997	
137	7	6	BU0077V	PMIS	632+00.5	632+01.0	0.5	K	5	4	0	0	94	0	0	42	0	0	.	.	6700	4116	33	2.5	20	1997	A600
137	7	16<	BU0077V	PMIS	632+01.0	632+01.5	0.5	K	5	4	0	0	100	0	0	56	0	0	.	.	13400	4116	32	2.1	12	1997	A025
137	7	16<	BU0077V	PMIS	632+01.5	634+00.0	0.4	K	5	4	1	0	92	0	0	47	0	0	.	.	17400	3293	33	1.6	6	1997	A010
137	7	16<	BU0077V	PMIS	634+00.0	634+00.5	0.5	K	6	4	1	0	100	0	0	56	1	0	.	.	17400	2926	32	2.3	15	1997	A025
137	7	16<	BU0077V	PMIS	634+00.5	634+01.0	0.5	K	6	4	1	0	0	0	0	25	6	0	.	.	15700	2926	62	2.3	29	1997	A105
137	7	16<	BU0077V	PMIS	634+01.0	634+01.5	0.5	K	6	2<	0	0	0	0	3	50	13	1	.	.	6000	2926	54	3.3	54	1997	A510
137	7	16<	BU0077V	PMIS	634+01.5	636+00.0	0.6	K	6	2<	1	0	0	0	0	0	25	0	.	.	6000	3511	100	3.2	98	1997	
137	7	16<	BU0077V	PMIS	636+00.0	636+00.5	0.5	K	6	2<	0	0	65	0	0	0	63	0	.	.	4500	387	59	3.5	59	1997	A615
137	7	7<	BU0077V	PMIS	636+00.5	636+01.0	0.5	K	6	2<	1	1	0	0	0	0	7	0	.	.	3100	387	100	3.1	95	1997	A705
137	7	7<	BU0077V	PMIS	636+01.0	636+01.5	0.5	K	6	2<	0	0	0	0	0	0	7	0	.	.	3100	387	100	3.3	100	1997	
137	7	7<	BU0077V	PMIS	636+01.5	638+00.0	0.5	K	6	2<	0	0	0	0	0	0	0	0	.	.	3100	387	100	3.8	100	1997	
137	7	7<	BU0077V	PMIS	638+00.0	638+00.5	0.5	K	6	2<	0	0	0	0	0	0	0	0	.	.	3100	19	100	3.9	100	1997	
				*** CONTROL-SECTION SUMMARY ****																							
137	7	6<	BU0077V	0102-12	630.000	638.033	8.000	K	A	3.10	0	0	27	0	0	17	9	1	.		7758	29935	76	3.2	69	100%	A600 ← PM ← AVERAGE
											1	1	100	0	1	56	44	0					32	1.9	9		A025 ← WORST 1 MILE (ANY
																											↑ REC ↓
											1	0	96	0	0	51	0	0					32	1.9	9		A025 ← AVERAGE OF WORST MILE (ADJ.

list of sections needing treatment. This list is then sent to the Director of TP&D who, with the assistance of the Pavement Engineer, makes the final prioritization. In Phase 2 development, this decision-making process must be studied more closely to evaluate the quality, quantity, and timeliness of information flow.

As mentioned in Chapter 2, the type of prioritization scheme which will work at the Director of TP&D level is not understood at this moment. It is acknowledged that the traditional area under the curve definition of benefits may not be appropriate when major rehabilitation and reconstruction projects are under consideration. It is proposed that a study be conducted which will include defining Benefits and cost effectiveness ratios for prioritizing projects for each treatment type, namely preventive maintenance, light rehabilitation, heavy rehabilitation, and reconstruction. The efforts started in the Corpus Christi District are a step in the right direction. In this district, the Area Engineers provide the candidate list, recommended treatment, and estimated cost for light rehabilitation projects. The 0.5 mile PMIS condition data are then summarized within the specified project limits to develop an overall project condition rating and needs estimate. These items then go into the prioritization scheme. The computed PMIS needs estimate can also be used to evaluate if the Area Engineer is proposing a reasonable treatment. It may then be necessary to do a detailed project level investigation, including nondestructive testing for sections which are in dispute or which are deteriorating too rapidly.

PAVEMENT LAYER DATA BASE

The lack of even a basic Pavement Layer Data Base is one of the main limitation of the existing PMIS system. TxDOT has known of this limitation for the past decade, but limited progress has been made in this area, primarily due to a lack of agreement on what are the top priority items to include, limited response from the districts in pilot implementation efforts, and limited funding for a large scale effort. The concept of a Pavement Layer Data Base is under study in another TxDOT research study, and several districts are independently developing the major components of the system, including a date of last surface maps (Fort Worth District).

To address this important issue in a statewide coordinated manner, the following need to be agreed upon.

a) Identify and Collect Only the Minimum Information Required Establishing a data base for the entire 70,000 lane miles will be expensive. It is critical at the outset to define the bare minimum information requirements. From the questionnaires for flexible pavements, the items most mentioned were: date and type of last surface, total surface thickness and base thickness. For CRCP the critical items were identified as pavement slab thickness, base type and thickness. Other items which would be "nice to have," such as aggregate type for concrete pavements, should not be mandatory items for all districts to collect; however, if a district is willing to collect this information, it should be stored in the data base.

b) Define a Data Collection Protocol This is important in sections which have been widened. It is not recommended to collect data in each lane of each highway. In the case of widened sections the outside lane and outside wheel path should be used.

c) Where to Get Data From Forth Worth has used the DCIS system to extract most of its date of last surface information. Ground Penetrating Radar has a place with both flexible and composite pavements in identifying section breaks and the thickness of the top layer. The Road Life development effort in Austin may be able to produce some key items, such as slab thickness and base type. No matter where the basic information is assembled from, it will be the individual district's responsibility to certify that this information is correct.

d) Storage and Reporting Limits Should the information be stored in 0.1, 0.5 mile sections or should dynamic segmentation techniques be used to provide flexibility?

e) Update Procedure How can the system be kept current? This may require some minor change to the documentation completed by a district when each new job is completed.

There are no technical reasons why TxDOT should not have the basics of a Pavement Layer Data Base assembled and in operation for the main highway system within 3 years and for the entire network within 5 years.

CHAPTER 4

RECOMMENDATIONS

Despite the limitations of the PMIS system, it was encouraging to find from the questionnaire responses that the vast majority of the districts (70%) consider PMIS data as an integral part of their network management. Most districts summarize the PMIS data and furnish an annual condition report to the Area Engineers. Most District Engineers want to see color-coded condition maps plus needs and funding estimates. The recent inclusion of the PMIS condition information into the district fund allocation formulae will accelerate district interest in PMIS activities.

It is clear from the interviews and questionnaires that now is the time to "go to the next level" in pavement management development. To proceed, the following are recommended;

1) A Pavement Management Steering Committee similar to the committee in place in the early 1990s should be re-established. That committee consisted of division, district and university personnel. It met at regular intervals to develop a roadmap for PMIS Phase 1 implementation. The committee should address the issues raised in this report.
2) The current PMIS system is well understood and generally liked by most districts. However, problems exist with the system. Several of the most critical problems perceived by the districts are presented in Chapter 2. A total of 20 action items were also proposed to address these perceived problems. The steering committee described above should review and prioritize these items as well as develop and initiate an implementation plan.
3) The steering committee should also develop a clear implementation plan for the District-Level Phase 2 implementation, identifying options, priorities, pilot test programs, research activities and resource requirements. A time line should be constructed and resource requirements identified. This plan should be presented to senior management for approval.

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APPENDIX

This appendix contains both District and division responses to the questionnaire developed in this study. The questionnaire was broken into 7 areas from Data Collection to Future Directions and Miscellaneous. The questions presented to the districts are shown in bold text at the top of the page. Each district's response is given, with the number indicating the District number. Districts 3 and 12 provided two replies to each question. The replies from the Austin division personnel are given at the bottom of each page.

District Review of TxDOT's Pavement Management Information System (PMIS)

Research Study 1420 "*Continued Development of TxDOT's PMIS*" is evaluating the recently-implemented Pavement Management Information System (PMIS). We are trying to answer questions such as:

1. Do the District and division users understand PMIS and how it works?
2. Are the PMIS data and reports useful to pavement managers?
3. Do the PMIS ratings, scores, and analysis results make sense?
4. What improvements are needed to make PMIS even more understandable, more useful, and more reliable?

This questionnaire is the first step in our evaluation of PMIS. Each District Pavement Engineer is being asked to give opinions on how PMIS can be made more understandable and more useful to District users. The questionnaire covers the following major parts of PMIS:

1. Data Collection Activities
2. Data Entry, Storage, and Availability
3. Data Analysis — Scores, Needs Estimate, Optimization, and Impact Analysis
4. PMIS Output Reports
5. Manuals/Documentation and Training
6. Future Developments
7. Miscellaneous.

We will also be conducting follow-up interviews to discuss specific PMIS problems, concerns, and improvements in greater detail.

Section 1. Data Collection Activities

Data collection is the most costly, time-consuming, and labor-intensive part of any pavement management system. Although PMIS cannot operate without reliable pavement data, it is important to reach a balance between the amount of data collected and its usefulness. PMIS currently uses pavement distress and ride quality data which are collected at the beginning of each fiscal year. PMIS also uses pavement deflection and skid resistance data, but collection of this data is optional.

1.1. Do we need to make any changes to the visual distress rating procedures for:

a) Flexible pavement?

1. Have trained personnel in each area office. Have rut bar developed to a stage where it can replace visual collection of rutting.
2. Check to see if they are sealed or not sealed. Need sealed and unsealed.

3a. None.

3b. No.

5. Yes - Make it a pavement position for 3-4 months. That way we can get the same people each year with no hassles from maintenance foreman and with the full support of the Deputy D.E.
6. Yes. Longitudinal and transverse cracking should not be rated, after they has been repaired by maintenance or contract forces.
8. No.
12. Repeatable results seems to be a problem. Much of the rating is subjective, ie. % alligator cracking. Do not have a problem with type of distresses being collected. Not practical many times to walk along the road as the raters are taught.

12a. Base failures in cement stabilized base that result in a slight depression should be counted as more than a transverse crack.

13. We are not sure of the value of counting cracks that are tightly closed or sealed. Any crack can be potentially harmful, especially if they are deep or wide and not sealed. However, when we count cracks in ACP-overlayed concrete sections, we are most probably counting a reflective crack, and it is a given. Like death and taxes, concrete cracks, and ACP on top of it will, too. In a non-composite pavement (more of a true flexible pavement), the formation of cracks can tell us something about the progression of deterioration of the roadway. Perhaps with the overlayed concrete pavements, we should count reflective cracks as a fact of life and not spend a lot of time on them. Perhaps for any cracks, if they are sealed, they should not be counted.
14. No.
17. Contracting out, repeatability/consistency is a problem. Did not use data from last year. It was no good. 10 crews are too many. Need fewer, highly trained crews.
18. Many sections can be rated by one rater instead of 2.
20. Keep field calculations to a minimum, and stabilize entries as much as possible.
22. Yes, automate and change survey time.

Austin Divisions

Pvts. 1. We need to automate the entire process, to improve reliability, increase safety, and reduce personnel required. Otherwise, we need to find some way to distinguish between sealed and unsealed cracks. And maybe pumping...

Pvts. 2. Add severity of distress for flexible pavements.

b) Rigid pavement?

1. None.
2. Need to record longitudinal CRC cracking and evaluate (not all lanes longitudinal joints).

3a. None.

3b. No.

5. Same.
6. Same as flexible pavements.
8. Yes, needs to be revised for small concrete sections such as intersections.
12. None.

12a. Large "holes" that do not meet criteria of punchouts should be considered a distress and counted. At this time, they are ignored. It is sometimes difficult to see the transverse cracks in CRCP, especially if the pavement has been timed. When a wide crack spacing is reported, the impact on the score is quite severe. Resulting in the score being unrealistic.

13. No comment here, because we have so little truly rigid, non-overlayed pavement.
14. None.
17. Same as flexible pavements.
18. Many sections can be rated by one rater instead of 2.
20. Keep field calculations to a minimum, and standardize entries as much as possible.
22. None.

Austin Divisions

Pvts. 1. Again, we need to automate this process.

Pvts. 2. Add measurement for faulting on concrete pavements.

1.2. The current distress and ride data sample is 100 percent each year for IH and 50 percent each year for all other systems. Should this sample size be changed?

1.	I think that the Interstates could fall into the 50% each year category.
2.	No opinion; we're going to try 100%.
3a.	None.
3b.	This is adequate
5.	No.
6.	Yes, I think we should collect 100%; our District found this to be very useful.
8.	No.
12.	Should be 100%, particularly for asphalt roads. Data that is 2 years old is too old to be useful.
12a.	Yes, needs to be 100%, since the system cannot project scores.
13.	There have been times when I wished we could have offered more current information to the users (rather than some of it being also two years old). We're straining ourselves to collect 50%.
14.	100% Austin District. No.
17.	Leave as minimums. Leave modifications to districts. Bryan does 100%.
18.	We may not need 100% of IH frontage roads each year. (How about 50% each year?)
20.	The ideal situation would be 100% for all systems of course, as PMIS plays an increasingly important role in administrative decision making.
22.	No.

Austin Divisions

Pvts. 1.	No, this is plenty of data for the "mandatory" sample.
Pvts. 2.	No comment on sample size.

1.3. The distress and ride data are currently collected between September and December, to provide analysis results in time for the annual Unified Transportation Program calls. But this schedule also "inflates" the PMIS ratings because raters collect data on so many newly resurfaced roads. In light of these conflicting demands, should the distress and ride data be collected at a different time of the year? And if so, why?

1. Not really, but better communication with other programs would help. Most PMIS coordinators are also involved with HPMS, and BRINSAP/PONTIS/SCOUR Contracts. Scheduling needs to be coordinated so that these programs are spread throughout the year, not all being performed, managed or due on or around the same times of the years. This would allow better control and commitments for these programs.

2. No opinion, but have had some complaints.

3a. None.

3b. Ok as is, in my opinion.

5. No.

6. Maybe sometimes after January would be more useful; by then the construction season should be over.

8. Should be at the beginning on the asphalt season prior to distresses being covered by seals or overlays.

12. No, newly resurfaced roads should be in good condition regardless of when the data is collected.

12a. No, need to have recent data for program calls. Newly resurfaced roads would not be a candidate for rehab.

13. Yes, it could be used earlier. By the time the ride info was entered with the visual, we could not use the data to assist in choosing District-wide overlay and seal coat projects. These may be let as early as December, and unless we have current data ready to look at several months before that, we can't use it. It will have to be stored and used for the following year's selection of projects, and then I'm afraid of offering "old data" again.

14. Yes, in the spring (February-April).

17. I like it in the fall, it matches money allocation schedule.

18. Yes, because HPMS data collection get rushed and quality suffers. HPMS deadline was March last year.

20. The data might be more representative of average conditions if it were collected in the spring, but then that would also be the wet season.

22. Yes, late fall or early spring in South Texas.

Austin Divisions

Pvts. 1. No, we just need to get the *Annual Report* results out more quickly, so that districts can use them while planning.

Pvts. 2. Season data collection is in areas with high-swelling clays. Store in PMIS Supplemental 1 and Supplemental 2.

1.4. Is your District willing to collect deflection data for PMIS ("network-level data")? Do you see any value in having this information? Should PMIS contain deflection data only for candidate projects ("project-level data")?

1. Yes, we are willing; however, FWD is a very time-consuming and scheduling nightmare. This data is not used to a great extent. I would recommend to get 100% FWD data in two years on a four-year basis. Any additional information on this four-year span could be collected on a needed basis by the area office or the District.
2. I am debating right now if I should collect such data. I am waiting to see how project level data collection pans out. Currently, don't have a purpose.

3a. No and yes.

3b. After "network-level" is gathered once, only "project-level" should be gathered yearly.

5. Yes, we do network. Yes, there is value in network. No deflection data should be for more than just project level. In our District, we do project, some network and modulus-level testing. Modulus-level testing is: to test a pavement within 3 years of construction/reconstruction to get strength of materials in place.
6. Yes, I think we should collect network - Level FWD data, may be 30% every year, since the visual data do not provide us with base condition.
8. No somewhat, but project-level data can be used for network, yes.
12. Yes, we have not used network-level FWD data, yes.

12a. Yes, need network-level data providing into on-base and subgrade strength.

13. No. No. Yes, we can actually build somewhat of a network level data base over time by collecting and carefully storing data gathered for particular projects. This data should possibly be stored as moduli that have been back-calculated. We may avoid taking more data for some projects, because the subgrade moduli may already be available from a nearby tested section.
14. We already do. No. Yes.
17. No! A waste of time and money. It is also unsafe..
18. Yes, but only 15% ± a year. The value is minimal but is fairly good for comparison purposes. I think PM should include network - level deflection data.
20. Our District supports collecting deflection data for PMIS, as it is an important structural strength indicator.
22. No, do not have a FWD and only need project FWD data.

Austin Divisions

Pvts. 1. Not applicable. But I recommend collection of at least 5 percent per county, for baseline purposes and to find "bad" sections that might have been missed. The information is definitely valuable. PMIS should not contain deflection data only for candidate projects.

Pvts. 2. Network-level seasonal data collection of deflection in areas with high-swelling clays.

1.5. Is your District willing to collect skid resistance data for PMIS ("network-level data"? Do you see any value in having this information? Should PMIS contain skid resistance data only for candidate projects ("project-level data")?

1. Time consuming. Would recommend performing as is currently done. On a needed basis.
2. Yes, yes, no. Should be for all. Helping to select projects for chip seal have their own skid trailer, doing regularly (micro on pcc).

3a. None.

3b. I like to skid all roads at least every third year and collect "project-level" as needed each year. - this gives us good coverage.

5. Yes, Yes, No - skid resistance can be use for aggregate grading.
6. No, we do not collect skid data, and we do not recommend it.
8. Yes, Yes - plans for resurfacing projects where necessary, No.
12. Yes. No. Yes.

12a. Network level data would be useful.

13. Yes, but the Austin District actually does most of the work for us.

    Yes, because we may be alerted to sections that we didn't previously realize were a problem.

    We would always need detailed project-level data that many times is requested by DPS or our maintenance foremen. Network-level collection, because it is a "lick and a promise" compared to project collection, will not find all the trouble areas; but, it will assist us in knowing a certain amount about our system. At random and without prompting from someone in the field, we may be able to head off problems before they become highly visible.
14. We already do. Yes. No.
17. No because of liability issues.
20. Our District supports collecting skid resistance data for PMIS. Our maintenance office has used this data in prioritizing.
22. Yes, if had skid tester and personnel.

Austin Divisions

Pvt. 1. Not applicable. There is value in the information, but it must be collected at least every 0.5-mile (or 1-km). PMIS should have network- and project-level skid data.

Pvt. 2. No comment on skid resistance data.

1.6. Has your District experienced any problems with data collected through automated means? If so, what solutions or suggestions do you have to help correct them.

1. Not really, but a training course for in-depth learning of the automation part would be a great tool. The manual is sometimes hard to follow.
2. No. Using multifunction vehicle.
3a. None.
3b. None.
5. Automated rutting cannot be over written. If field personal visually observe a different value.
6. No.
8. Yes, equipment break downs, difficult to decipher, not enough correlation between automated/manual means.
12. No.
12a. Yes, most urban freeways are rated using video images. This is difficult since the image is two dimensional. Speed of rating is another problem. It is difficult to distinguish the size at the distress or the length of patches.
13. No problems. Actually, the automated rutting data pointed out to us that we had some problems with one team or raters. We may not have audited them for rut if the automated data had not shown a discrepancy.
14. This year's rut data didn't represent what was there. This is a problem with rut bar begin inconsistent. None.
17. Austin (Pavement Design) should manage/control data collection. It would improve consistency and repeatability. Make the District in charge of quality control.
18. Siometer readings across bridges should be omitted because of rough readings. MFV has had some poor quality videos or roadways and couldn't make out the distresses.
20. In 1994, a new concrete pavement in our District was flagged by the FHWA as being deficient with an average shallow rutting index of 24.38; it is believed that the surface tinning of the new concrete was read by the Rutbar as rutting.
22. None.

Austin Divisions

Pvts. 1. Not applicable.
Pvts. 2. Ride data calibration has been a problem on network level. Since a lot of allocation money is riding on the results of this data, I suggest implementing a large calibration site, with restricted traffic utilization, in an area remote from variations influenced by seasonal changes.

1.7. What other changes would you like to see in the way TxDOT collects PMIS data?

1. I do not want TxDOT to start contracting this data.
2. None.
3a. None.
3b. None.
5. Consistency in the people that do the PMIS rating. Support from the Deputy DE and DE.
6. None.
8. Uniformity of the collection of data throughout the state. Same in all districts/
12. None.
12a. None.
13. as fully automated as possible. As a Pavement Engineer/BRINSAP coordinator, I am more worried about getting the data collected than I am in using it. I think we should be users-not collectors. With a shortage of personnel, my supervisors give us help in collecting the data. If we get it done on time, we've met the PMIS requirement for the year, and getting use out of the data is a bonus.
14. None.
17. None.
18. Be allowed to use "one man" visual raters when distress conditions permit. The Siometer operator can stay ahead of visual raters and be able to tell the roads with few distresses that can be rated by a single rater.
20. More automation as new technology becomes available.
22. None.

Austin Divisions

Pvts. 1. I want to see it all automated and measured, as soon as possible. We are using the data for too many important things to afford the luxury of worrying about the quality of the data.

Pvts. 2. Implement routing of data collecting progress reports to SMT, and DES.

Section 2. Data Entry, Storage, and Availability

Once the PMIS data have been collected, they are uploaded or keypunched to the mainframe database for validation and storage. Only then are the data available for reporting and analysis. In this section, we would like to ask for your opinions of PMIS data entry, storage, and availability.

2.1. Currently, PMIS allows use of three methods for entering distress data: uploading from laptop computers; keypunching from computer-generated distress rating forms; and on-line data entry from manual rating forms. Do you have suggestions for any other improvements to these methods?

1.	No.
2.	No. No problems. Upload from micro is best.
3a.	Scanning and optical character recognition.
3b.	No, like it as is.
5.	Arbiter bites - the system is too complicated. I have to have someone from Automation do mine because there are no classes/manuals.
6.	I suggest connecting the laptop to a DMI and assigning the computer keys such as "F" keys will make it easier to collect data faster and continuously.
8.	No.
12.	No.
12a.	Will not accept change in pavement type in batch mode, and changes will not always be reflected in next year's data.
13.	No
14.	No
17.	Go directly to ROSCO. The District uses paper, most consultants use laptops. Probably should provide laptops. Consistency of keystrokes in ROSCO/CISC programs.
18.	Form rating is best for back-up purposes and other notes.
20.	No.
22.	Used laptop last year to upload all survey data.

Austin Divisions

Pvts. 1.	They seem to working well, but I don't have to enter data.
Pvts. 2.	None

2.2. PMIS allows uploading of ride data from laptop computers, with no keypunching of data required. Do you have suggestions for any other improvements to this method?

1.	No.
2.	None.
3a.	No.
3b.	No - good method.
5.	Same.
6.	No.
8.	No.
12.	No.
12a.	Went smooth.
13.	No.
14.	No.
17.	
18.	No.
20.	No.
22.	None.

Austin Divisions

Pvts. 1. I would like to see all PMIS data -- not just Ride -- tied to a specific point on the road (using GPS latitude and longitude) for storage. Then we would need to have a way to dynamically store/report the data into pre-defined or user-defined segments. Ideally, we should not even have to do an annual segmentation for PMIS. Such a dynamic segmentation capability would allow us to merge PMIS data into other files such as research databases, SHRP sections, load-zoned roads, control-sections, and so many others.

Pvts. 2. None

2.3. Have you had any problems uploading PMIS data to the mainframe? If so, what were they? How could these problems have been prevented?

1. Yes, I do not recall the problems, but in-depth training would have eliminated this problems.
2. No.
3a. None.
3b. No.
5. Most people can't get into Arbiter without help and training.
6. No.
8. No, N/A.
12. No.
12a. Can only be uploaded through Arbiter which will be eliminated in a couple of months.
13. The Windows-based transfer program was a lot easier that the Arbiter longhand method. We're told (from our AA) that it can't be used any more with the network.
14. Arbiter tends to crash sometimes.
17. No, more training.
18. No.
20. No.
22. None.

Austin Divisions

Pvts. 1. Arbiter! It takes some getting used to, and with Windows it is a memory hog. Craig's Transfer program makes it much easier, though, but that is work we should not have had to do (nor should we have even been able to!).

Pvts. 2. None

2.4. PMIS allows on-line and batch editing of its data files. Have you had any problems editing your PMIS data? How could these problems have been prevented?

1.	No, better training.
2.	No.
3a.	None.
3b.	No.
5.	No.
6.	No.
8.	No - NA.
12.	None.
12a.	See No. 1 (2.1).
13.	No.
14.	No.
17.	No, more training.
18.	No.
20.	No.
22.	None.

Austin Divisions

Pvts. 1.	Not applicable to me.
Pvts. 2.	None.

2.5. After the data has been stored, how long do you have to wait before it becomes available to you for analysis?

1.	Not long - no problems.
2.	Immediately. Don't get scores until all data entered.
3a.	None.
3b.	No availability problems.
5.	I don't know.
6.	About three.
8.	Before we need it to this point.
12.	Not long.
12a.	Never had to wait.
13.	No wait after it has been stored.
14.	No time.
17.	Immediately available.
18.	Sometimes, about 2 weeks.
20.	I believe, about a month or so.
22.	Some immediate, some longer, may be a month.

Austin Divisions

Pvts. 1.	This is a trick question - you don't have to wait. Getting the data into the Needs Estimate, Optimization and Impact Analysis programs is another matter; but, at worst, that is done every two weeks, or we can build the data file upon request.
Pvts. 2.	None.

Section 3. Data Analysis — Scores, Needs Estimate, Optimization, and Impact Analysis

The first step in analyzing the data occurs when PMIS computes Distress, Ride, Condition, SSI, and Skid Scores for each 0.5 mile Data Collection Section. These scores range from 1 ("very bad") to 100 ("very good"), except for the Ride Score, which ranges from 0.1 ("very rough") to 5.0 ("very smooth"). PMIS Scores appear on the Ratings and Scores reports and on the Raw Data reports.

The next step is to run the PMIS Needs Estimate program, which uses a series of decision trees to relate pavement distress and ride quality to the level of treatment needed. These levels of treatment are: Needs Nothing ("NN"), Preventive Maintenance ("PM"), Light Rehab ("LRhb"), Medium Rehab ("MRhb"), and Heavy Rehab/Reconstruction ("Hrhb").

The final step is to run the PMIS Optimization and Impact Analysis program, which uses a series of pavement deterioration curves to predict future pavement conditions and needs over time, based on user-defined funding levels. The Optimization program generates a ranked list of 0.5 mile Data Collection Sections for each fiscal year. The Impact Analysis program generates summary tables which describe "before" and "after" effects of funding, truck traffic, and treatment decisions on pavement condition and needs.

These analysis procedures are the heart of PMIS. They are meant to go beyond the traditional reporting of entered data and convert that data into meaningful information which can be used to improve pavement decisions.

We are very interested in learning if your District has compared these analysis results to your own field observations and recommendations. If you have found that any of the analysis procedures are not useful to you, or if they are difficult to understand, please let us know in the questions below.

Step 1 — Compute PMIS Scores (Distress, Ride, Condition, SSI, and Skid)

3.1.1. A few districts have expressed concern that some of the distress types have too much (or not enough) impact on the PMIS Distress Score. Have you compared any of the distress ratings and Distress Scores with your own observations and recommendations? Did you find any instances where they did not make sense? If so, what was the problem?

1. No.
2. No. Different Deducts - Seal vs. Unseal - Long Crack

3a. No.

3b. We use the scores to reinforce decisions made by observations. Also use for budget request support documentation.

5. None observed.
6. None.
8. Just when we have just sealed a section of road or get some "healing over" from the hot summer.
12. Yes, some distress types such as logitudinal and transverse cracking have too much impact, while distresses such as alligator cracking do not have enough impact. Patches do not count nearly as much as failures. Quite often a failure is a future patch that has not yet been repaired.

12a. Crack spacing in CRCP carries too much weight. Quite often this input is not reported correctly, since it can be difficult to see tight cracks, especially on tined pavements. The impact of patches vs. failures needs to be investigated. If have light distress in two categories, the score may be very low. i.e. on CRCP 10' crack spacing with 2 patches and a score of 45.

13. No - We simply have not had the time or made the time to find faults with our system.
14. Patching has too high of an impact on Distress Scores.
17. None.
18. We think that distresses and rutting do not have the correct/impact on the scores.
20. In all cases where we have compared, we have found no discrepancies.
22. Yes, except for the Interstate.

Austin Divisions

Pvts. 1. Block cracking is the only distress type that I remember to be seriously "out of line." Its effect needs to be reduced. Of more concern is the behavior of the sigmoidal utility curves at the "top" of the range. For example, on Pavement Type 10, it takes the following ratings to lower the Distress Score to 99: Shallow Rutting, 5 percent; Deep Rutting, 4 percent; Patching, 3 percent; Block Cracking, 3 percent; Alligator Cracking, 2 percent; Longitudinal Cracking, 40 feet/station; and Transverse Cracking, 3 per station. In fact, because of these ratings, the Needs Estimate program will recommend a PM treatment for Transverse Cracking greater than 2 per station, even though the Distress Score is 100! This doesn't make sense. Conceptually, only those roads with no distress should have a Distress Score of 100.

Pvts. 2. Suggest adding a menu option to allow the printing out of reference information for PMIS variables and analysis.

3.1.2. Other Districts have also expressed concern that the PMIS Ride Scores are too high (or too low). Have you compared any of the PMIS Ride Scores with your own observations and recommendations? Did you find any instances where they did not make sense? If so, what was the problem?

1. No.
2. No. Seems appropriate
3a. No.
3b. Usually "line-up" with our observations.
5. None observed.
6. We had good experiences with the ride data.
8. Did not find differences and felt they correlated in most instances but you have to still drive the road to know. Still have to use engineering judgement.
12. Yes, but they can usually be explained, i.e. jointed pavement or curb and gutter section. This needs to be accounted for or noted when collecting data. It may also be useful to separate these types of pavements.
12a. Seem ok.
13. No. We simply have not had the time or made the time to find faults with our system.
14. Ours are right on target. No.
17. No.
18. We feel that ride score has too much of an impact on the condition score.
20. The scores appear reasonable to me.
22. No.

Austin Divisions

Pvts. 1. Ride Scores on most urban highways lower the Condition Score by too much. Part of this problem is that bridge decks have not been "commented out" of the data file, but shouldn't we be able to locate bridge decks beforehand? After all, they don't move very often. OH, well this is another problem for another day! Variable speeds ("stop and go" traffic) mess up the Ride data, too. The Siometer/rutbar equipment codes do not "notice" long-wavelength roughness, such as that caused by swelling clays (or "poor" compaction). Hopefully, profile-based equipment will address that problem, but I remember that we had similar hopes ten years ago when we replaced the Mays Ride Meters with the first Siometers. We shall see, I guess! I would suggest addressing these problems first before we do any serious tinkering with the Ride utility values (ADT, Speed Limit, and other stuff).

Pvts. 2. Ride Score on many sections showed improved quality from 1993 to 1994, even though many of the section had no treatment applied. Similar calibration problems occurred in the late 1980s with Ride data.

3.1.3. Finally, some pavement managers have been concerned that the PMIS Condition Score does not always represent actual road condition (especially in the case of "moderately rough" roads in urban areas). Have you compared any of the PMIS Condition Scores with your own observations and recommendations? Did you find any instances where they did not make sense? If so, what was the problem?

1. One problem is for isolated sections or areas that have generally lower scores - (i.e. tight curves with super, intersections and higher traffic) can bring the overall score for the road condition down.
2. No. Seems Appropriate.

3a. No.

3b. Usually fall fairly close to observations.

5. None observed.
6. No.
8. See 2.
12. We mainly use distress scores. Due to problems mentioned in #2 the ride score sometimes changes the conditions score too much.

12a. Yes, heavy traffic can have a significant impact on score.

13. No. We simply have not had the time or made the time to find faults with our system.
14. Ask me next year.
17. Modify factors to include Maint cost/Mi, traffic, cost effectiveness index.
18. Ride data on distress free concrete makes bad predictions (especially on 25 mph to 40 mph roadways) Siometer readings across bridges are misleading of the "Pavement" ride.
20. The scores appear reasonable to me.
22. None, except the Interstate needs criteria should be changed.

Austin Divisions

Pvts. 1. Well, I answered my own question. "Moderately rough" roads in urban areas is the biggest problem with the Condition Score. It is also one of the biggest problems with the Needs Estimate program - it drives pavement needs in the metropolitan Districts into the stratosphere and draws funding away from badly-needed rehabilitation work in rural Districts.

Pvts. 2. No comment on the representation of the PMIS Condition Score.

3.1.4. Have you compared any of the deflection data and SSI Scores with your own observations and recommendations? Did you find any instances where they did not make sense? If so, what was the problem?

1. No.
2. Yes - Yes - SSI did not correlate with our distress condition.

3a. Yes - generally accurate.

3b. No.

5. Rating different roadbeds - different lanes.
6. No.
8. No.
12. No.

12a. None.

13. No. We simply have not had the time or made the time to find faults with our system.
14. They correlate well.
17. No.
18. No.
20. I have not compared deflection data.
22. No.

Austin Divisions

Pvts. 1. We have found a bug in the SSI score calculation program. Hopefully, it will fix the major problems with SSI. Bob Briggs always complained that it was not possible to have an SSI score between 92 and 100 --when we plotted the cumulative distribution of SSI scores, there would always be an ugly-looking flat line for values 93-99, and then the "curve" spiked up to 100. Again, maybe that was caused by this SSI bug.

Pvts. 2. No comment on deflection data and SSI scores.

3.1.5. Have you compared any of the skid numbers and Skid Scores with your own observations and recommendations? Did you find any instances where they did not make sense? If so, what was the problem?

1. No.
2. No.
3a. No.
3b. No.
5. N/A.
6. No.
8. Yes, sometime areas that are flushed doesn't show, especially if using automated; but, using manual override, you can sometime get the expected results.
12. No.
12a. None.
13. No. We simply have not had the time or made the time to find faults with our system.
14. Yes. No.
17. No.
18. No.
20. The scores appear reasonable to me.
22. No.

Austin Divisions

Pvts. 1. I have not compared any of the skid results. The biggest problem I have had with skid is getting data "close enough" or "recent enough" at an accident site to be of any use.

Pvts. 2. I think the PMIS needs estimates will help balance pavement conditions statewide.

Step 2 — Run PMIS Needs Estimate Program

3.2.1. Have you compared any of the PMIS Needs Estimate results (sections, treatments, and costs) with your own observations and recommendations? If so, how well did they match up?

1. In process.
2. Yes, it matched up quite well.

3a. No.

3b. OK.

5. Very well - This is a very good feature when you consider all the variability involved.
6. Yes, there were some minor differences, mainly the costs.
8. No.
12. Yes. Too much information to digest. Did not match. If long cracking and transverse cracking are all that is present, we are not likely to rehab.

12a. Yes, costs are under estimated. Sections selected are questionable.

13. Have not used these results at all.
14. No.
17. Need an option to include District specific decision trees. Use defaults for Austin.
18. Sometimes not well because of a poor ride score on low speed concrete roadways and intersecting roadways.
20. I have not done so yet.
22. Well, except for the Interstate.

Austin Divisions

Pvts. 1. I haven't compared specific treatments, costs, or sections, but I have heard concerns about "excessive" rehab treatments to fix "moderately rough" urban sections, and I have also heard complaints about the CRCP crack spacing and punchouts/patches rehab treatments being "too much." In fact, CTR has recommended projecting a combined number of patches and punchouts — this idea is looking better and better all the time.

Pvts. 2. No comment on PMIS needs estimate results.

3.2.2. Have you ever heard an explanation of the Needs Estimate decision trees (for selecting treatments)? If so, did you understand the explanation?

1. Only from the manual. Overall understood.
2. No. Never heard explt. but understand concept.

3a. No.

3b. Fairly well, yes.

5. Yes.
6. Yes.
8. No.
12. Yes.

12a. Yes.

13. Do not recall getting an explanation.
14. No.
17. Yes.
18. Yes.
20. I don't think I have.
22. Not familiar with them.

Austin Divisions

Pvts. 1. I've heard it, given it, and written it — many times. And it made perfect sense. Just a little sarcasm. I couldn't resist!

Pvts. 2. Feedback I have gotten indicates that Appendix C of the PMIS Manual is fairly useful in determining explanations of the Needs Estimate decision trees.

3.2.3. Have you seen a list of the PMIS Needs Estimate decision trees?

1.	Yes.
2.	No, but would like to!!
3a.	No.
3b.	Yes.
5.	Yes.
6.	Yes.
8.	No.
12.	Yes.
12a.	Yes.
13.	No.
14.	No.
17.	
18.	Yes.
20.	I don't think I have.
22.	

Austin Divisions

Pvts. 1.	Not applicable - I have them. Keeping them current is the problem.
Pvts. 2.	Have seen the code for PMIS needs estimate decision trees?

3.2.4. Are the decision trees adequate for your requirements? Do we need more, or different, decision tree statements?

1. Yes, it provides a general need that can be a basis from which to use or modify to the districts needs or districts own recommendations.
2. No opinion. Must see them first.

3a. ?

3b. A good idea for those with limited maintenance experience, but decisions are usually made according to personal preference and experience guides.

5. I am satisfied.
6. No.
8. Don't know.
12. Don't know.

12a. Need to review.

13. Don't know.
14. None.
17. Need an option to include District specific decision trees. Use defaults for Austin.
18. They are satisfactory. It just seems that in some instances, the ride carries too much weight.
20. N/A.
22.

Austin Divisions

Pvts. 1. Eventually, I think that we need to split up the decision trees for different ACP pavement types (especially for composite — types 7 and 8). Also, many users do not understand that the decision trees ignore Distress and Condition Score. They expect PM to be 80-89 (for example), LRhb to be 70-79, MRhb to be 60-69, and HRhb to be 1-59. That doesn't happen. In fact, it's common to have a PM treatment with a lower Distress or Condition Score than a Lrhb. But the biggest problem I have with the decision trees is that I have no sure way of guaranteeing "closure" on them. In other words, how can I be sure that I have covered all possible combinations of distress, ride, and whatever, without having some roads "fall through the cracks" (so to speak)?

Pvts. 2. No comment on decision trees.

3.2.5. Do you think that the PMIS Needs Estimate will help your District?

1. Yes, currently in process of starting to use.
2. Yes, I use it for selecting/prioritizing preventive maintenance projects.

3a. Yes, if used.

3b. Maybe.

5. It already has.
6. Definitely.
8. If it was easy to use because decision makers get into these systems so infrequently.
12. Not in current format - nice to know.

12a. Yes, they are useless as currently set up. The cost data in the summaries are understated. When looking at the details sheets, you have to look at thousands of lines of "needs nothing" to kind of sections that need some work. Finally, if there is a way to prioritize projects, I have not found it. We really need this ability.

13. Yes, we just need to make it more available.
14. Don't know yet.
17. Need an option to include District specific decision trees. Use defaults for Austin.
18. Yes, to help prioritize.
20. Yes.
22.

Austin Divisions

Pvts. 1. Not applicable, but I hope so. It's definitely helping us.

Pvts. 2. I think the PMIS needs estimates will help balance pavement conditions statewide.

Step 3 — Run PMIS Optimization and Impact Analysis Programs

3.3.1. Have you compared any of the PMIS Optimization and Impact Analysis results with your own observations and recommendations? If so, how well did they match up?

1. No.
2. No. Not compared.

3a. No.
3b. Very little.

5. I make my own decisions and I don't use this PMIS function.
6. Yes, good.
8. No.
12. Not well.

12a. Yes. Not well.

13. No.
14. Haven't used yet.
17.
18. Fairly well.
20. I have not done so yet.
22.

Austin Divisions

Pvts. 1. I haven't, but I've heard that some districts have, with about 90 percent success.
Pvts. 2. No comment on comparison of the PMIS Optimization and Impact Analysis results.

3.3.2. Have you ever heard an explanation of the Optimization and Impact Analysis program? If so, did you understand the explanation?

1. Yes.
2. No. Haven't heard, but would like one.

3a. No.

3b. Some - yes.

5. Yes.
6. No.
8. Has been briefly explained but not used.
12. Yes.

12a. Yes.

13. A short explanation somewhere was given, but we were pressed for time and I don't really think I grasped the explanation.
14. Haven't used yet.
17. Not formally.
18. Fairly well.
20. I don't think I have.
22.

Austin Divisions

Pvts. 1. I've heard it, give it, and written it, too - many times. And it made perfect sense. Just a little more sarcasm. It's getting late and it's been a long day!!!

Pvts. 2. No comment on the Optimization and Impact Analysis program.

3.3.3. If you have used the Optimization program, did the rankings and treatments shown on the report make sense to you?

1. Yes.
2. No opinion. Haven't used.

3a. ?

3b. Some.

5. Yes.
6. Yes.
8. No.
12. No.

12a. Treatments need better definition.

13. Have not used.
14. Haven't used yet.
17. No.
18. We have used the program. Cost effectiveness ratio we do not quite understand.
20. N/A.
22.

Austin Divisions

Pvts. 1. They made sense, but I haven't looked at the results that closely.

Pvts. 2. No comment on rankings and treatments.

3.3.4. Do you think that the PMIS Optimization and Impact Analysis will help your district?

1. Yes.
2. Yes.

3a. It could - if used.

3b. Maybe.

5. Undecided.
6. Yes.
8. Don't know.
12. It can it into appears valid.

12a. If the program works better, see previous page #5.

13. Do not know.
14. None.
17. Not sure.
18. None.
20. Yes.
22.

Austin Divisions

Pvts. 1. I think it will, but there is definitely room for improvement. District users are not familiar with the Optimization and Impact Analysis programs yet. They have gotten familiar with the Needs Estimate program, at their own pace, and we have decided not to push them too far or too fast. But it's clear that we should focus education effort now on these two programs, because many districts are ready to take that next step, and because there are so many benefits to be gained. Dependence on the Analysis Work File is one big problem, because it does not always reflect most-recently stored data. We have also been unable to run statewide optimization for more than 6 years, because the program runs out of CPU time. I would also like to be able to split budgets by treatment type — or at least by PM and rehab. This is the way that districts do their planning. We need to have a report which ranks the projects by Cost-Effectiveness Ratio, so districts can review their "top 10" or "top 20" projects and identify projects that are "on the bubble." I would like to be able to specify conditions at the end of the analysis and have the Optimization program determine funding levels, projects, and treatments, for each year, to meet that goal. We don't have a simple way to summarize the Impact Analysis results. This is a problem because the Impact Analysis is meant to provide summary information for executive decision makers; yet, the program prints pages and pages of printout that very few people understand. Maybe we need some kind of charts or plots or other summary tables...

Also related to Impact Analysis is a longer-term need to be able to specify the parameter to be analyzed. For example, in our PMIS Annual Report, we report pavement condition in terms of the percentage of lane miles in each of five pre-defined condition Classes ("A" through "F"). I would like to report Impact Analysis results in the same way. We also report "overall" condition in terms of the area under the Condition Score cumulative percentage distribution. I would like to report that value in Impact Analysis. And there may be many more measures that we could use. It really should be user-definable. The problem is that we don't have a good query language and analysis engine to make up these parameters "on the fly." ISD has to code all of that stuff from scratch, and then we get crabby when it doesn't work smoothly (considering what has to be done, it's a surprise that it even works at all!).

Pvts. 2. I think the PMIS Optimization and Impact Analysis will help balance pavement conditions statewide.

Section 4. PMIS Output Reports

In this section, we would like you to evaluate the PMIS reports available on the mainframe computer. Are these reports useful to you? Have you had any trouble running the reports or understanding the results? We would also be very interested in finding out about any other reports that you need to have available in PMIS.

4.1. The next few pages have a list of all the current PMIS reports. Please rank the usefulness of these reports and add any comments that you might have about improving or replacing them.

1. OK.
2. OK.

3a. OK.

3b. OK.

5. OK.
6. OK.
8. OK.
12. OK.

12a. None.

13. OK.
14. OK.
17. Before, we ran reports but didn't understand them (no documentation, training), so we didn't use them. Now we can see their benefit.
18. OK.
20. OK.
22. OK.

Austin Divisions

Pvts. 1. OK.

Pvts. 2. OK.

4.2. Which PMIS reports are the most useful to you?

1. Status Report - to be in compliance value ratings and scores report.
2. Distress, skid, needs estimate.

3a. None.

3b. None.

5. Needs/Scores/Multi year.
6. All of them.
8. Distress score, pavement score, ride, rutting deep/shallow, block/trans/long crack, struct strength.
12. Single-year and multi-year score reports.

12a. Status of data collected. Single-year ratings and scores. Multi-year rating scores.

13. Distress Data Report.
    Critical Value Ratings & Scores Report,
    Skid Resistance Data Report,
    Single Year Rating & Scores,
    Ride Quality/SI Data Report.
14. None.
17. Scores. If modified, may use Optimization more.
18. Status report and Optimization report.
20. The Needs Estimate reports.
22. Needs Estimate.

Austin Divisions

Pvts. 1. Raw Deflection Data, Single-Year Ratings and Scores, Multi-Year Ratings and Scores, Needs Estimate (detail, highway system summary, and Executive summary), Optimization and Impact Analysis, Analysis File Build and Status, Report Usage.

Pvts. 2. Average PMIS Scores and Needs Estimates reports by District are currently most useful.

4.3. Which PMIS reports are the least useful to you?

1. Don't know.
2. None.

3a. None.

3b. None.

5. Optimization/Impact Analysis.
6. None.
8. None.
12. Needs estimate and optimization. Data needs to be shown graphically on GIS. Many recommendations are bogus.

12a. I have very little confidence in the needs estimates, optimization and impact analysis. I have not given these reports to anyone outside my section because they could jeopardize the credibility of PMIS and those of us who work with it.

13. All other than above at this time.
14. None.
17.
18. Undetermined.
20. The deflection raw data reports.
22.

Austin Divisions

Pvts. 1. Raw Distress Data, List of Sections to Be Rated -- results are duplicated in other reports.

Pvts. 2. No comment on any least useful.

4.4. What kinds of changes would you like to see made to the PMIS reports? Please attach examples, if you have them.

1. None.
2. None.

3a. None.

3b. None.

5. Less useless numbers, letters, whistles, stuffed animals - Just give me the meat, leave out the garbage - headings subtitles.
6. None.
8. Automatic ranking from worst to best by category or type of road. Graphically display information with quick guidelines from ref mrkr to ref mrkr.
12. Show in GIS. Use date of last surface to identify preventive maintenance projects. Revise score calculation procedures.

12a. The results to be correct.

13. Under the Administrative Summaries I would like to have the average PMIS scores by county.
14. Each report should have a "help screen" attached to it up front, so the uninitiated can read the report.
17.
18. No comment at this time.
20. None.
22.

Austin Divisions

Pvts. 1. "Combined" level of service; use of "and/or" queries in Critical Values Ratings and Scores; list Needs Estimate sections by treatment type; sort Optimization sections by Cost-Effectiveness Ratio; ability to run all reports for multiple Maintenance Sections ("Area Office" reports); more parameters for Impact Analysis ("combined" level of service, Score classes, cumulative distributions, percent of sections or mileage with a particular distress type, percent of "substandard" mileage). The list could go on and on. Would anyone else use these reports? How could we develop, maintain, and document these reports? As mentioned below, the real need is to be able to generate such reports "on the fly."

Pvts. 2. Include in title, what type of weighting, if any, was used.

4.5. What new kinds of reports should be developed? Please attach examples, if you have them.

1. None.
2. None. Does his own prioritize/ranking.

3a. None.

3b. None.

5. Needs estimate should be scored numerically:

100-90	do nothing	60-70	med
80 - 90	preventative	50-60	heavy
70 - 80	light		

6. None.

8. Graphs of roads attached are examples created by our Hamlin office.

12. See example.

12a. List of prioritized sections.

13. Don't know.

14. None.

17. Info for ranking attached reports as described earlier.

18. Needs estimate graphing capability.

20. None.

22.

Austin Divisions

Pvts. 1. We need summary reports for the TxDOT legislative performance measures ("percent of lane mileage in "Good" or better condition" and "percent of lane mileage giving "Acceptable" or better level of service") and the five Unified Transportation Plan (UTP) allocations (based on various percent of "substandard" mileage totals). Examples will be shown in the next **PMIS Annual Report** (expected publication in mid-June, 1996). We also need a Management Section detail report that lists all of the Data Collection Sections (ratings and Scores) and then lists the resulting Management Section limits, ratings, and Scores. And maps! District maps, by county, and state maps, by District (or county), showing average PMIS Scores, percent of "substandard" mileage, maintenance levels of service (all of them), Score classes, funding and lane mile needs, distress ratings, ride quality, deflection values — and practically everything else in the PMIS database. It's not worth trying to list all of the possible PMIS reports — I did that once before (February, 1992) and the notebook came out to 216 reports and 636 pages (double-sided)! What we really need is the ability to generate and summarize our own reports "on the fly" and then save them!

Pvts. 2. GRADES report. Comparisons of individual distress ratings report (i.e. % sections with shallow rutting, deep rutting, etc). Total Lane Miles report. Graphical reports (bar charts, cumulative distribution charts, SAS maps, etc) of PMIS scores and distress ratings by District or County or District-Maintenance Sections. See attached maps as of PMIS data as of 4/22/96.

4.6. When presenting report results to your senior District personnel, do you summarize the outputs or do you show them the regular PMIS reports? What types of reports or summaries does the District engineer like to use? Please give examples, if you have them.

1. The reports are fine I think - I attach info from the manual on how to understand and read the report.
2. I summarize the outputs. Using excel for charts, etc.
3a. None.
3b. None.
5. 1. I must summarize - their time is money and I am getting paid to know and understand PMIS not them.
   2. I show my superiors the truth as I understand it. If the data is inconclusive, I leave it to stand alone. I did not build PMIS and will <u>not</u> defend it.
   3. The data stands or falls on its own, because I will not and do not totally trust it.
6. Pavement condition report on color coded maps generated by GIS.
8. See 4.
12. See #5.
12a. Outputs are summarized in a report by condition score and distress score. Each county is summarized individually as well by highway type.
13. When presenting the data or reports, we generally have hand-written explanations on the printout as well as some xeroxed figures or explanation of values attached.
14. None.
17. Summarize based on special report.
18. We summarize the outputs. This is what he likes.
20. I have presented single-year ratings and critical value ratings results to our design engineer using both summaries and regular reports.
22. Use reports and summarize. How well we compare to other districts.

Austin Divisions

Pvts. 1. Yes, I definitely summarize the outputs! Our most important summaries are in the **PMIS Annual Report**, but we also summarize: Needs Estimate funding, by treatment type; Distress, Ride, and Condition Score grades, by fiscal year; Impact Analysis (average Scores and maintenance levels of service) after Optimization, by funding level.

Pvts. 2. Control-Section summaries of pmis scores and ratings is begin requested by some Districts. Ad-hoc reports are being used to meet this need since PMIS Management Sections cannot be joined across maintenance section boundaries or minor pavement type changes.

4.7. Have you done anything in-house to make the PMIS data and reports more understandable? Again, if you have any examples, please attach them.

1. Above.
2. Yes, I use the data in Excel worksheets.
3a. None.
3b. None.
5. We color the reference marker maps according to the needs estimate.
Red - Heavy Rehab
Orange - Med Rehab
Yellow - Light Rehab
Green - Preventative
Blue - Needs Nothing
6. Yes, we used SAS - Graph to display the PMIS data, and now we use ARC/INFO Geographic information system (GIS) software to display PMIS data geographically. This will make it easier and quicker for the District management and maintenance section to read and analyze.
8. Graphs.
12. See #5.
12a. SAS maps with color coded pavement scores.
13. Only verbal explanations, to the best of our ability.
14. None.
17. No.
18. Explained reports to maint. foremen personally. Give copies of PMIS rater's manual to personnel using the reports and data.
20. I have screen printed PMIS entry screens (showing input procedures) for all of our area offices and maintenance sections. Out PMIS coordinator has also visited individual area office to offer assistance on using PMIS.
22.

Austin Divisions

Pvts. 1. Not as much as I would like — especially with the Impact Analysis reports. Actually, the **PMIS Annual Report** is the best example of how we have tried to make the data and reports more understandable.

Pvts. 2. MAPS - should be available from menus using plotter destination from User Job Submission Profile. See attached maps made using PC-SAS.

Ranking of PMIS Reports:

When filling out this table, please rank the usefulness of each PMIS report using the following scale:

0 — "Never Used"
1 — "Critical" (used extensively)
2 — "Important" (used frequently)
3 — "Useful" (used sometimes)
4 — "Needs Improvement (some value, but could be dropped or improved)
5 — "Not Needed" (report gives little or no value)

CURRENT PMIS REPORT																	
Title	Rank 0-5 District																
	1	2	3a	3b	5	6	8	12	12 a	13	14	17	18	20	22	Pvts. 1	Pvts. 2
Data Collection Reports (PMIS User's Manual Chapter 6)																	
List of Pavement Sections to be Rated	1	0	0	1	1	1		1	1	1	1		1	1	1	3 - See next report.	NA - Not involved in data collection.
Status of Data Collection Survey	1	3	0	1	1	1		2	1	2/0	1		1	3	3	1 - Shows what needs to be done and what has been done.	3 - Tabulate % completed by District, County, etc.
Raw Data Reports (PMIS User's Manual Chapter 12)																	
Distress Data	2	2	2	2	2	1		2	1	½	2		4	2	2	4 - Data found in other reports.	3
Ride Quality Data	2	0 Except as used in needs GST	2	2	2	2		3	2	½	1		4	2	5	3 - So much data. Makes more sense when plotted.	3
Deflection Data	2	2 Except as used in needs GST	1	3	1	1		4	3	½ - We use for pavement design. Are we even getting this as a PMIS report?	3		3	0	5	1 - Both versions (normalized and raw) are critical.	3

CURRENT PMIS REPORT

Title	Rank 0-5 District															
	1	2	3a	3b	5	6	8	12	12 a	13	14	17	18	20	22	Pvts. 1	Pvts. 2
Skid Resistance Data	3	2 Except as used in needs GST	2	2	2	5		4	3	2/1	1		NA	1	Good if skid run	1 - Critical for accident investigations.	3
Automated Rutting Data	2	0 Except as used in needs GST	2	3	2	1		0	0	2	1		4	2	2	3 - Only recently available.	3
Ratings and Scores Reports (PMIS User's Manual Chapter 13)																	
Single Year Ratings and Scores	2	2	2	3	2	1		2	1	2	2	1 - Need definitions of headings. Output to spreadsheet. Used most for location, maint cost, AADT, 18K.	1	1	1	1 - Documents needs estimate treatment code.	2
Critical Value Ratings and Scores	2	2	2	3	2	2		0	2	1	1	1 - Need report option for range, i.e. 30-50, GT, LT.	1	1	2	2 - Needs better query capability (and/or).	1 - Need to show total section length analyzed and lane miles analyzed currently shown. Tabular summaries by District or County or etc. would be a good option.
Multi-Year Ratings and Scores	2	2	2	3	1	1		2	1	2	2	0 - Did not know it was available. Considered important, especially if Surf date, maint cost available.	1	2	2	1 - Used to answer special requests for "all data."	2
Administrative Reports (PMIS User's Manual Chapter 14)																	

CURRENT PMIS REPORT																	
Title	Rank 0-5 District																
	1	2	3a	3b	5	6	8	12	12a	13	14	17	18	20	22	Pvts. 1	Pvts. 2
Average PMIS Scores, by District	2	2	2	2	0	2		3	2	3	0	3 - Of interest, not used extensively.	4	1	2	2 - Average is not the best parameter with our non-normal distributions.	1 - Weighted by section-length. Title should indicate weighting used. At first told submit IRR
Average PMIS Scores, by Highway System	2	2	2	4	0	3		3	3	3	5	3	4	3	3	1 - See previous report.	1 - Weighted by section-length. Title should indicate weighting used. At first told submit IRR
Maintenance Level of Service, by District	2	3	2	3	0	2		3	2	0	5	2 - Very important, but need to be able to modify ranges. Need to be able to do by area office or county.	3	1	3	1 - Essential for routine maintenance budgeting. Needs to add "Combined" level of service.	1 - Percentages weighted by lane mile. Title should indicate weighing used.
Maintenance Level of Service, by Highway System	2	3	2	4	0	3		3	3	0	5	3 - Need to able to do by area office or county.	4	3	3	2 - See previous report.	1 - Percentages weighted by section-length. Title should indicate weighting used.
Needs Estimate Reports (PMIS User's Manual Chapter 17)																	
Detail	0	1	0	3	1	1		4	3	0	3	2 - Important. District should be able to modify costs and decision tres.	1	1	1	1 - Among many things, useful for Management Sections. Need to group sections by treatment type.	3
Highway System Summary	0	2	0	3	1	1		0	3	0	4	2/3 - 2 if modifications made, 3 as is	2	1	2	1	1

CURRENT PMIS REPORT																
Title	Rank 0-5 District															
	1	2	3a	3b	5	6	8	12	12 a	13	14	17	18	20	22	Pvts. 1	Pvts. 2
Executive Summary	0	2	0	4	1	2		3	2	0	5	2/3 - 2 if modifications made, 3 as is	2	1	2	1 - Loaded into Executive Information System.	1 - Should include graphical bar charts and maps.
Multi-Year Needs	0	2	0	3	1	2		3	1	0	3	0 - Not well documented. 3 if we can use own decision trees and costs.	1	3	3	3 - We also need to accumulate treatment types, mileages, and costs in this report to come up with a true "unlimited funding" scenario.	2
Optimization Reports (PMIS User's Manual Chapter 18)																	
List Sections Which Can Be Treated	0	2	0	3	4	1		3	3	0	5	1	2	0	4	1 - Need also to sort by Cost-Effectiveness Ratio. Maybe also group by treatment type (especially Stopgap).	3
District Summary by Highway System	0/3 - Like to know its there if needed	2	0	4	4	3		3	3	0	5	3	4	0	4	3	2
State Summary by Highway System	0/3 - Like to know its there if needed	3	0	4	4	3		0	0	3	5	3	4	0	4	1	2
State Summary by District	0/3	3	0	3	4	3		0	0	3	5	3	4	0	4	1	2
Impact Analysis Reports (PMIS User's Manual Chapter 19)																	
District Impact by Highway System	0/3	2	0	3	4	1		3	2	0	5	1	4	0	3	3	2
State Impact by Highway System	0/3	3	0	3	4	3		3	0	0	5	3	5	0	5	1	2
State Impact by District	0/3	3	0	3	4	3		3	0	0	5	3	5	0	5	1	2

Section 5. Manuals/Documentation and Training

PMIS can be a large, complex system. Although the Design Division has tried to provide many manuals, documentation, and training courses for PMIS over the last three years, they may not have reached the right people, and they may not have met the needs of the people they ***did*** *reach.*

The current manuals/documentation and training for PMIS are listed below:

Current Manuals/Documentation:

- "PMIS User's Manual" *(September, 1994)*
- "Pavement Management Information System" *brochure (February, 1992)*
- "Managing Texas Pavements — An Introduction to TxDOT's Pavement Management System and Concepts" *(January, 1993)*
- "Condition of Texas Pavements — Pavement Evaluation System Annual Report, Fiscal Years 1988-1992" *(December, 1993)*
- "Texas PMIS — Basic Concepts" *12:40 minute videotape (March, 1992)*
- "Texas PMIS — Data, Equipment, Scores, and Information" *15:30 minute videotape (August, 1992)*

Previous/Available Training:

- "PMIS Data Entry and Reports" *(October, 1993, through January, 1994, in Austin)*
- "Introduction to TxDOT's Pavement Management System and Concepts" *(January, 1993, through April, 1993, in 13 District offices)*
- "PMIS Data Entry and Reports" *(available on-site, 8-12 hours)*
- "PMIS Interpretation and Analysis" *(available on-site, 7 hours)*
- "PMIS Concepts for Administrators" *(available on-site, 6 hours)*

In this section, we would like your opinion on the quality and usefulness of the PMIS manuals, documentation, and training courses.

Current Manuals/Documentation:

- "PMIS User's Manual" *(September, 1994)*
- "Pavement Management Information System" *brochure (February, 1992)*
- "Managing Texas Pavements — An Introduction to TxDOT's Pavement Management System and Concepts" *(January, 1993)*
- "Condition of Texas Pavements — Pavement Evaluation System Annual Report, Fiscal Years 1988-1992" *(December, 1993)*
- "Texas PMIS — Basic Concepts" *12:40 minute videotape (March, 1992)*
- "Texas PMIS — Data, Equipment, Scores, and Information" *15:30 minute videotape (August, 1992)*

5.1. Are you missing any of the current manuals/documentation listed above?

1. Yes.
2. No.
3a. Yes - video tapes.
3b. Am sure have received but unsure of locations.
5. Yes - No one ever published a list of available manuals until this questionnaire.
6. Yes, the video tape.
8. I believe we have all the manuals we need.
12. No.
12a. None.
13. No.
14. Yes, PMIS user's manual.
17.
18. No.
20. Yes, the 15:30 minute videotape.
22.

Austin Divisions

Pvts. 1. No.
Pvts. 2. No comment.

5.2. Have you had problems understanding any of the manuals? Are they too complicated? Too simple? Too long? Too short? Too many?

1. Yes, sometimes. It is written to try and be very simple; this simpleness sometimes makes it harder to read/understand. *Would like see cut and dried procedures.
2. No.
3a. PMIS users manual - works for me.
3b. No - No.
5. They need to be on less of a need system more friendly, easier to use, not this ad hoc crap.
6. No.
8. Most of us don't know enough about the system that we need it step by step by step without leaving off any information. It is best to think we are stupid and can't remember our passwords.
12. No.
12a. They are ok. Can usually figure out solution without manual.
13. No to all. We use the PMIS brochure frequently as a reference.
14. No.
17.
18. N/A.
20. No.
22. Need updates, need access to computer system. (I just received the I.D.)

Austin Divisions

Pvts. 1. My biggest problems with the manuals, as might be expected, are keeping them current and distributing them.
Pvts. 2. No comment.

5.3. Would you recommend any other kinds of manuals/documentation for yourself or for other District users?

1. Above comment*.
2. No.

3a. Would like to see what videos have to offer. If not good, then some media to explain system.

3b. No.

5. I still can't get into Arbiler with out help. I'm no computer - how would I ok my automation people know if something is wrong with the way my system is set up?
6. No.
8. No.
12. No.

12a. None.

13. No.
14. No.
17.
18. Updated PMIS Users Manual.
20. No.
22.

Austin Divisions

Pvts. 1. Difficult to say. I want to have everything available immediately - on-line, ideally- but I can only keep up (and do) so much.

Pvts. 2. No comment.

5.4. Have you ever had a PMIS question that you could not answer by referring to the manuals or documentation?

1.	Yes.
2.	No.
3a.	No.
3b.	No.
5.	Yes - obtain - mostly how does this thing work.
6.	No.
8.	We ask CODY.
12.	No.
12a.	None.
13.	Probably, but we can't recall specifics.
14.	Yes.
17.	No.
18.	Yes.
20.	No.
22.	

Austin Divisions

Pvts. 1.	Yes. Then I have to ask one of the program developers or scrounge through the original program and report specifications. This happens more often than I would like to admit (one of the casualties of being promoted to management!).
Pvts. 2.	No comment.

Previous/Available Training

- "PMIS Data Entry and Reports" *(October, 1993, through January, 1994, in Austin)*
- "Introduction to TxDOT's Pavement Management System and Concepts" *(January, 1993, through April, 1993, in 13 District offices)*
- "PMIS Data Entry and Reports" *(available on-site, 8-12 hours)*
- "PMIS Interpretation and Analysis" *(available on-site, 7 hours)*
- "PMIS Concepts for Administrators" *(available on-site, 6 hours)*

5.5. Are there any of the above-listed training courses that you were not aware of?

1. Yes - Most of them.
2. No.
3a. PMIS - data entry and reports - interaction and analysis - concepts for administration.
3b. No.
5. I wasn't aware of any of them.
6. No.
8. There are so many training classes that the users that work with it right away and often are the only ones benefiting from any additional training.
12. No.
12a. None.
13. Yes. PMIS Data Entry and Reports; PMIS Interpretation and Analysis; PMIS Concepts for Administration.
14. No.
17.
18. No.
20. Yes, the "PMIS Interpretation and Analysis" and "PMIS Concepts for Administrators."
22.

Austin Divisions

Pvts. 1. Not applicable.
Pvts. 2. No comment.

5.6. Are there any of the above-listed training courses that you have not attended, but would like to attend?

1.	Yes - Most of them.
2.	No.
3a.	All listed in No. 1.
3b.	No.
5.	I have <u>no</u> idea without a detailed explanation of what they are.
6.	The last two.
8.	See 1.
12.	No.
12a.	None.
13.	Yes, the three above.
14 .	PMIS concepts for administrators.
17.	
18.	No.
20.	Yes, the "PMIS Interpretation and Analysis" and "PMIS Concepts for Administrators."
22.	

Austin Divisions

Pvts. 1.	Not applicable.
Pvts. 2.	No comment.

5.7. If you have attended any of these training courses, do you have any suggestions on how they could have been improved to better meet your needs?

1.	No.
2.	No. Have attended.
3a.	None.
3b.	No.
5.	Same.
6.	No.
8.	Thought Brain S. one day District Show was just about right.
12.	No.
12a.	None.
13.	N/A.
14.	No.
17.	
18.	No.
20.	No.
22.	

Austin Divisions

Pvts. 1.	Have someone else do them. I get bored after the fifth or sixth time.
Pvts. 2.	No comment.

5.8. Would you recommend any other kinds of training courses for yourself or for other District users?

1. No.
2. No. Pavement engineer trains areas.

3a. None.

3b. No.

5. I have gotten to the point where I don't care. I can use 50% of the system -- mostly self-taught -- I cannot get enthusiastic about this stuff any more after all the frustration it's caused me. I repeat, I really don't care.

6. No.

8. No, we tend to get Cody to pull the info we need.

12. No.

12a. None.

13. It would be nice to have a class explaining the Network Analysis Menu.

14. No.

17. PMIS Coordinator and Pavement Engineer should attend together. Central training.

18. No.

20. No.

22.

Austin Divisions

Pvts. 1. I would rather defer on this question to other users.

Pvts. 2. No comment.

Section 6. Future Developments

Several important features are still not available in the current version of PMIS. These features are: Management Sections, Microcomputer Applications, and Layer Thickness and Work History Information ("Road Life System"). A brief description of these features is given below.

We would like to ask your opinion on how important each of these features will be to your usage of PMIS.

Management Sections

PMIS changed the 2 mile sections used in the old Pavement Evaluation System to0.5 mile Data Collection Sections. This was meant to improve the usefulness of the pavement evaluation data, but it created the problem of having four times as many pavement sections to analyze — none of which would likely correspond to a typical candidate project.

To address this problem, the PMIS Project Team came up with the idea of "Management Sections." Management Sections would let the District PMIS Coordinator or Pavement Engineer define candidate projects, based on beginning and ending Reference Marker. PMIS would then use the Management Sections to estimate needs, rank projects, and assess the impacts of funding (and other factors) on "real" projects.

A prototype version of these Management Sections is available in PMIS, but there are still some problems to be fixed.

6.1.1. Before reading this questionnaire, had you ever heard an explanation of the Management Sections concept? If you had, did the explanation make sense?

1. Yes - I read it.
2. No. Hadn't heard.
3a. No.
3b. Yes.
5. Yes.
6. Yes, Yes.
8. Yes, Yes.
12. Yes, Yes.
12a. Yes.
13. No, we hadn't.
14. No.
17. Yes, mostly.
18. Yes.
20. Yes, Yes.
22. Yes.

Austin Divisions

Pvts. 1. Yes. I was there when TTI defined the original PMIS Management Section concept. It didn't make sense at first, but it does now.

Pvts. 2. Have heard explanations of management sections but don't understand why a Maintenance Section cannot be joined across Maintenance Sections boundaries in case pavement engineers want to do so.

6.1.2. Do you think you will be able to define Management Sections for your highway network?

1. Yes.
2. Yes.

3a. DEF - a M.S. is a project location bound by reference marking.

3b. Yes.

5. I could, but I don't believe in it. What I mean is - the system we're using now ain't broke; why mess with it.
6. Yes.
8. Yes, past project lengths.
12. Yes.

12a. Yes.

13. Yes.
14. Yes.
17. Won't, but if done would be based on Control Section.
18. Yes.
20. Probably.
22. Project or similar sections.

Austin Divisions

Pvts. 1. Not applicable. But I would prefer to initially define Management Sections by Control-Section, which is what most districts do.

Pvts. 2. Unless Management Sections can be joined across Maintenance Sections boundaries, Management Sections can never be modified to match Control Section limits.

6.1.3. Do you think that Management Sections will be useful to you?

1. Yes.
2. Yes.

3a. If they make corrected data more accessible.
3b. Possibly.
5. Undecided.
6. Yes.
8. Yes, don't have to filter out the small sections and can get a better picture overall.
12. Yes, but not very important.
12a. Somewhat.
13. Not sure.
14. Yes.
17. If defined "on the fly" based on condition.
18. Yes.
20. Yes.
22. Yes, if access to computer.

Austin Divisions

Pvts. 1. It will help us some, but not much. Now, if we got Management Sections defined by Control-Section, or if we went back to the original "Base" management Sections and "District" Management Sections, that would be better. But the main intent of the Management Sections has always been to help districts work with candidate projects. If we were able to develop a true "dynamic segmentation" process from the Management Sections program and apply it to other types of sections, that would be useful!

Pvts. 2. Management Sections will be useful if allowed to match Control Section limits.

6.1.4. When making a Management Section, PMIS will combine the distress ratings and ride quality data for all of the 0.5-mile Data Collection Sections and combine them into an average set of ratings and scores. For long Management Sections, these averages could be misleading. Should we use some other method to combine the ratings and scores (for example, worst-case, best-case, or some other statistic)?

1. If it could be broken down to allow for scores between R.M.'s of our choice.
2. Yes. Other method may be worst case.
3a. For long sections - yes but I don't know what.
3b. No.
5. No opinion.
6. We usually design for worst case.
8. I think we need some detail which a graph of the details for the management section would give a good indication of where we are overall (average line) and what are the highs/lows/consistency etc.
12. Yes.
12a. None.
13. I think this could mean that we limit the length of the section. For certain maximum lengths, we could use the worst case if the frequency of occurrence is at a certain level. However, for long sections, the info for the 0.5 mile sections should be shown if the worst condition deviates from the median or average by a certain amount.
14. Flag sub-critical value sections or downward trends thru sections.
17. Summary and detail listing.
18. For management section, be able to get both overall average scores and average scores with top and bottom score thrown out. Also, provide breakout with three-mile maximum sections.
20. Maybe the averages can be used along with percentages.
22. Average, variance and list of scores.

Austin Divisions

Pvts. 1. I suggest that we keep the existing length-weighted process. Anything else would be more complicated and no better. As mentioned earlier, it would help to have a report that listed all Data Collection Sections (ratings and Scores) and then a "total" line showing the Management Section.

Pvts. 2. Averages for distress ratings and ride quality ok, but weighting and worse case will be needed for ADT by lane and functional class decisions. Recommend removing functional class from decision trees.

6.1.5. Do you think it would be feasible for PMIS to automatically define Management Sections based on distress ratings or scores?

1.	Don't know.
2.	Yes.
3a.	This could be interesting.
3b.	Maybe.
5.	Couldn't hurt.
6.	No.
8.	No, we need control for use in projects.
12.	Have as an option.
12a.	Maybe.
13.	No, we're set up with CSJs.
14.	No. This is for the district to decide.
17.	Yes, preferable.
18.	Not at this time.
20.	Yes.
22.	No.

Austin Divisions

Pvts. 1.	Or needs estimate treatment? Good luck - I'd like to see the algorithm for that one.
Pvts. 2.	I don't recommend automatically defining Management Sections based on distress ratings or Scores.

Microcomputer (PC) Applications

Although PMIS was designed to be a mainframe-based system, it was planned to provide ways for the districts to download current and historical data files onto their PCS. It was also planned to provide PMIS programs which would run on the PC. This would give the districts flexibility to report the data anyway they needed to, without having to wait on mainframe programs to run.

Although the Design Division expects to release a PC-based data plotting program in May, 1996, there are no other PC-based PMIS programs. A recent mainframe computer upgrade, along with the statewide networking of all districts and divisions, has improved this situation, but the original problem of mainframe- versus PC-based applications remains.

6.2.1. How important is it for you to have PMIS applications running directly on your PC? Would it be acceptable to have PMIS applications running on your network server, instead?

1. Doesn't matter.
2. It is important. Yes.
3a. Not important - Yes.
3b. Not important to me - doesn't matter.
5. No idea - which is easier and faster?
6. Very important because the speed and simplicity.
8. If it is necessary to get the reports I will use, then it is very important.
12. Would be more convenient and useful to run on PC.
12a. Yes.
13. I enjoy the freedom that Microsoft Access gives me with my BRINSAP database. It seems to me that we would all go for the data more readily if it was available by PC.
14. No.
17.
18. PC applications not important at this time. It would be acceptable to use network server.
20. Not that important/Yes.
22. No.

Austin Divisions

Pvts. 1. I would like to run PMIS applications on the PC (and especially on our LAN server), but after what happened this afternoon, I'm not sure that will be possible! Maybe client-server will solve this problem, but if it does I suspect it will take a few years.

Pvts. 2. Since my job typically involves statewide network-level analysis, PC-based analysis is not a good alternative; however, the availability of high resolution graphics devices from the mainframe would be a very important enhancement. Network server PMIS applications - don't make me laugh! We are barely equipped with enough space for the PMIS manual and 1 copy of the current Annual Report.

6.2.2. How important is it for you to have the PMIS data files on your PC? Would it be acceptable to have the PMIS data stored on your network server, instead?

1. Doesn't matter.
2. It is important, yes.
3a. Not important, yes.
3b. It isn't - yes.
5. No idea - which is easier and faster?
6. We like it on PCS, that way can produce customized reports and color maps using applications such as GIS and Microsoft accesses relational data base.
8. Yes, but the IS people would scream.
12. Yes.
12a. Yes.
13. I feel it would be important to have it on the PC, and it would be used more. Having it on the server seems OK.
14. No.
17. Important for manipulating data. Dump whole data base for a District.
18. Server would be ok if updating of database is timely.
20. Not that important/Yes.
22.

Austin Divisions

Pvts. 1. Not as important for me as a statewide user — insufficient hard disk space, network traffic and contention problems, and super-slow execution time. However, we do have to download District files, and that would be a big help — especially if we could get the file into an ASCII flat file or an Access 2.0 database file!

Pvts. 2. Have quite a few PMIS data files on my PC already, but it doesn't justify me any more space than a secretary. Store on the server - ha, ha, stop it.

6.2.3. What kind of support would you need from the divisions or the universities?

1. Current support is very acceptable.
2. General "help desk" support.
3a. Unknown at this point.
3b. Unknown.
5. No idea.
6. Software.
8. Make it easy to use (for us morons that don't use it enough remember paths to reports but something that we can point and shoot).
12. N/A.
12a. Not sure.
13. Don't know.
14. N/A.
17. Program development and training.
18. The same type of support we have now.
20. Layer Thickness and Work History Information (Road Life System).
22. None.

Austin Divisions

Pvts. 1. I will defer suggestions about division support. University support is needed to keep up with advances in pavement management research, analysis procedures, and data collection.

Pvts. 2. More disk space from ISD. I didn't know anything was available from the universities.

Layer Thickness and Work History Information ("Road Life System")

The PMIS Project Team realized early on that we have a major problem with our knowledge of pavement layer thickness ("cross-section") and work history. When PMIS adopted the old Pavement Evaluation System (PES) pavement types, this problem became greater because the pavement types affected the performance prediction models, the PMIS Score calculations, and all of the PMIS analysis programs. The simple fact is that, for the majority of highways, it is difficult for the pavement manager to determine current surface and base type (or thickness). It is also difficult to keep track of what was last done to a particular highway section.

As a minimum, it was hoped to have surface thickness and base type for flexible pavements, and have slab thickness and base type for rigid pavements. Other items (such as the date of last surface) were considered useful, but not critical.

It was hoped that automation of the Road Life System would solve these problems, but that effort has been delayed. The Design Division will sponsor mainframe- and PC-based prototypes of the Road Life System this summer, but that still will not solve the current PMIS problems.

6.3.1. What do you think is the minimum cross-section and work history information needed for flexible pavements?

1. Don't know.
2. Last surface type and placement date and thickness. Paved width - base type is <u>not</u> a minimum.

3a. Surface thickness, base thickness, type - treatment of subgrade or base, thickness.

3b. No opinion.

5. The minimum depth would be depth of ACP - thickness of base - which means min depth is depth to subgrade.
6. Layer thicknesses and types and last date surfaced.
8. None.
12. Got to have date of last surface. Essential to plan a preventive maintenance program.

12a. Info from typical section. Aggregate type. Date of last surface is critical to schedule preventive maintenance.

13. Surface thickness, total flexbase depth (not by type or source necessarily); most recent seal.
14. Base thickness for entire width, including widened sections. Pavement thickness. Last surfacing.
17. Number of lanes, should width, layer types and thicknesses, subgrade type, surface type.
18. Layer types and thicknesses are needed but would be very hard to achieve.
20. Surface thickness and base type.

Austin Divisions

Pvts. 1. Whatever is needed by FPS-19 and MODULUS 5 (or whatever) to backcalculate layer modulus and do pavement design. Also, whatever will be needed to support mechanistic design programs. Minimum work history information would be date (month/year) of original surface, seal coat, and overlay. We can add pavement maintenance and all other non-pavement stuff later.

Pvts. 2. For each lane, list thicknesses of all layers that can be discerned from a core test or as-built plans. Work history should at least include date of last major overlay and all recent seal-coats.

6.3.2. What do you think is the minimum cross-section and work history information needed for rigid pavements?

1. Don't know.
2. Thickness, type and date of construction. Paved width - base type not a minimum.
3a. Concrete PVMT Type/Depth - Base Thickness/Type - Treatment of subgrade/base and thickness.
3b. None.
5. Thickness of all layers, depth to subgrade.
6. Same as last question.
8. None.
12. Not as critical.
12a. Same.
13. Thickness of concrete, possibly last major joint repair, punch-out repair.
14. N/A.
17.
18. Same answer exactly as No. 1.
20. Slab thickness and base type.
22. Year of last overlay, pavement thickness and base thickness.

Austin Divisions

Pvts. 1. See above - same as for flexible.
Pvts. 2. For each lane, thickness of all discernable layers and any treatments used. Work history should at least include date and type of last surface work.

6.3.3. What do you think should be done to solve this problem?

1. Don't know.
2. GPR, plans investigation, coring.
3a. Radar backed up by coring.
3b. None.
5. No idea.
6. Provide regional ground penetrating radar (GPR) capability to districts.
8. We do this manually by pulling out old plans and getting an idea, then coring for the proposed project. This would be most helpful for network/quick reference but detailed investigation would still be needed for each section because of maintenance activities that don't show up on as builts.
12. Date of last surface into should be available on DCIS. Seems like we could tie into that system.
12a. Needs to be supplied upon completion of job.
13. Research old plans, RI sheets and verify with GPR.
14. The division should research the history of every roadway.
17. Connect Roadlife to PMIS.
18. All roadways typical sections can be looked up in the District library and recorded on the mainframe database. However, accurate data on subsequent overlays, seal coats, maintenance work, etc. Would be very hard to obtain without coring.
20. Use coring and technology such as Ground Penetrating Radar.
22. Use info from HPMS to start.

Austin Divisions

Pvts. 1. Turn us loose and let us finish Road Life!

Pvts. 2. Mandate core test data logging into a TRM-based database for any and all cores taken from here on. Move all Material Control System (MCS) screens that can be related to a specific road location to the TRM-based database. Research concentrations of particular distress types already showing up in patterns throughout the state and use results to justify mandated entry of cross-section information, particularly in areas experiencing high maintenance costs. Establish accountability of data entry.

Section 7. Miscellaneous

This questionnaire has asked many questions about the usefulness and reliability of PMIS, but there may be some other questions/issues that you would like to raise. Thus, we would like your opinion on the following items (or any others that you would like to add).

7.1. Does your District view PMIS as mainly a tool for Austin to use to make budget requests and allocations?

1. Prior - yes. Currently - No. Beginning to use PMIS info on District decisions.
2. Yes, I am trying to reverse that opinion.
3a. Yes.
3b. Not necessarily.
5. No we also use it for programming projects.
6. No.
8. None.
12. At this time.
12a. Somewhat.
13. I would say "yes."
14. Yes, so far.
17. No, used to select construction projects. Big believer in PMIS.
18. No, we are using it and hope to make better use of it in the future.
20. No.
22. No.

Austin Divisions

Pvts. 1. Not applicable to us.
Pvts. 2. No comment on District view of PMIS.

7.2. How is PMIS being used in your district?

1.	Data/scores are beginning to be used in a formula to help select roads for rehab/reconstruction.
2.	Help select preventive maintenance projects, and in the future, rehab and reconstruction projects.
3a.	Sparingly.
3b.	Use it to support observed roadway conditions for program decisions.
5.	Same.
6.	Very effectively in project selection process.
8.	Project Selection and overall view of how the District is doing.
12.	Monitor overall condition of pavements.
12a.	Scores are used in prioritizing rehab projects.
13.	Scarcely, Sparingly, Reluctantly. Skid and Deflection data is used most but on the project level-this is not really PMIS.
14.	None.
17.	Very and modify project requests.
18.	To help formulate preventive maintenance projects. Also, to help justify the need for other projects as well as help to determine budget needs.
20.	Our District has used critical rating reports in some programming decisions.
22.	Used to help prioritize projects in TIP.

Austin Divisions

Pvts. 1.	Not applicable for us.
Pvts. 2.	PMIS used in my division to enhance analysis of statewide pavement conditions.

7.3. What typical requests (if any) are you getting from the District Engineer?

1. Information to help the above answer.
2. Project selection and project treatment for preventive maintenance. Decision support "why doing that road?"

3a. None.
3b. Occasional condition, ride and skid data.
5. Some.
6. Pavement condition reports or maps.
8. Overall view, trends.
12. None.
12a. None.
13. None from the DE.
14. None.
17. Condition, distress on pavements, $ needed.
18. Same answer as No. 2.
20. Color-coded maps to help identify critical sections.
22.

Austin Divisions

Pvts. 1. Not applicable to us.
Pvts. 2. I'm getting requests for Needs Estimate Treatment recommendations by Control-Section.

7.4. How do you distribute PMIS data and results to the area offices? What are they doing with it? Are they running PMIS reports themselves?

1. I don't. They will get this info upon request. Don't know if they run themselves.
2. Many offices run the reports themselves.

3a. It stops here - Don't know if they use it or not.

3b. They can run reports but I will also supply them with info as they request.

5. Some.
6. No, we run the reports and generate maps and provide them, and they use them for selecting projects and for maintenance purposes.
8. Have the area offices pull them or call Cody Parkhill and he finds out what they needs and sends it to them. Using to justify projects in project selection. Yes/Sometimes/No depends on the office.
12. Distribute raw data and color coded maps displaying pavement scores.

12a. Maps that show pavement scores. Charts and graphs that summarized data.

13. PMIS Coordinator sends scores and results for information and comment. We may be asking "Do you agree with this?" or "This is what we have on the condition of your pavement. What do you think?" We get few arguments from the AE's; some comments or defense from the maintenance foremen. No one is running reports other than the District PMIS Coordinator.
14. By hardcopy. Using SN and Distress to back-up candidate requests. No, except for skid.
17. Distribute upon request. They can run their own reports. They use it to select projects.
18. They are not running reports. We intend to send area offices needs estimates and distress ratings. We are not sure what they will use them for.
20. Our PMIS coordinator sends copies of PMIS data and results to the Area Offices with the critical sections flagged. Some Area Offices are running reports themselves.
22. Send them maps with needs shown on them.

Austin Divisions

Pvts. 1. Not applicable for us.

Pvts. 2. Have been distributing latest available Condition, Distress, Ride, and individual utility maps using WP attachments to Groupwise to encourage completion of data submission. Don't know what most are doing with them, but some are using in planning processes. Tardiness of data submission in some areas is of concern in accuracy of maps.

7.5. How do you distribute PMIS data and results to the Maintenance Sections? What are they doing with it? Are they running PMIS reports themselves?

1. Same as above.
2. Area offices provide info to maintenance. Some offices running themselves.
3a. Don't know.
3b. Some maintenance sections, request scores for various reasons from condition scores to skid data.
5. Doubtful.
6. Same as previous question.
8. Typically, don't send to maintenance sections.
12. See #4.
12a. Same.
13. See answer to Question 4. We send info to both the AE office and the maintenance offices.
14. Same. Just stanted. No.
17. Area Engineers only.
18. Same answer as No. 4.
20. Our PMIS Coordinator sends copies of PMIS data and results to the Maintenance Sections with the critical sections flagged. I do not believe they are running reports themselves.
22. Depend on the Area Offices.

Austin Divisions

Pvts. 1. Not applicable to us.
Pvts. 2. Don't know how to best distribute PMIS data and results to the Maintenance Sections.

7.6. What are the biggest problems your District is having with PMIS?

1. Scheduling and coordinating the collection of the data. Have to use area office employees. Area offices are already short on bodies.
2. Downloading PMIS data from the mainframe. For area offices.
3a. Administration not interested in using PMIS.
3b. Know of no problems.
5. It's too complicated.
6. None so far.
8. The low frequency that we use the information we forget what reports we want (path to that report) and how to get them. We begin at the beginning of the learning curve all over again. Need quick way of getting the data.
12. Scores do not always seem reliable.
12a. Lack of confidence in scores and treatments.
13. 1. Selling it as a useful tool. A management system is seen essentially as something the Feds made us do, in my opinion. We didn't need it <u>before</u> to maintain pavements or allocate $.
   2. Having the time and people to give it the proper chance. We barely have time to collect and maintain the data. We don't seem to have time to stop and use it.
14. Starting a program.
17. Field data is not consistent or accurate enough. Need graphic display of condition data as in GIS.
18. How best to utilize the information.
20. It is a chore going through stacks of print-out reports using reference marker notations to locate the sections on a map. We are looking forward to the day when computer color-coded mapping technology would be available.
22. Showing Interstate needs.

Austin Divisions

Pvts. 1. Not applicable to us.

Pvts. 2. Getting enhancements. Retaining top-grade programmers on the ISD side of the project. Threatened discontinuations of analysis software (i.e. PC-SAS) without consideration for substitute analysis software.

And the biggest problem of all: a GRAPHICAL USER INTERFACE (GUI). In the original design, PMIS had a selection for PLOT RAW DATA. All that remains of this option is a destination field in the User Job Submission Profile screen for "plotter". PLOT RAW DATA was destined to be a stepping stone for migrating to improved mainframe graphics. PMIS even purchased multiple copies of a HOST GRAPHICS software to allowed pre-plotting reviews of the graphics on PC monitors. However, at some point ISD programmers made a decision to remove the menu selection for PLOT RAW DATA. The Host Graphics software was discarded, and at some point, even the REMOTE SUBMIT option of SAS was discontinued. Throughout the 90s, we have moved farther away from a GUI than we were in the 80s.

Without a GUI, PMIS graphics will only be as new as the latest published report. In today's world windows and icons, this total lack of GUI will keep PMIS years behind many other decision-making processes. For network-level decisions, analysis of PMIS data on a local server is not a viable option. The mainframe is still the best environment for network-level data, and it is difficult understand how ISD can be so highly advanced in the area of engineering workstations, but has virtually closed the door PMIS graphics needs. It is as if ISD considers managing Texas pavements' "another Division's" responsibility and the only support they will provide is through a lengthy and cumbersome Information Resource Request (IRR) process.

As an old cliche put it: "A picture is worth a thousand words." In terms of PMIS, "one image can be worth 181,904 lines of section list data."