Pavement Preservation: Integrating Pavement Preservation Practices and Pavement Management

NHI Course 131104

National Highway Institute

Federal Highway Administration

Related NHI Courses

- 131054: The Preventive Maintenance Concept
- 131058: Selecting Pavements for Preventive Maintenance
- 131103: Design and Construction of Quality Preventive Maintenance Treatments

Importance of Integration

- Each $1 in preventive maintenance saved $4 to $10 in the rehabilitation program
- Substantial improvement in condition and ride quality realized
- Pavement management was crucial to the development of cost-effective preventive maintenance programs

Course Guidelines

- Participation is essential
- Speak loudly so all participants can hear
- One person speaks at a time
- Return from breaks promptly
- Turn cell phones and pagers to vibrate mode

Course Materials

- Participant's Workbook
- Reference Manual

Course Content

- Executive Summary
- Module 1: Course Introduction
- Module 2: Importance of Integration
- Module 3: Project-Level Performance Issues
- Module 4: Network Modeling and Analysis Tools

Course Content (cont.)

- Module 5: Incorporating Pavement Preservation into Strategic Decisions
- Module 6: Implementation Concepts
- Module 7: Summary and Wrap-Up
- Workshops

Before Getting Started…

- Are there questions on logistics?
- Are there questions about the course materials?
- Are there other questions that need to be addressed before moving on to the technical material?

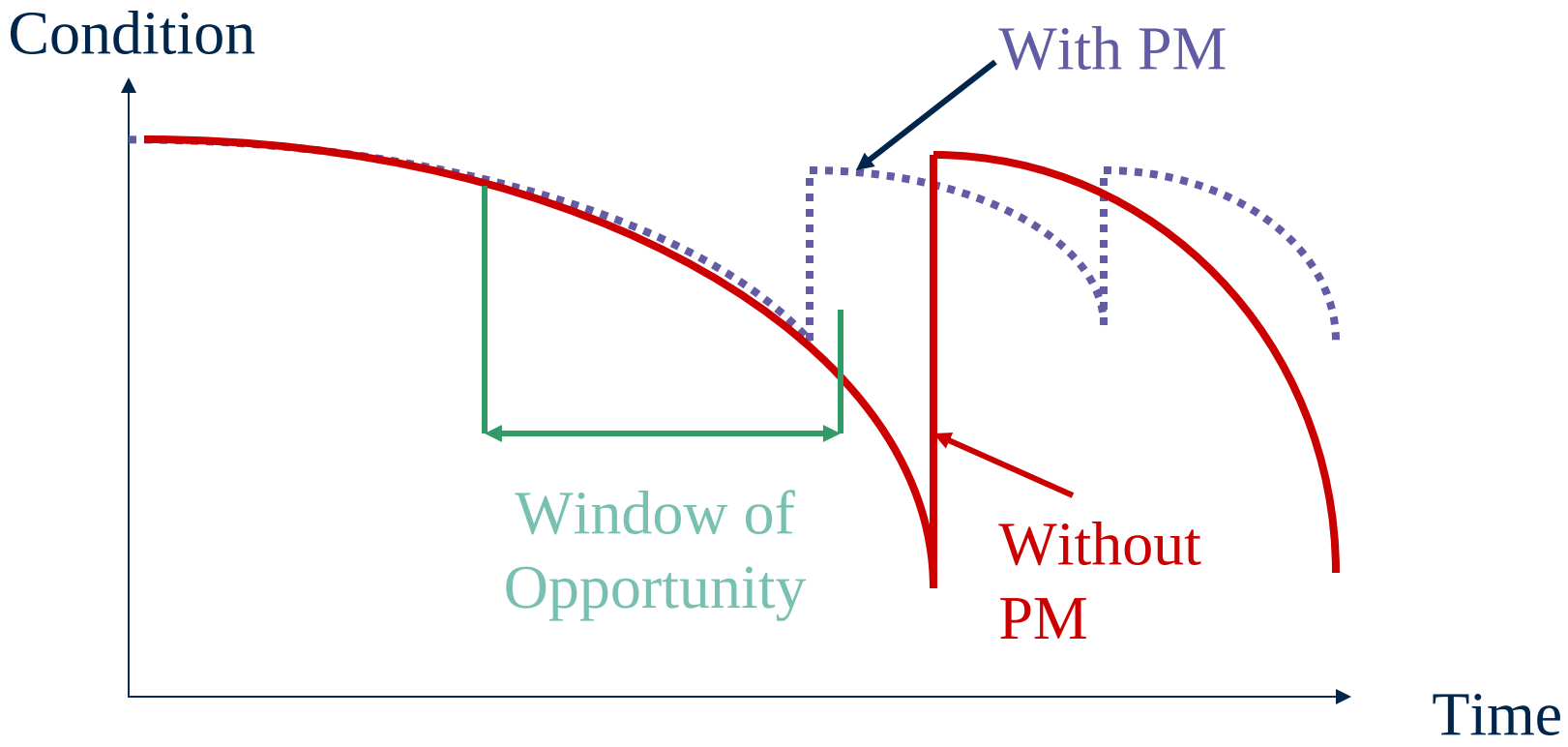
Importance of Integration

Module 2

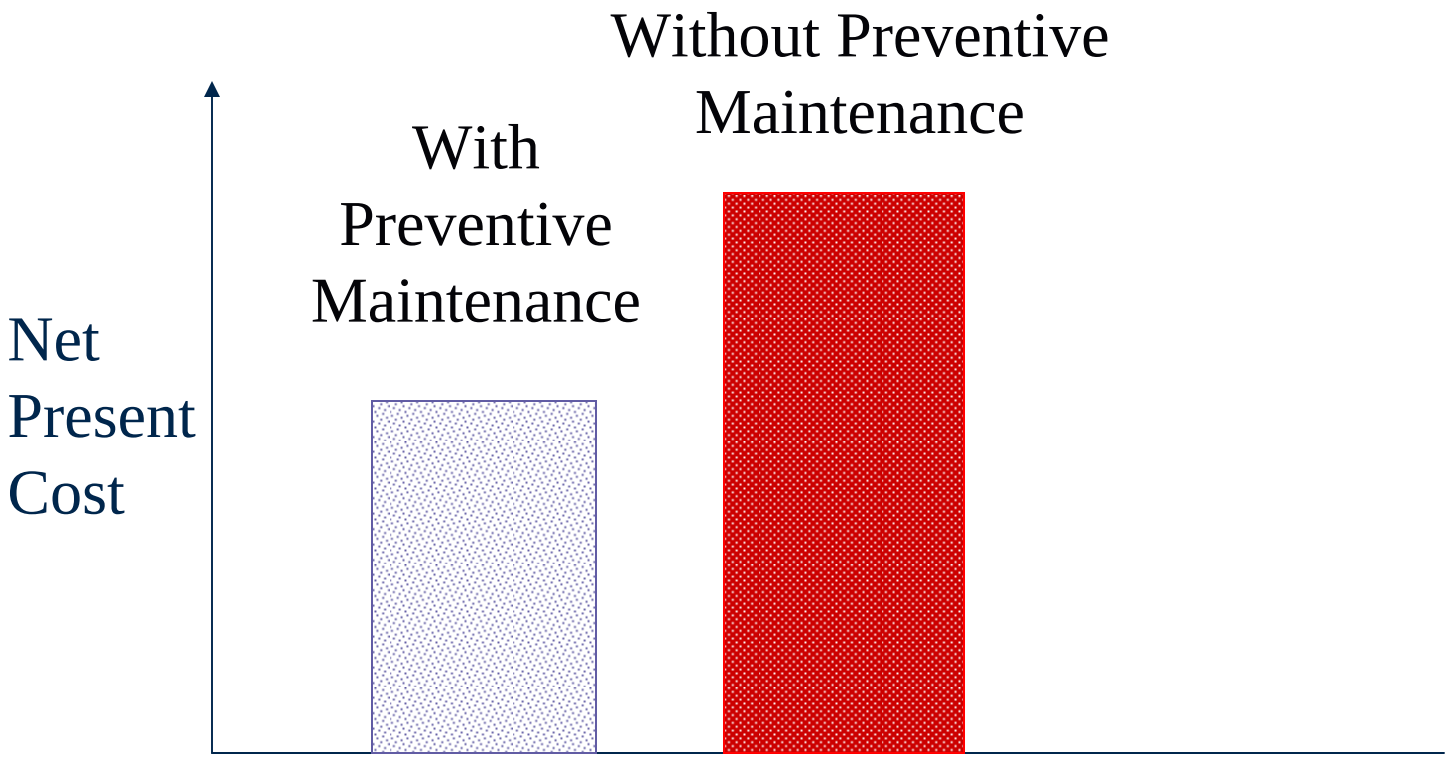
Key Concepts

- Pavement Preservation
- Preventive Maintenance
- Pavement Management
- Pavement Management System
- Integration

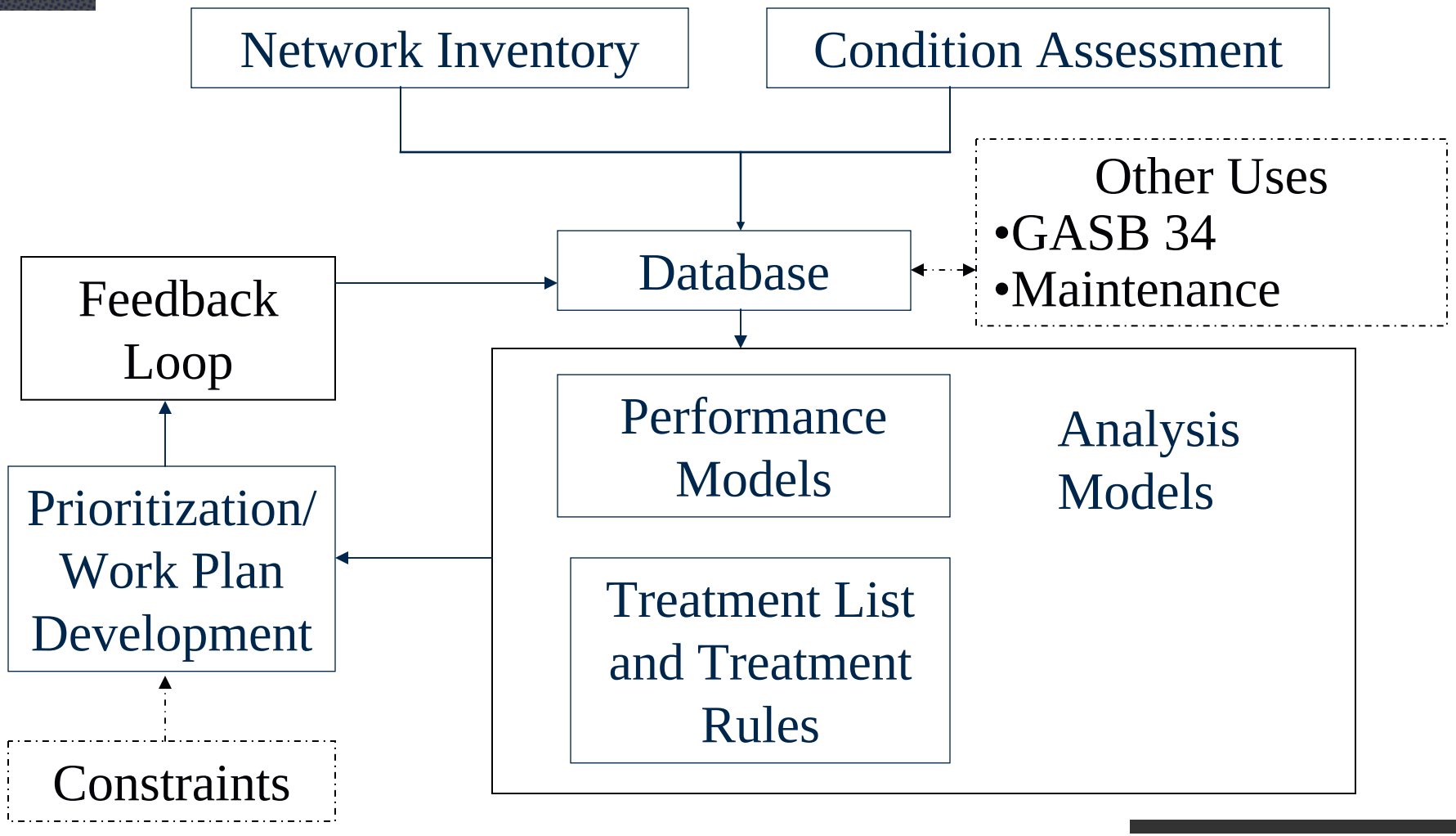
Importance of Preventive Maintenance



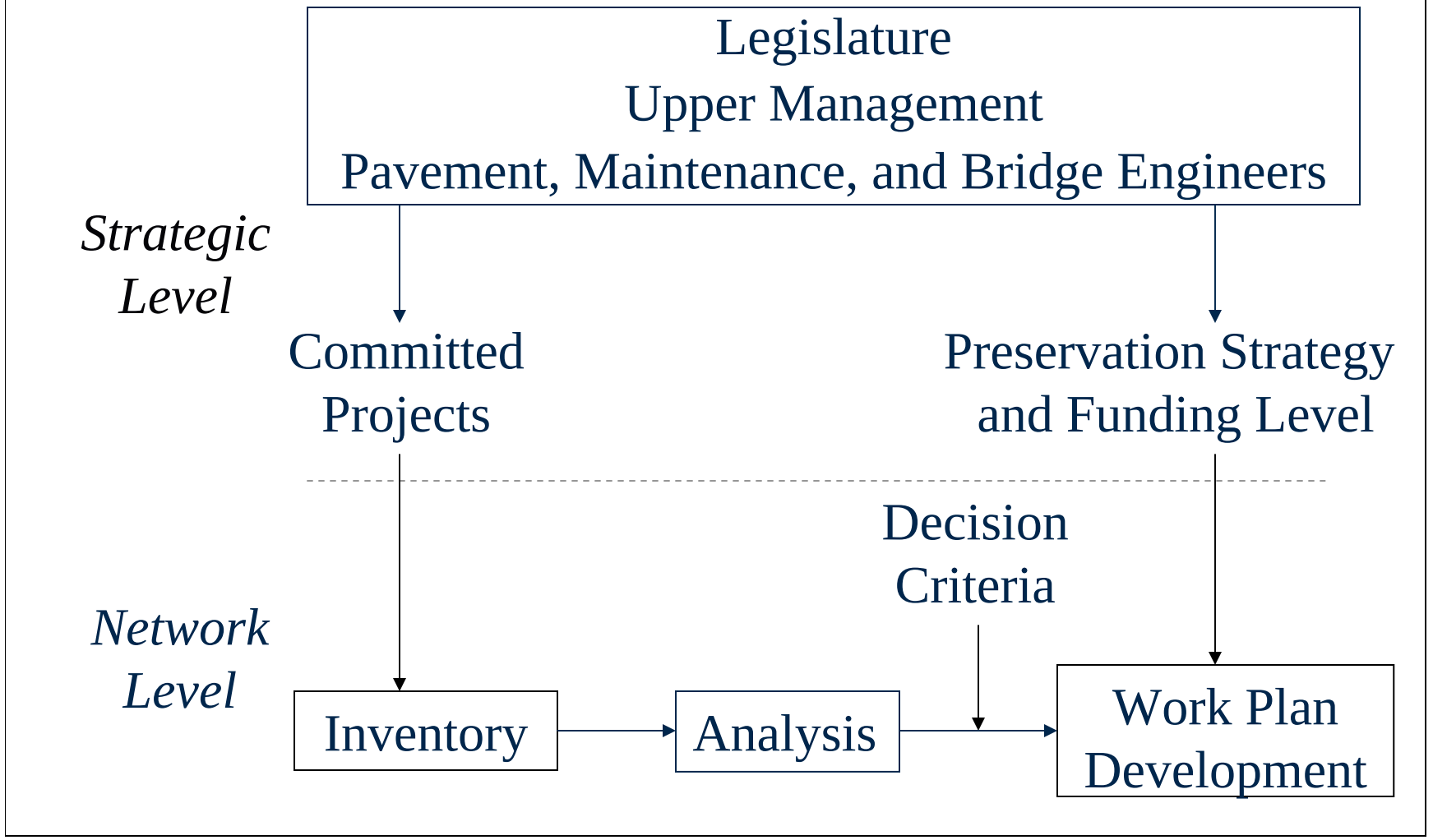
Cost-Effectiveness of Preventive Maintenance



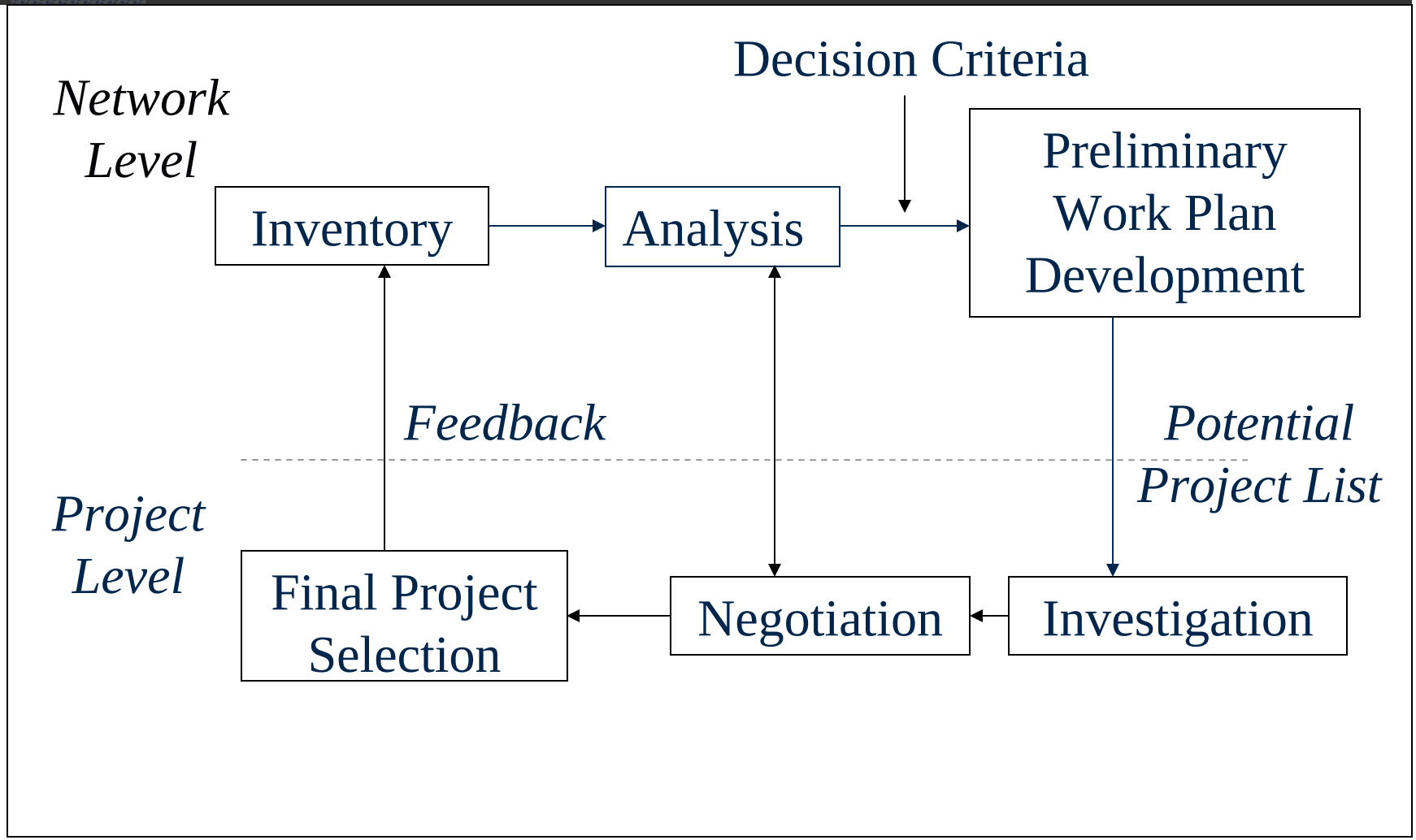
Pavement Management Components



Decision Levels



Decision Levels



Decision Levels

- At what level is network condition information collected?
- At what level are funding levels established?
- At what level are candidate projects established?
- At what level are projects designed?
- Which level typically uses the most detailed information?

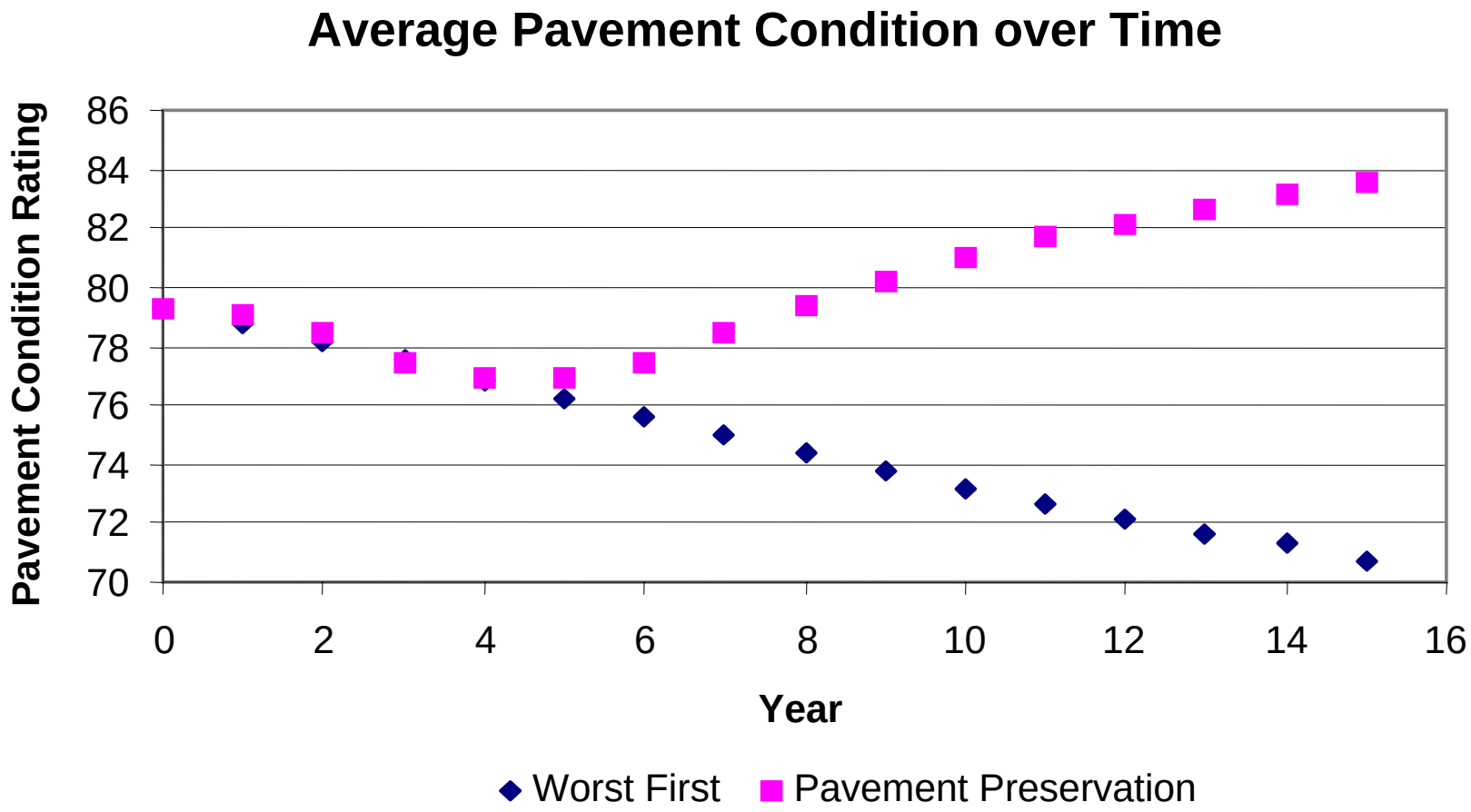
Use of Pavement Management to Support Preventive Maintenance

- Demonstrate the benefits associated with preventive maintenance
- Estimate funding needs to achieve specific targets or goals
- Allocate available funding cost-effectively
- Identify and prioritize treatment needs

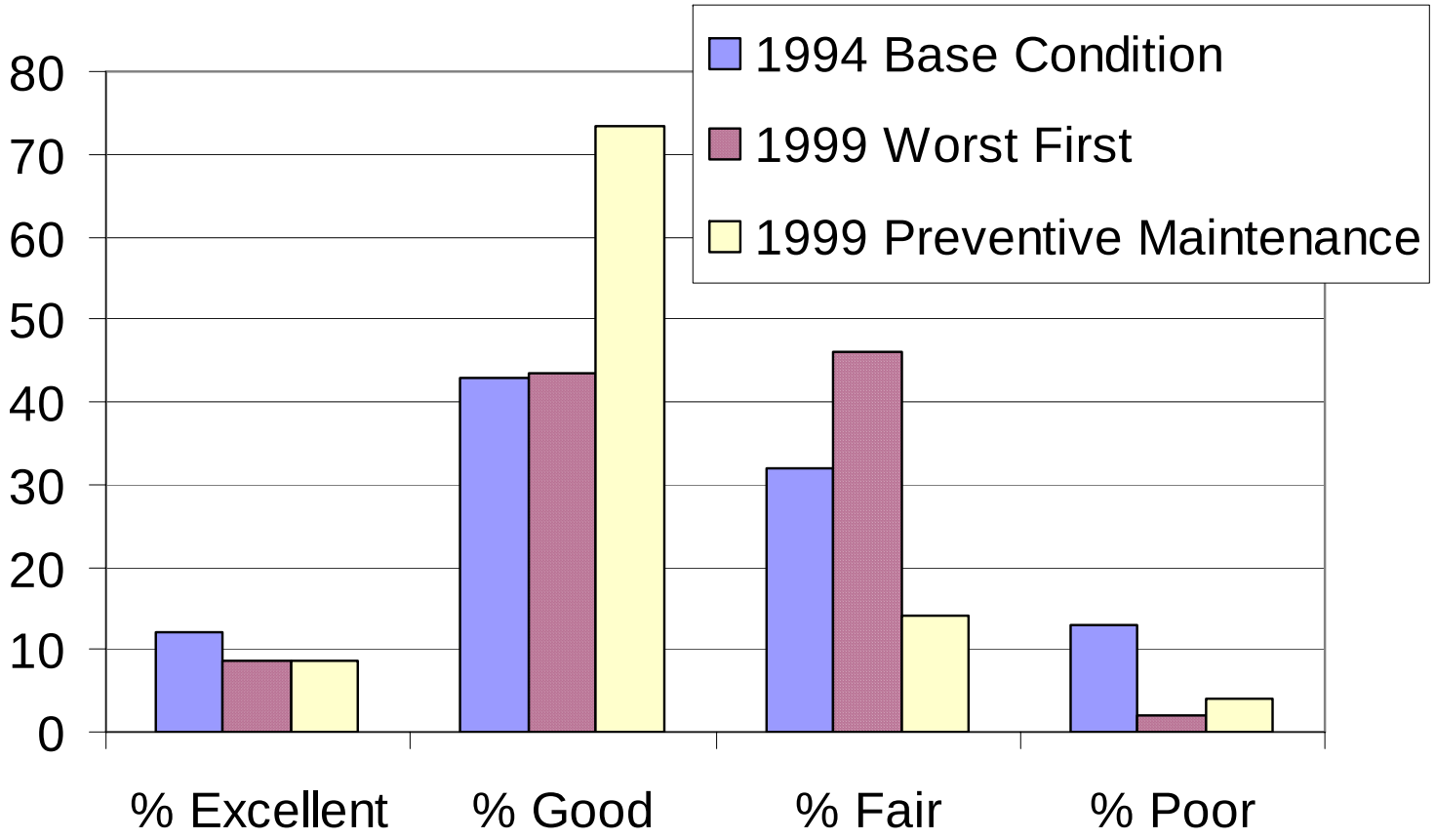
North Carolina Department of Transportation Simulation

- 1000-mile network
- Distribution of network conditions based on actual conditions
- Evaluated a “worst first” strategy
  - 50 miles of roads in poor condition resurfaced
- Evaluated a “pavement preservation” strategy
  - 100 miles of roads in fair condition addressed first before roads in poor condition

Simulation Results



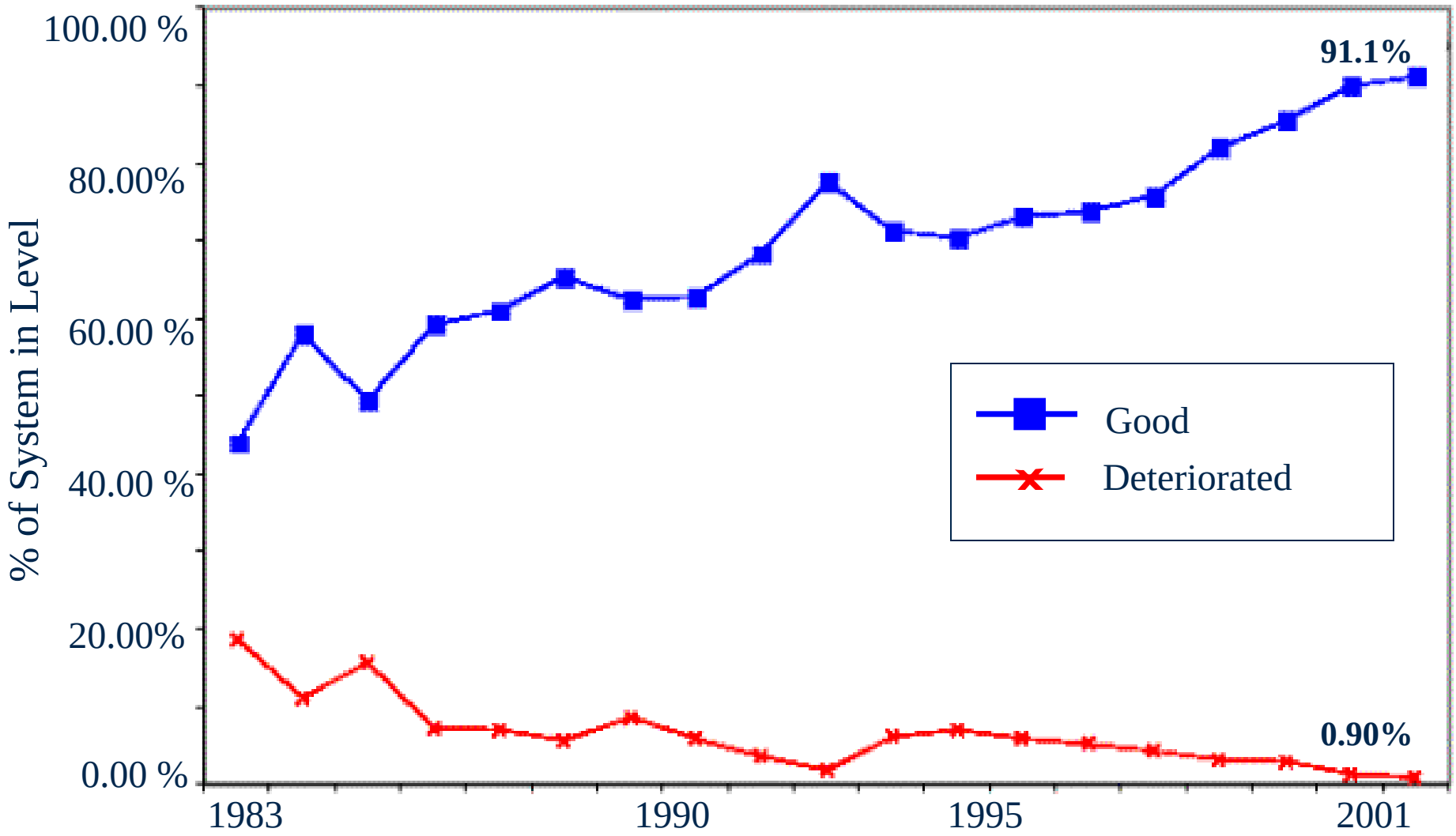
New York State Department of Transportation Example



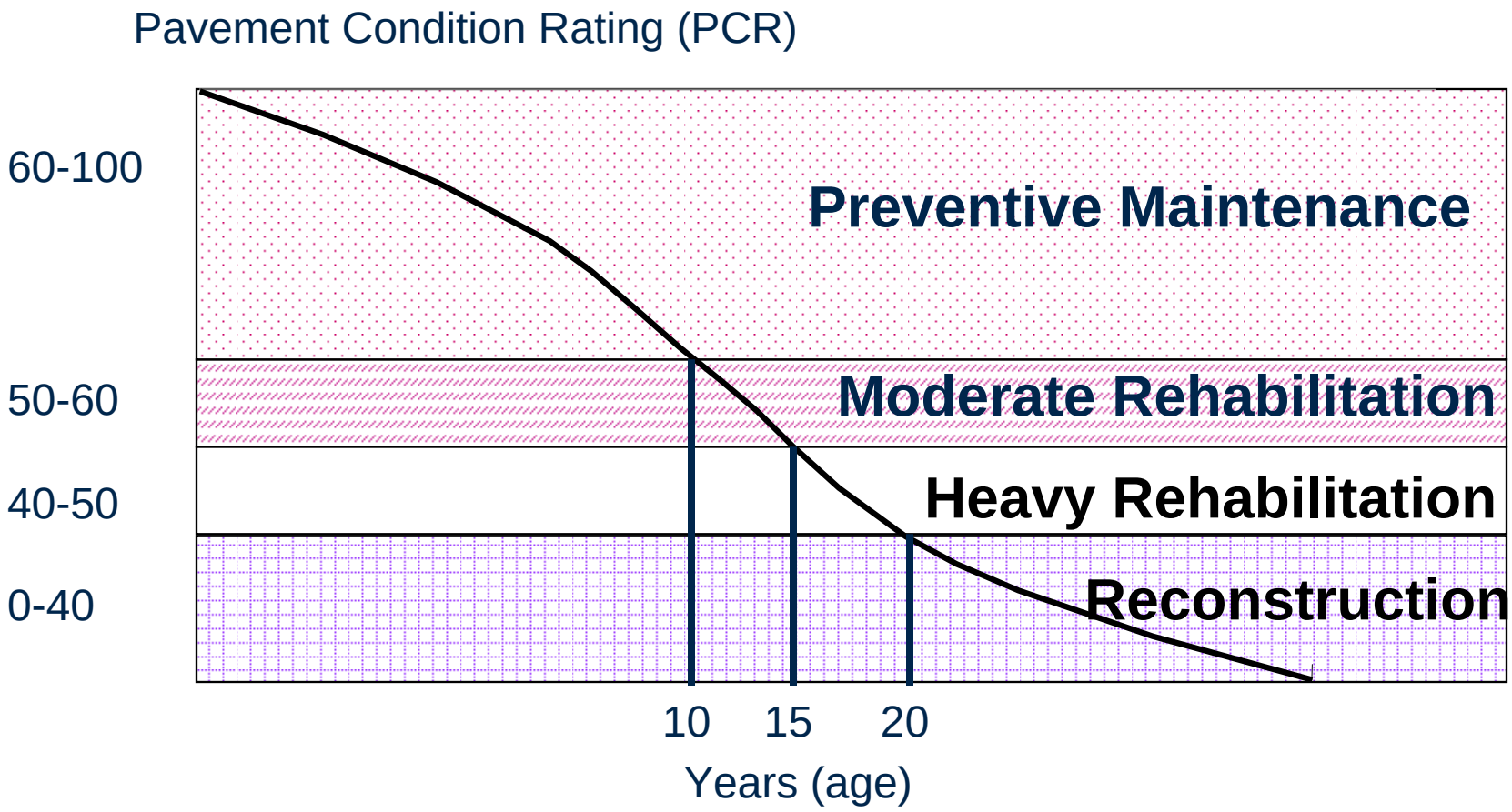
Impact of Pavement Preservation Program on Safety - NY

	Fatality Rate Per 100 Million VMT New York	Fatality Rate Per 100 Million VMT U.S. Average
1990	2.07	2.07
2000	1.13	1.52

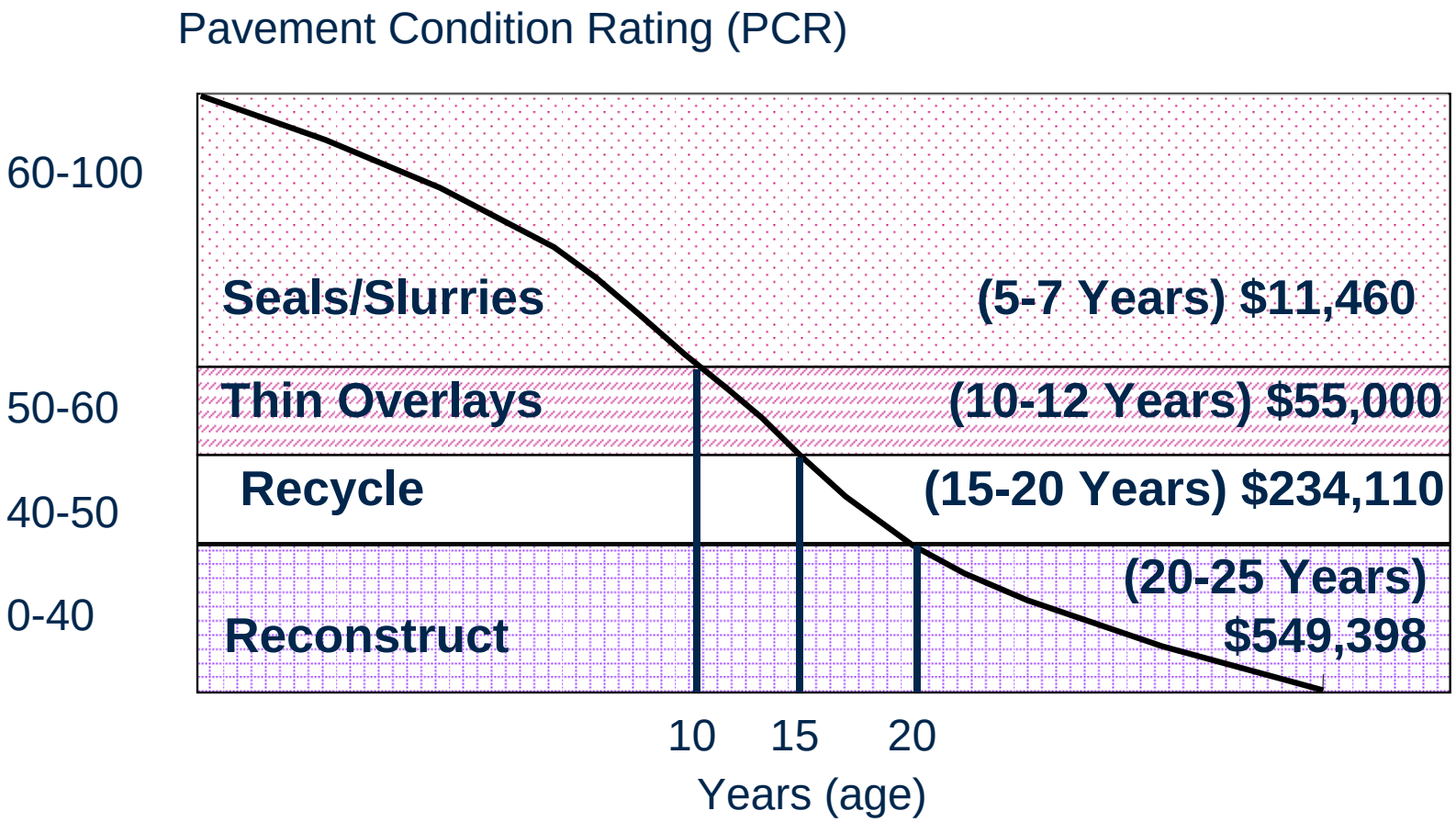
Kansas Department of Transportation



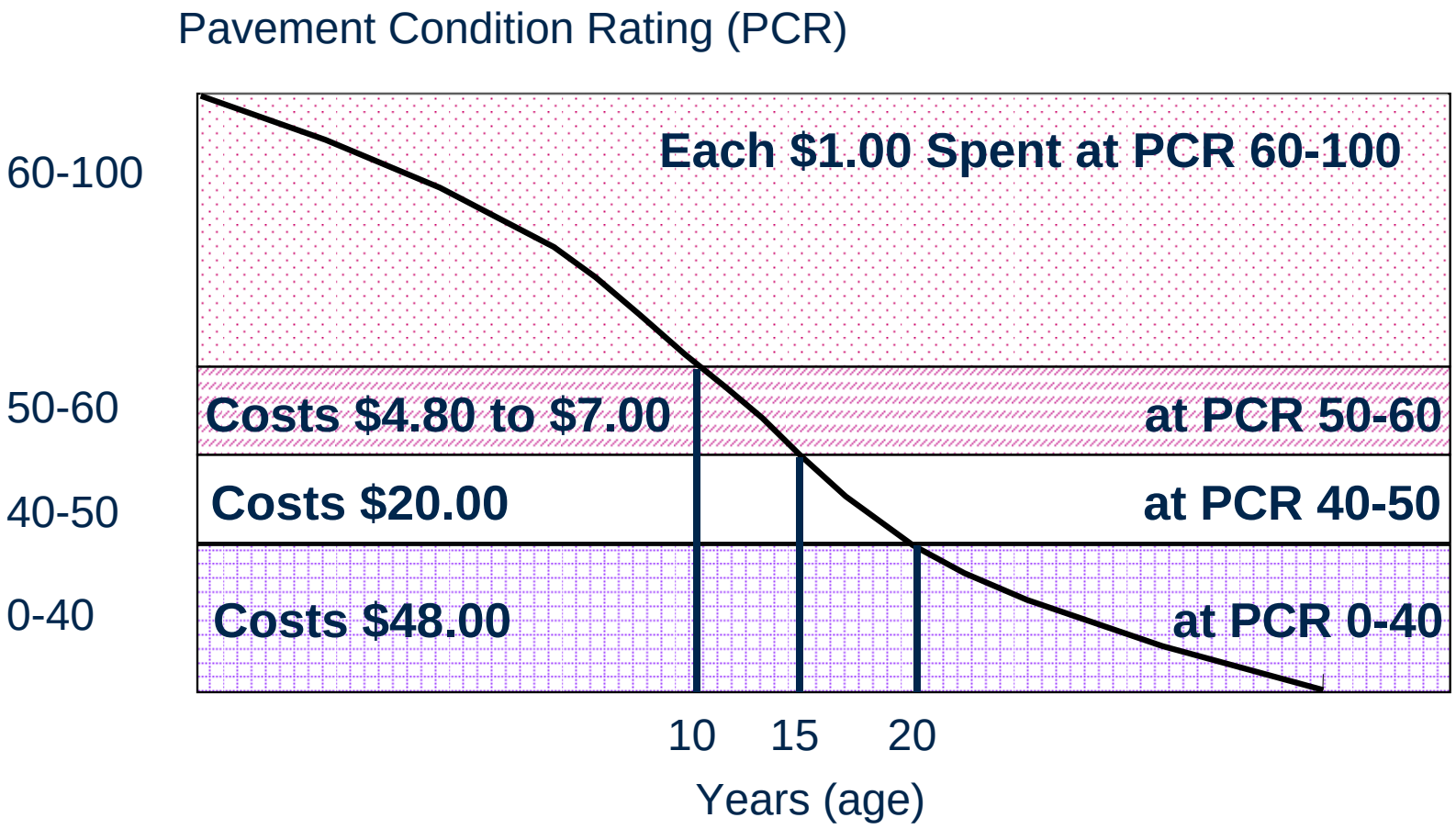
Thurston County
Appropriate Levels of Repair



Thurston County - Costs



Thurston County - Summary



Integration Requirements

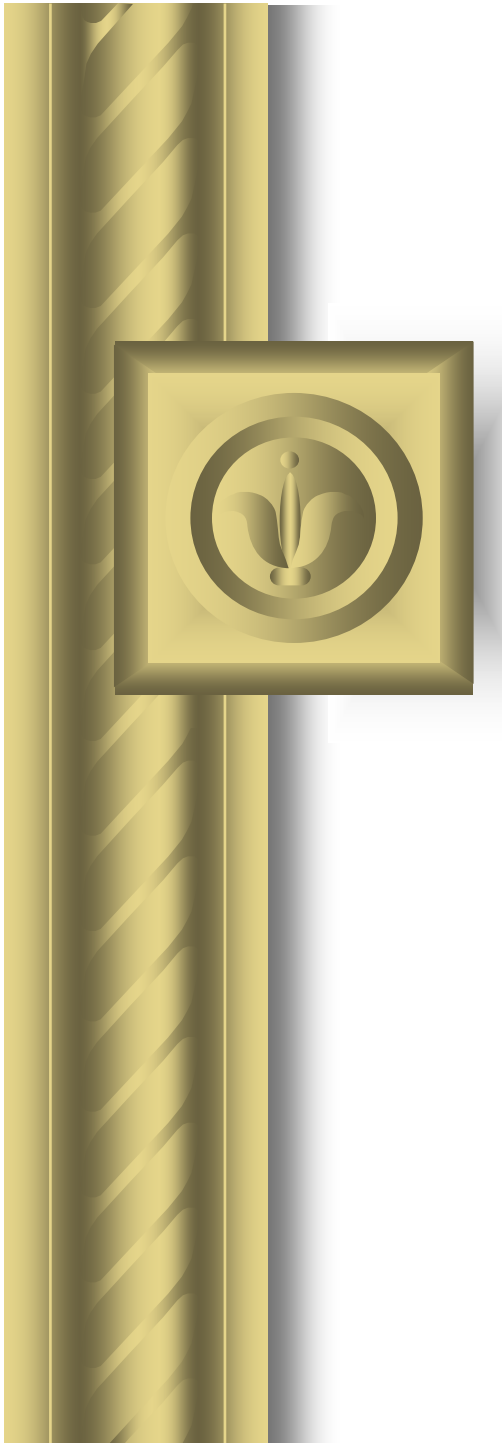
- Method of identifying preventive maintenance needs
- Models that reflect future pavement performance with and without preventive maintenance treatments
- Prioritization process that considers preventive maintenance
- Analysis period long enough to display the impact of preventive maintenance

Integration Gaps

- Not tracking maintenance histories and performance
- Not collecting data to support preventive maintenance treatment selection and timing
- Maintaining independent databases
- Others?

Why Address Integration Issues?

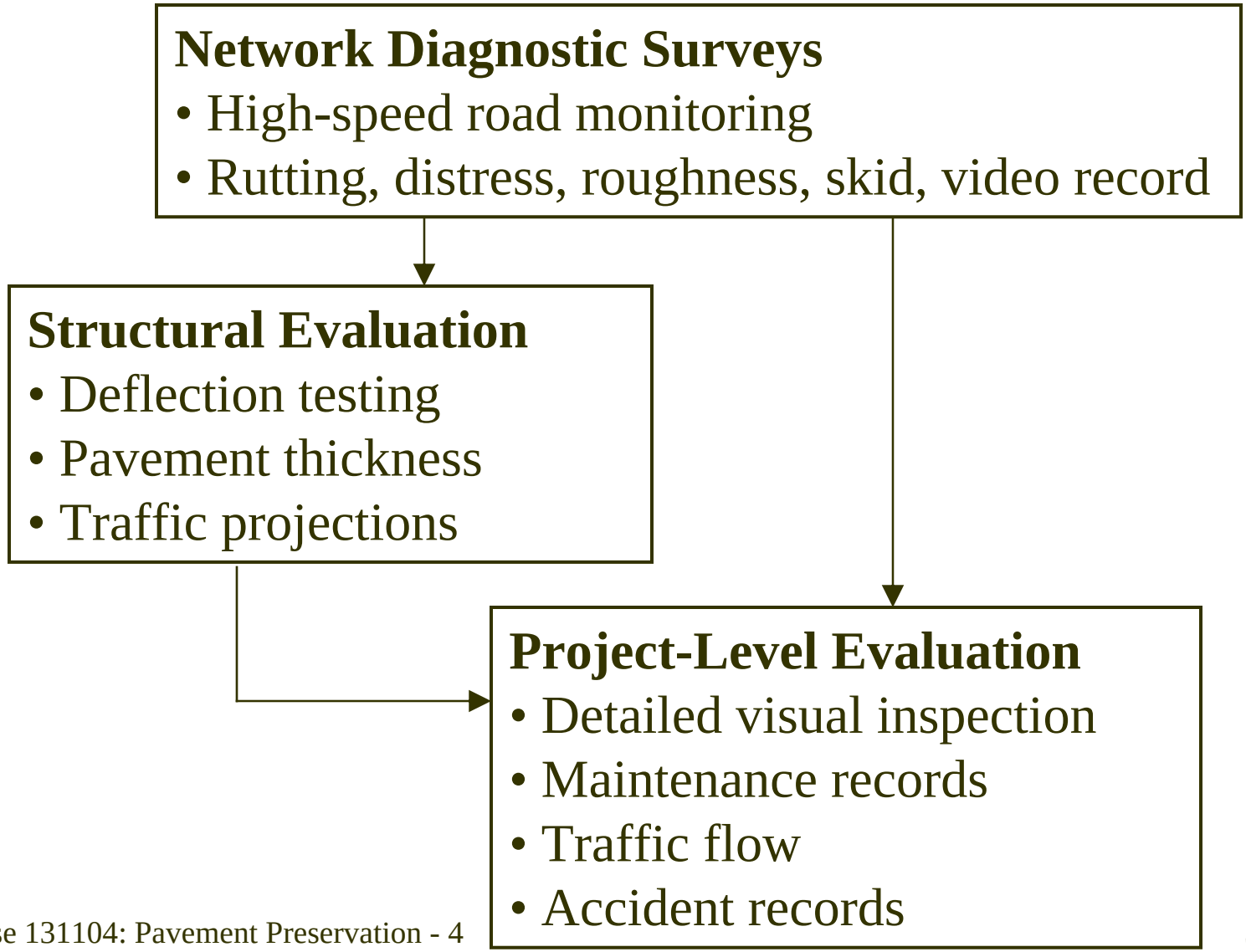
- Develop a more coordinated work plan to accomplish agency goals
- Better demonstrate the benefits in using preventive maintenance treatments
- Keep the decisions at the appropriate level within the agency
- Make better informed decisions about treatment needs



Project-Level Performance Issues

Module 3

Level of Detail Comparisons

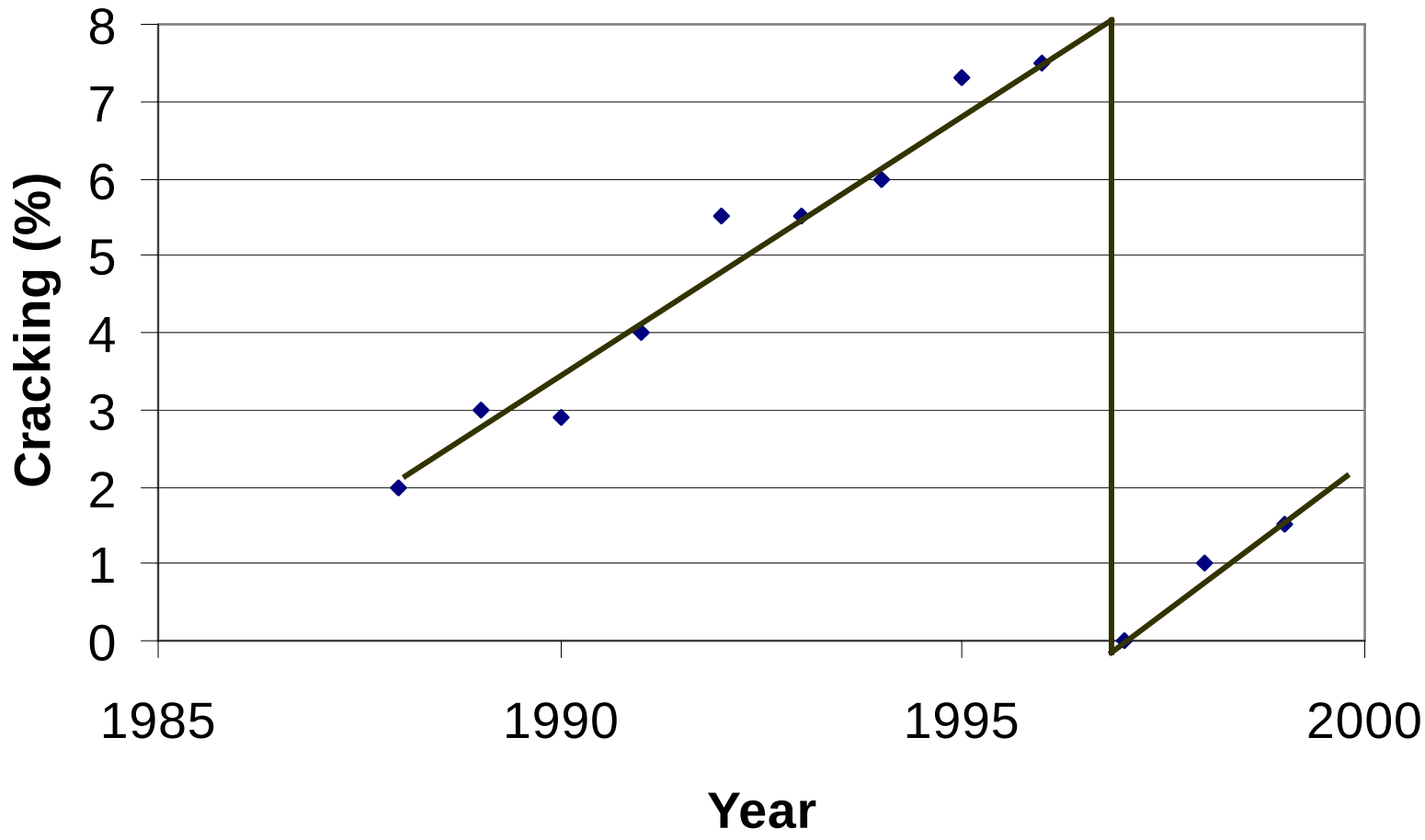


Questions to be Addressed

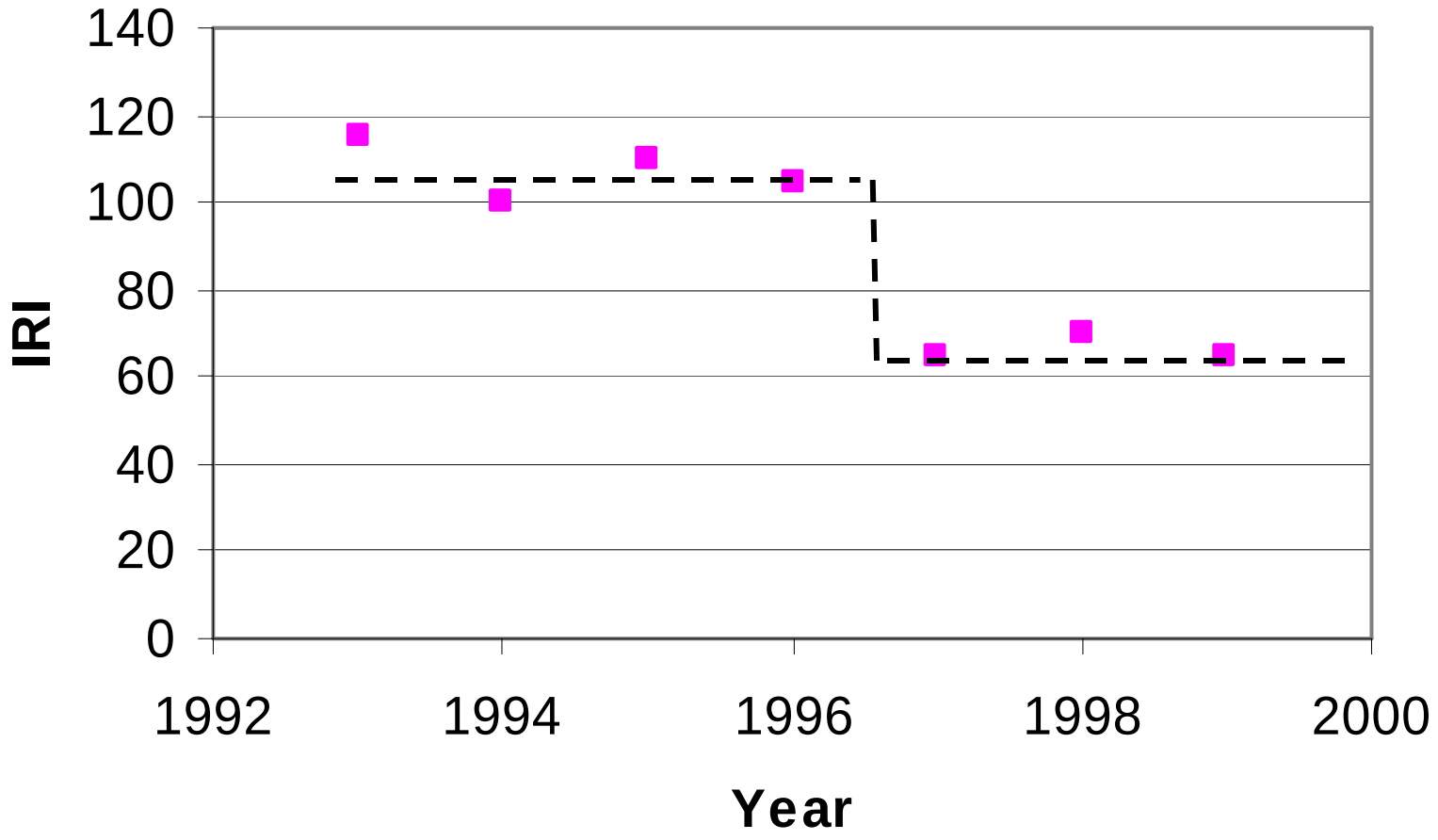
- **Is it structurally adequate?**
- **Is it functionally adequate?**
- **Is the rate of deterioration normal?**
- **Are the materials durable?**
- **Is drainage adequate?**
- **Has previous maintenance been normal?**
- **What geometric factors are important?**

Impact of Preventive Maintenance Treatments on Pavement Performance

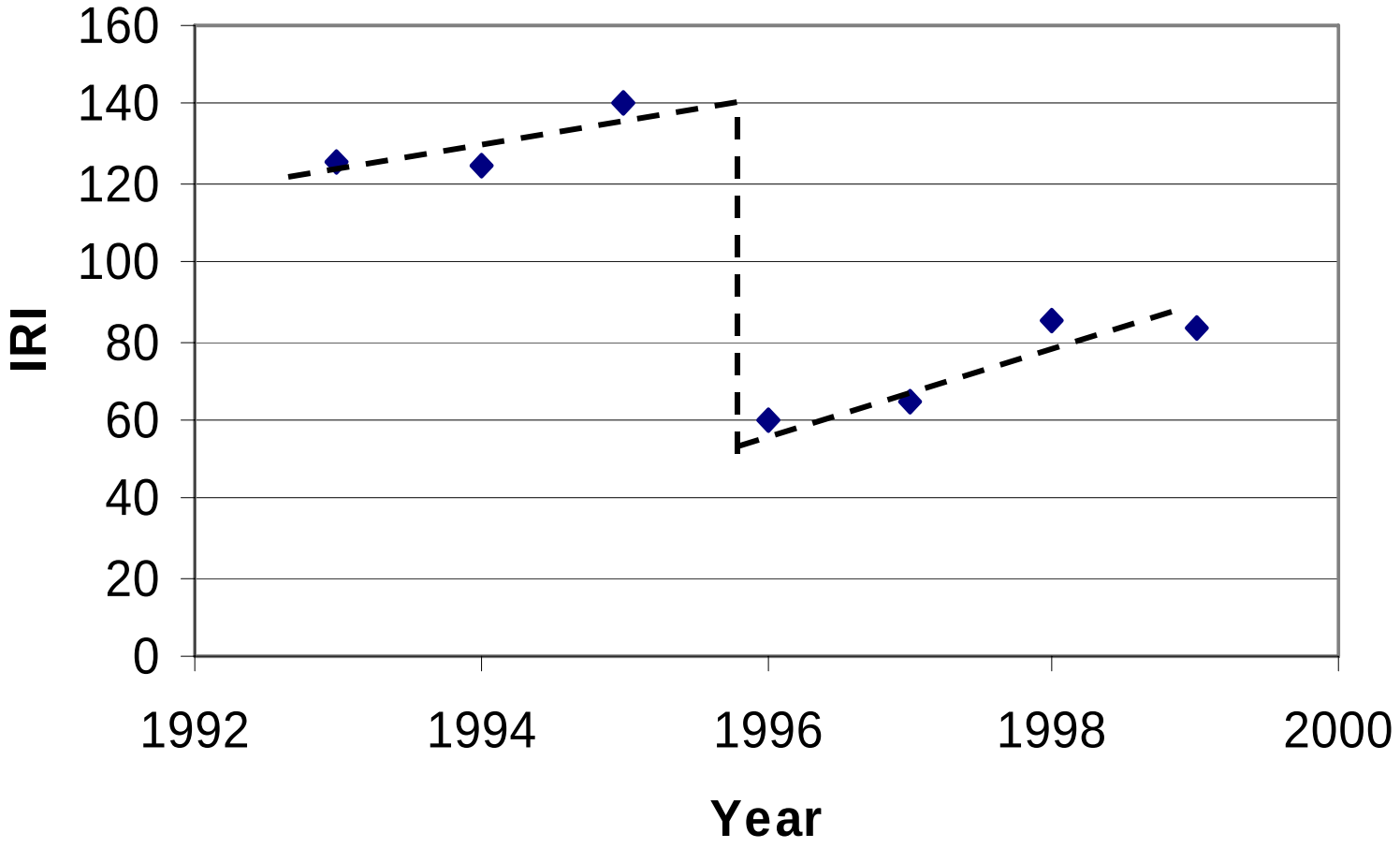
Impact on Cracking - Arizona



Impact on Roughness (Joints Repaired) - Pennsylvania



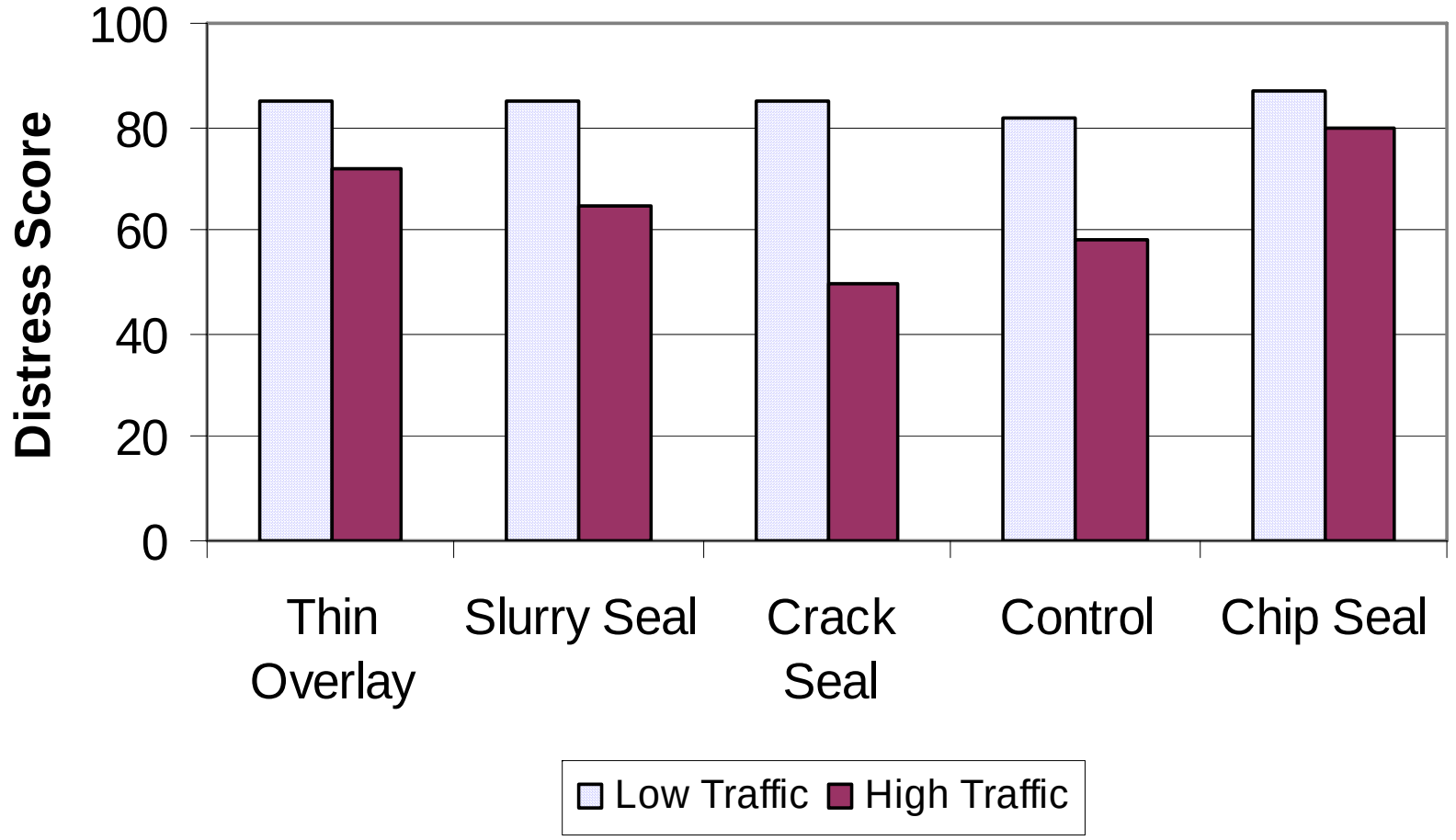
Impact on Roughness (Joints Not Repaired) - Pennsylvania



Texas SPS-3 Test Sections

ID	Highway	Date Constructed	Date of Survey	KESAL per year	Thin Overlay	Slurry Seal
48D3	IH20	9/90	7/95	530	85.6	84.6
48M3	US59	10/90	3/97	40	91.1	93

Effect of Traffic – Texas

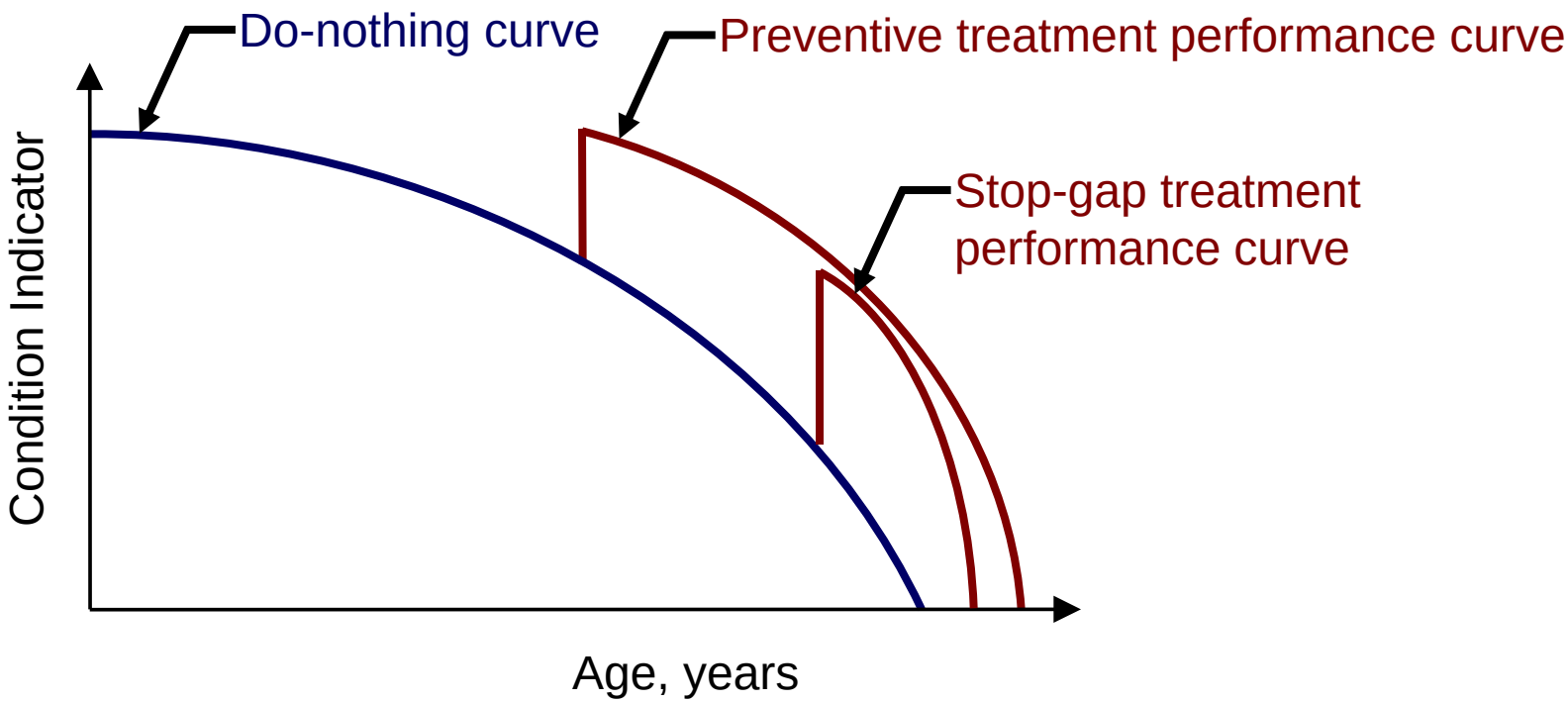


Reductions in IRI Rate of Change Due to Maintenance Expenditures

Increase in Expenditure Level ($/lane mile/year)	Patching and Joint and Crack Sealing	
	North	South
$50 to $100	0.29	0.19
$100 to $150	0.17	0.11
$150 to $200	0.12	0.06
$200 to $250	0.10	0.05
$250 to $300	0.07	0.04

The Impact of Treatment Timing on Pavement Performance

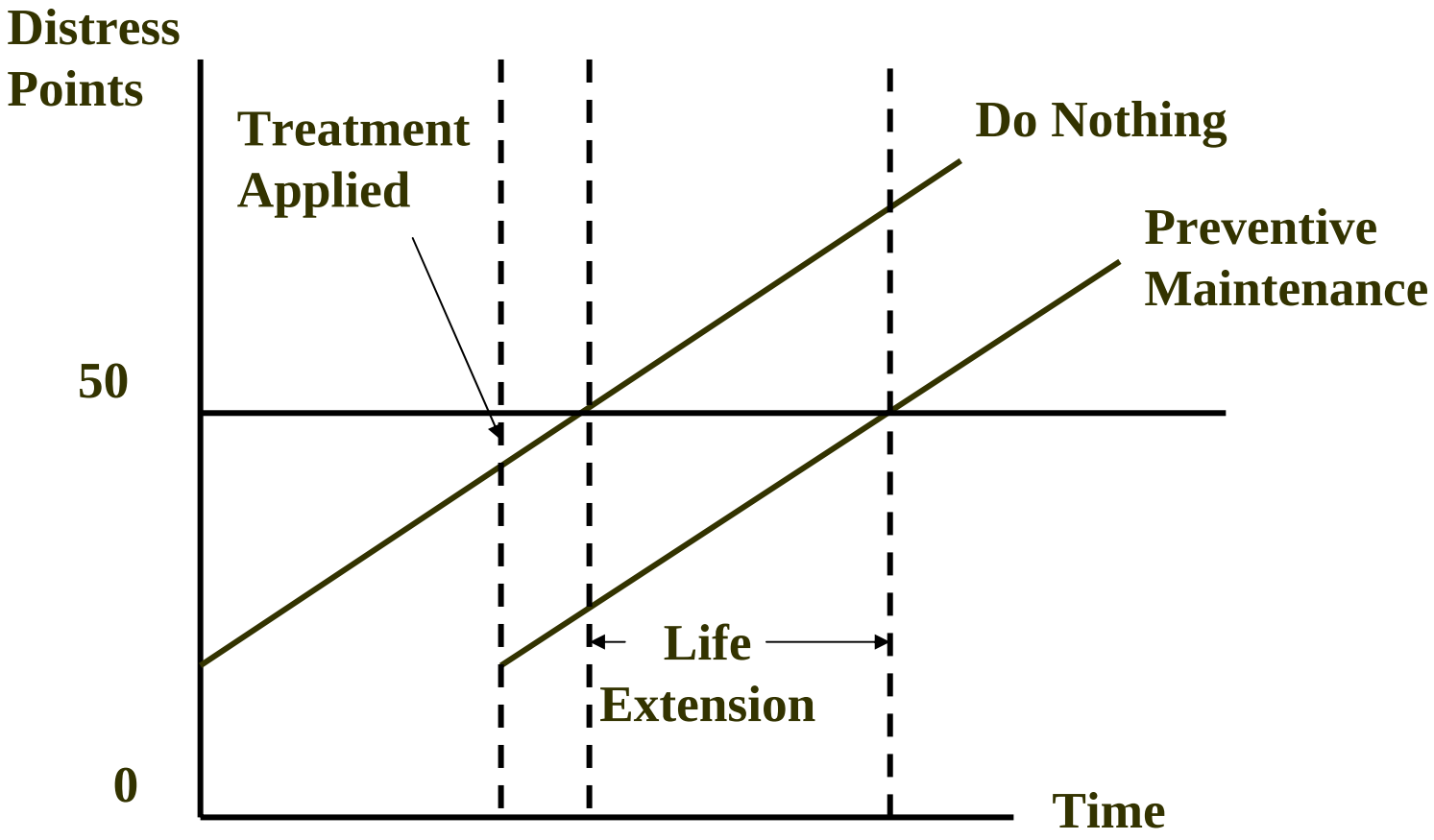
Effect of Timing on Performance



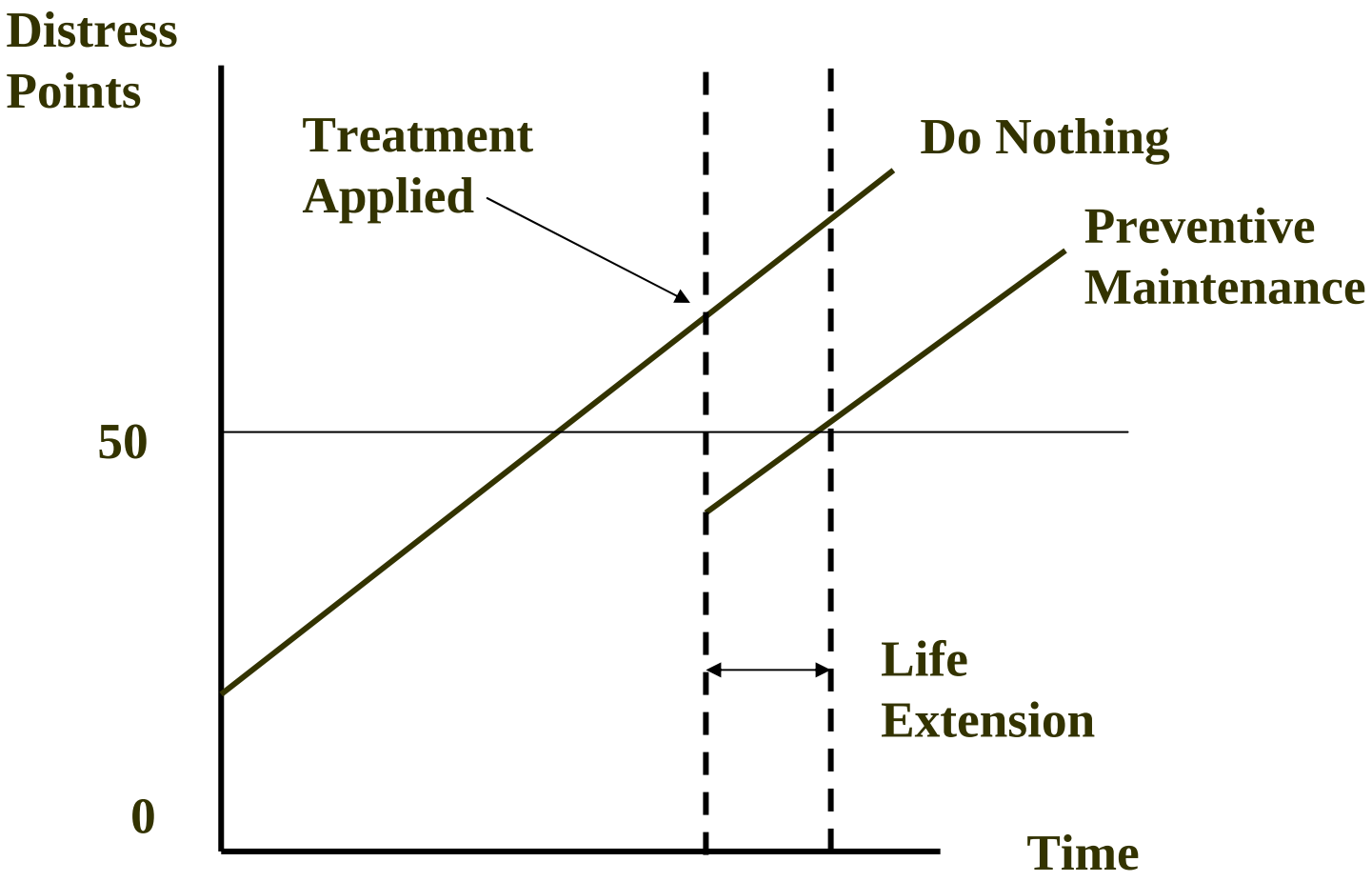
Suggested Optimal Timing

- **Fog seals, 1 to 3 years**
- **Crack seals, 2 to 4 years**
- **Chip seals, 5 to 7 years**
- **Slurry seals, 5 to 7 years**
- **Thin overlays, 5 to 10 years**

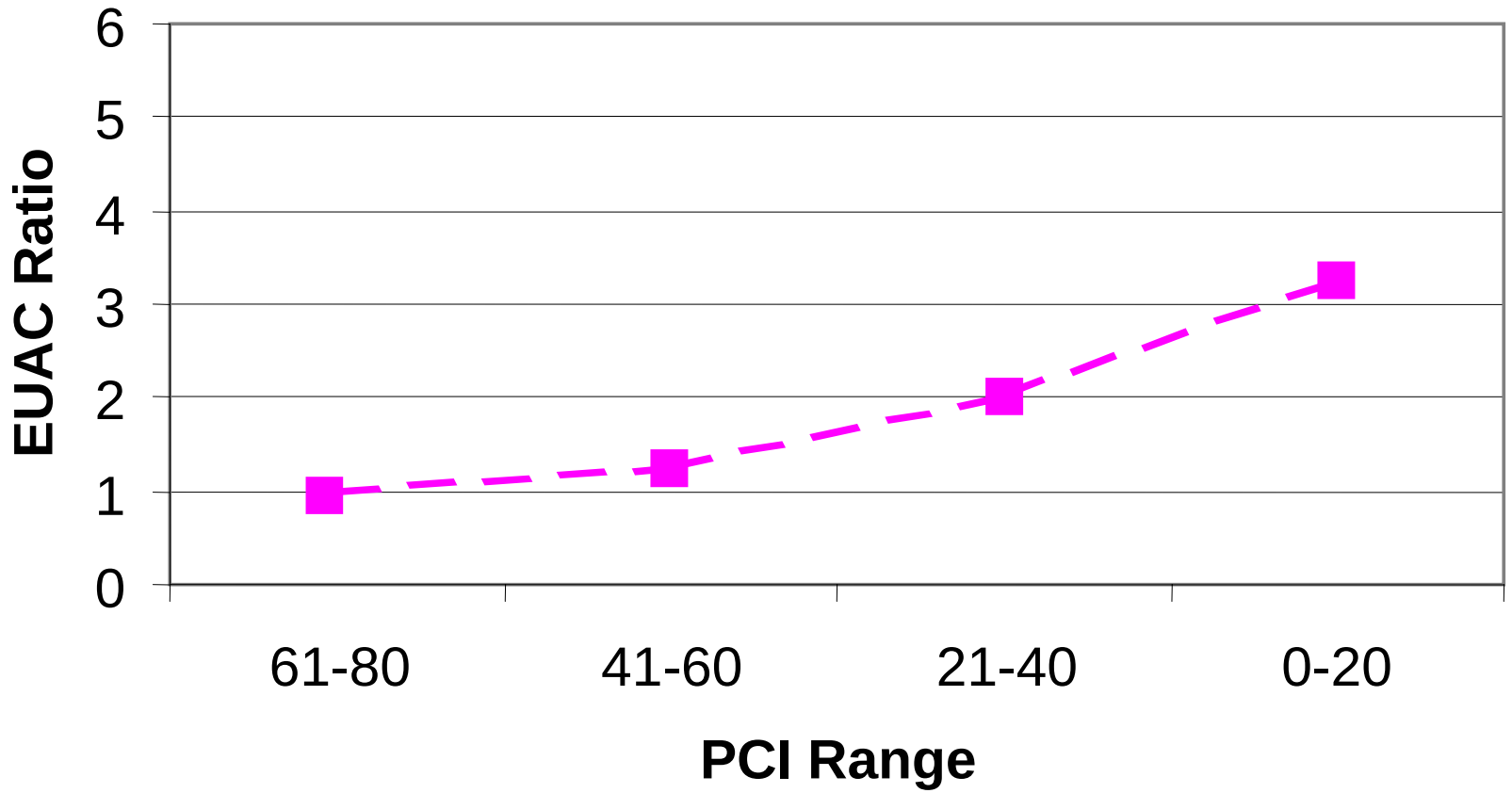
Effect of Proper Timing



Effect of Improper Timing



Average Equivalent Uniform Annual Cost (EUAC) Ratios for PCI Ranges



Strategies to Assist With Timing

- **Earlier thresholds**
- **Quick delivery contracts**
  - **Montana**
  - **Caltrans**
  - **Michigan**
  - **Georgia**
  - **New York**

Links to the Network-Level

- **Guidelines for using treatments**
  - **Preventive maintenance manual**
- **Compatible data collection efforts**
  - **Frequency and timing of surveys**
  - **Availability of desired information**
  - **Accuracy of survey data**

Network Modeling and Analysis Tools

Module 4

Approaches to Integration –1

- Establish treatment rules for rehabilitation and reconstruction
- Pavement sections that are NOT candidates for rehabilitation or reconstruction are candidates for maintenance

Rehabilitation and Reconstruction OR Preventive Maintenance Candidate

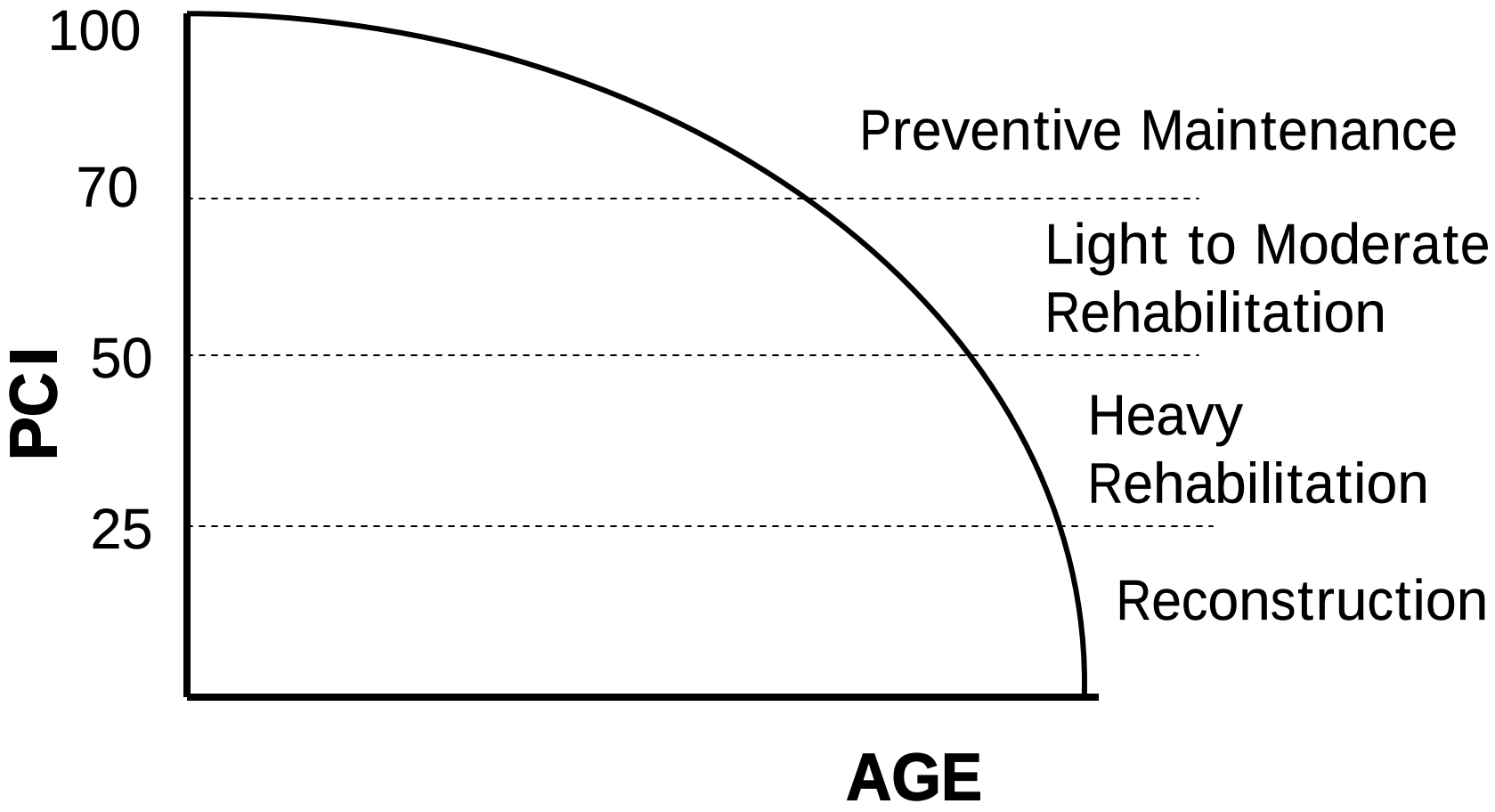
Approaches to Integration - 2

- Preventive maintenance treatments are considered collectively as a treatment and the specific treatment is not identified

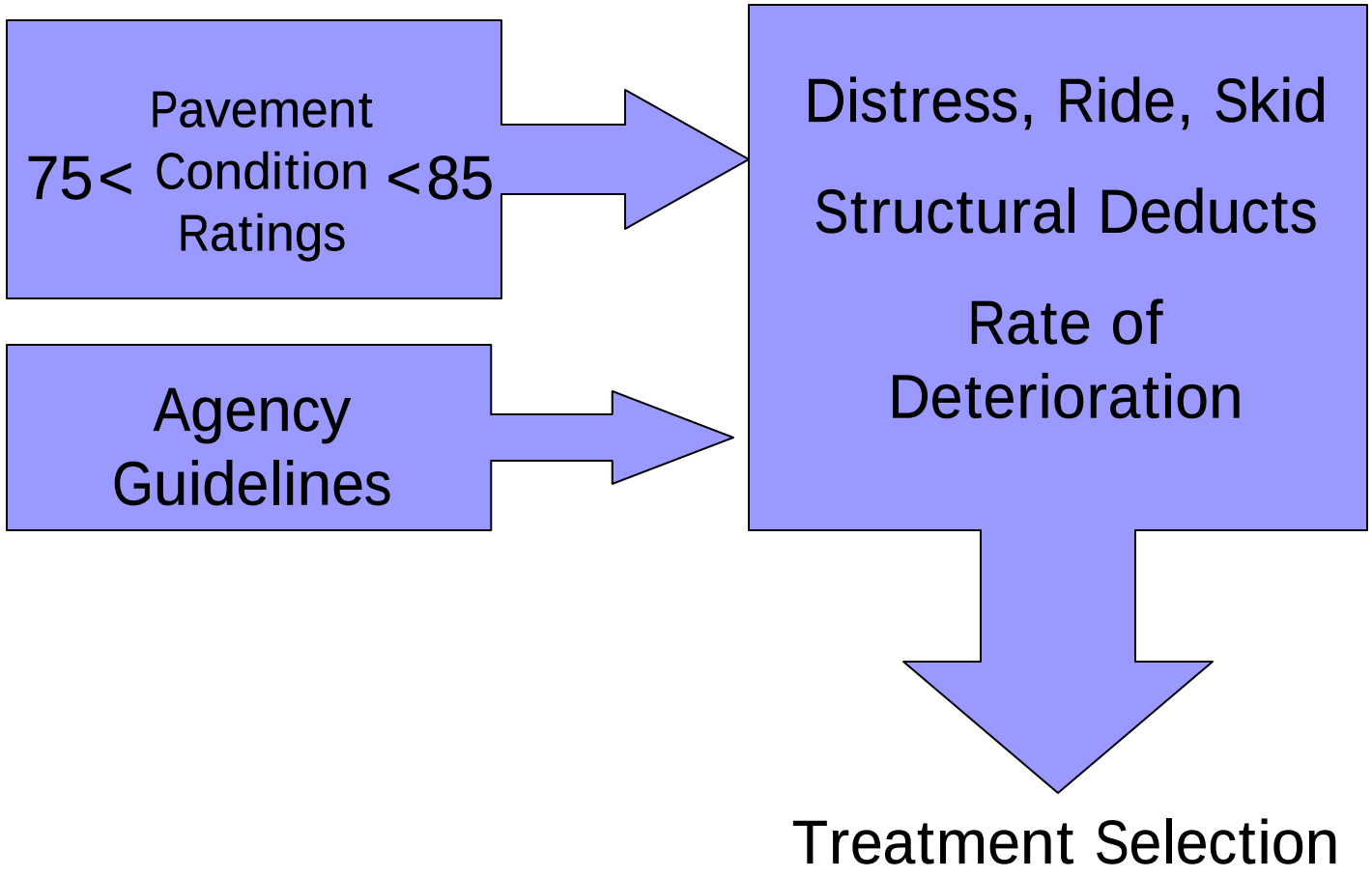
Treatments Considered

Preventive Maintenance
Thin Overlay
Mill and Fill
Structural Overlay
Reconstruction

Example


100
70
50
25
PCI
Preventive Maintenance
Light to Moderate Rehabilitation
Heavy Rehabilitation
Reconstruction
AGE

Ohio Department of Transportation



Treatment Rules Based on Timing

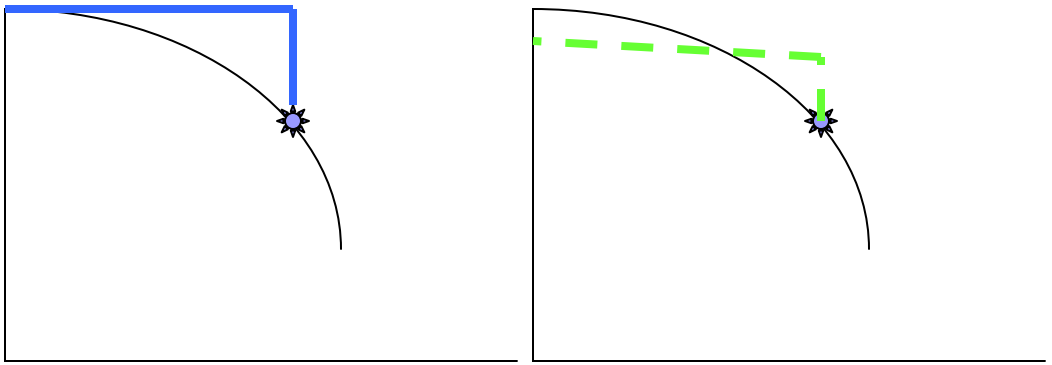
- Rehabilitation and reconstruction activities are triggered based on condition information
- Preventive maintenance treatments are triggered based on time since last activity

Approaches to Integration – 3

- Specific preventive maintenance treatments are recommended based on information available in the pavement management system

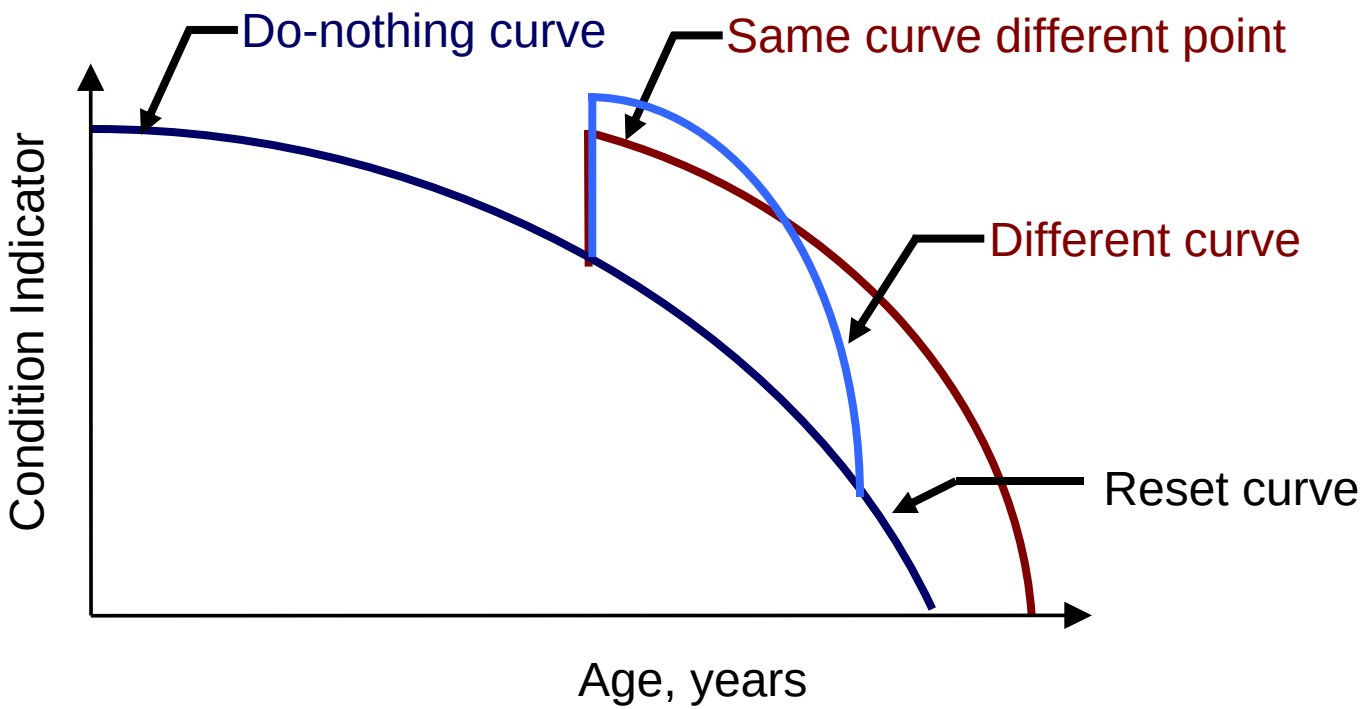
Improvements in Condition

- Add points



- Change distress severity
  - Medium and high severity cracks go to Low severity after crack sealing
  - Corresponding changes to indexes are calculated and used to establish rules

Change in Rate of Deterioration



Pros and Cons to Approach 3

- Allows an agency to incorporate treatment selection with project identification
- Models can be more specific to the treatment
- Requires more supporting information in the pavement management system

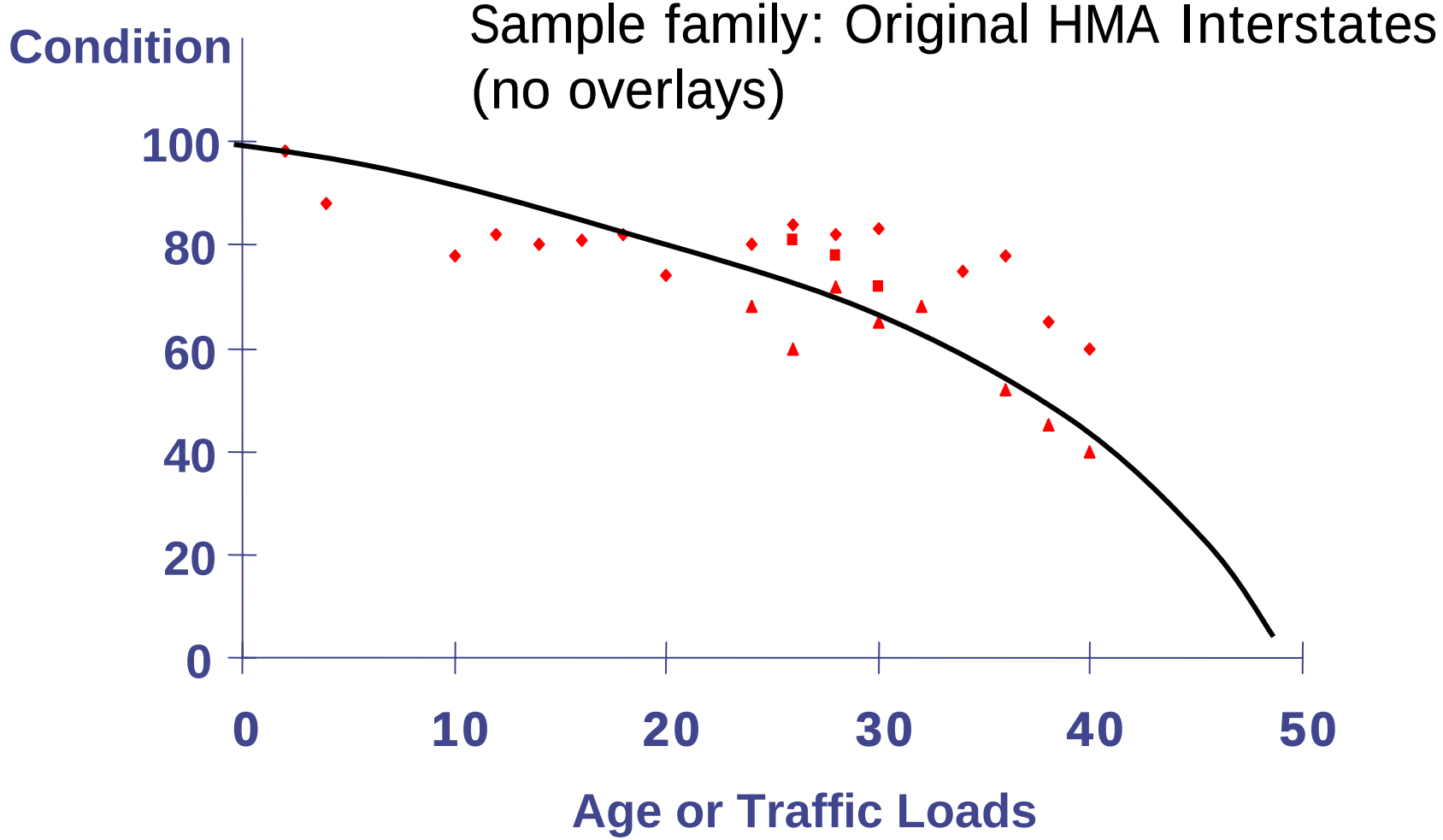
Condition Surveys and Condition Index Calculations

- Types of distress surveyed
- Use of individual versus composite indices
- Frequency of surveys
- Others?

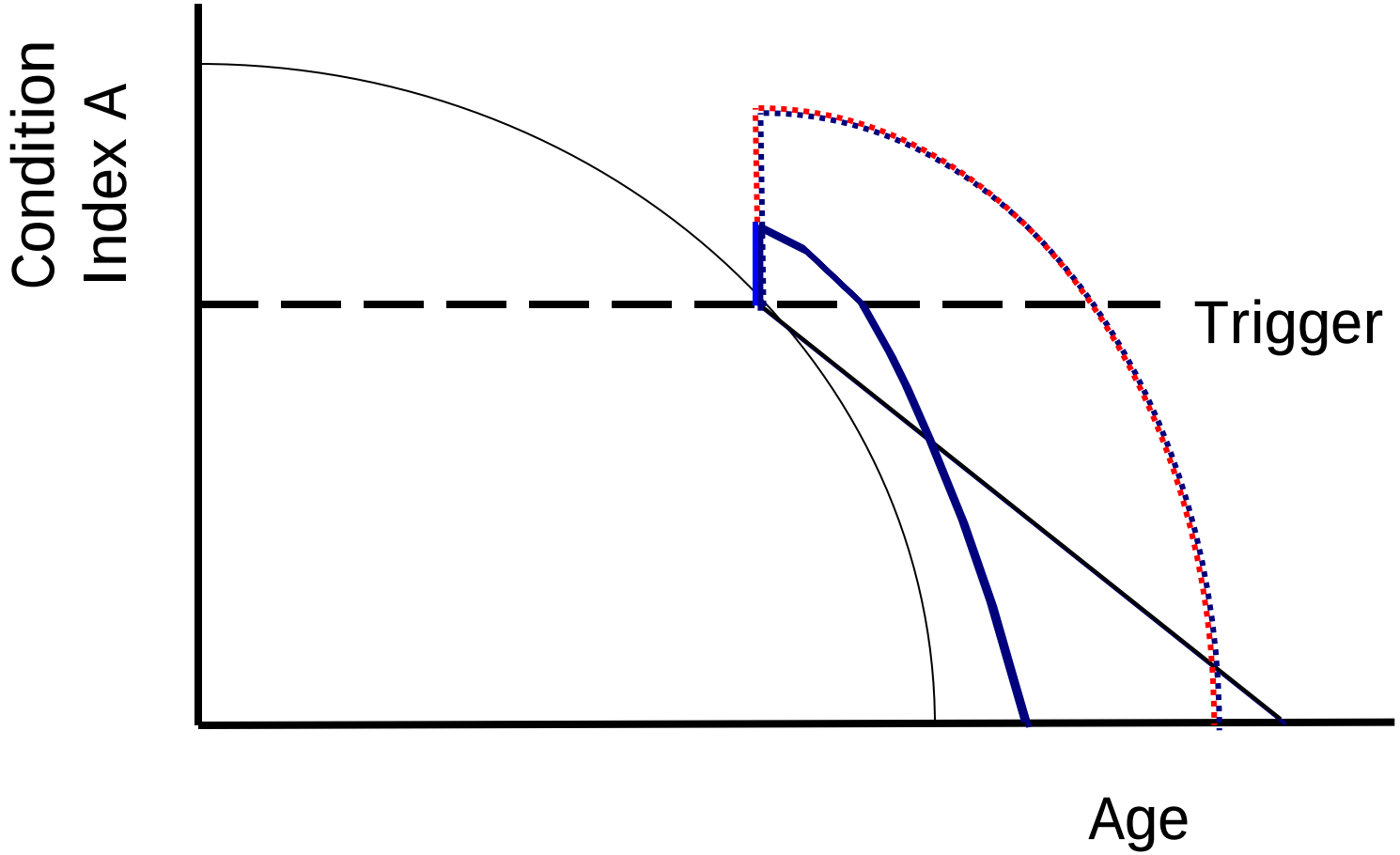
Pavement Performance Models

- Ability to develop distinct curves for each treatment and condition index
- Availability of necessary information in the database

Family Modeling Approach



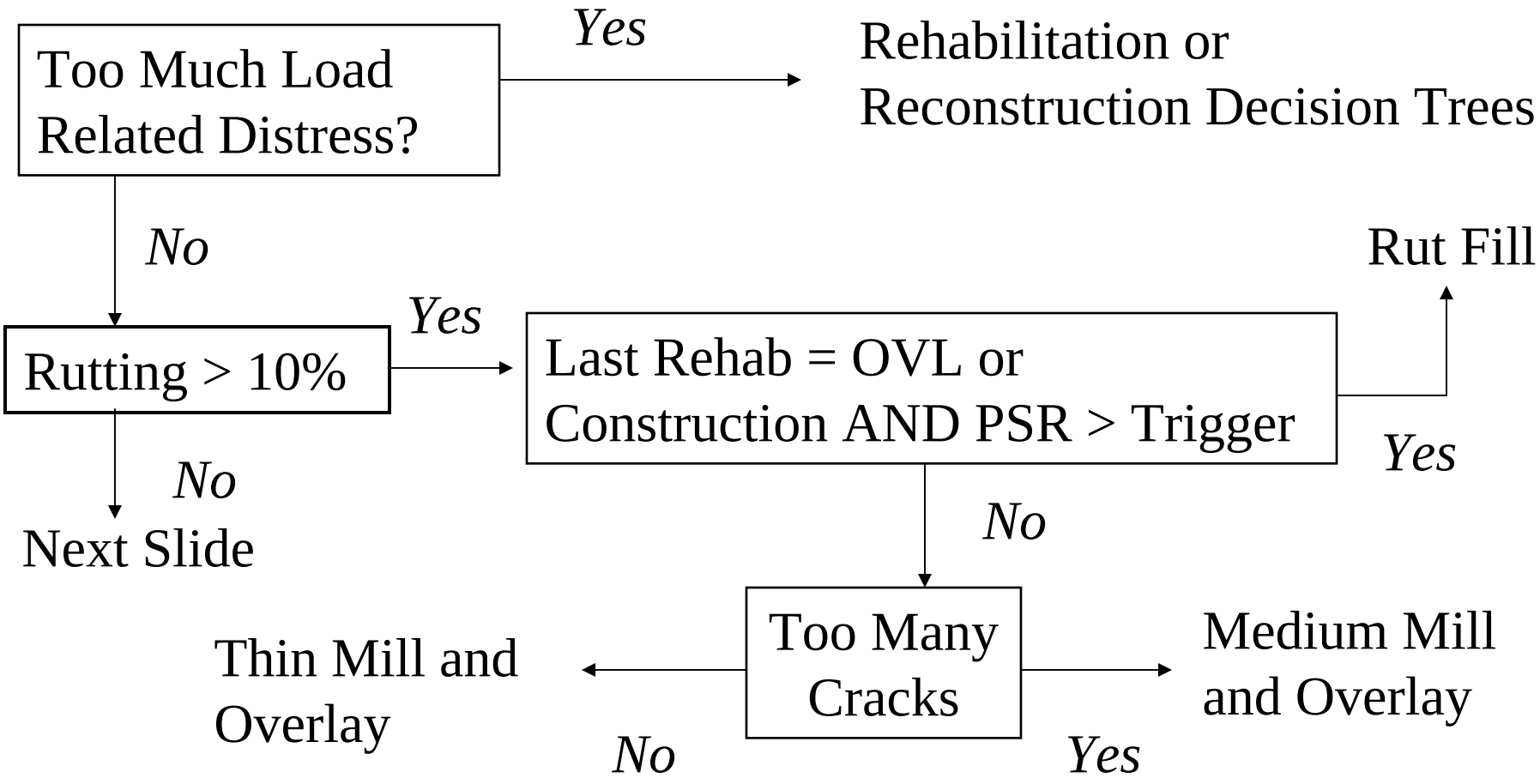
Preventive Maintenance Treatment Performance



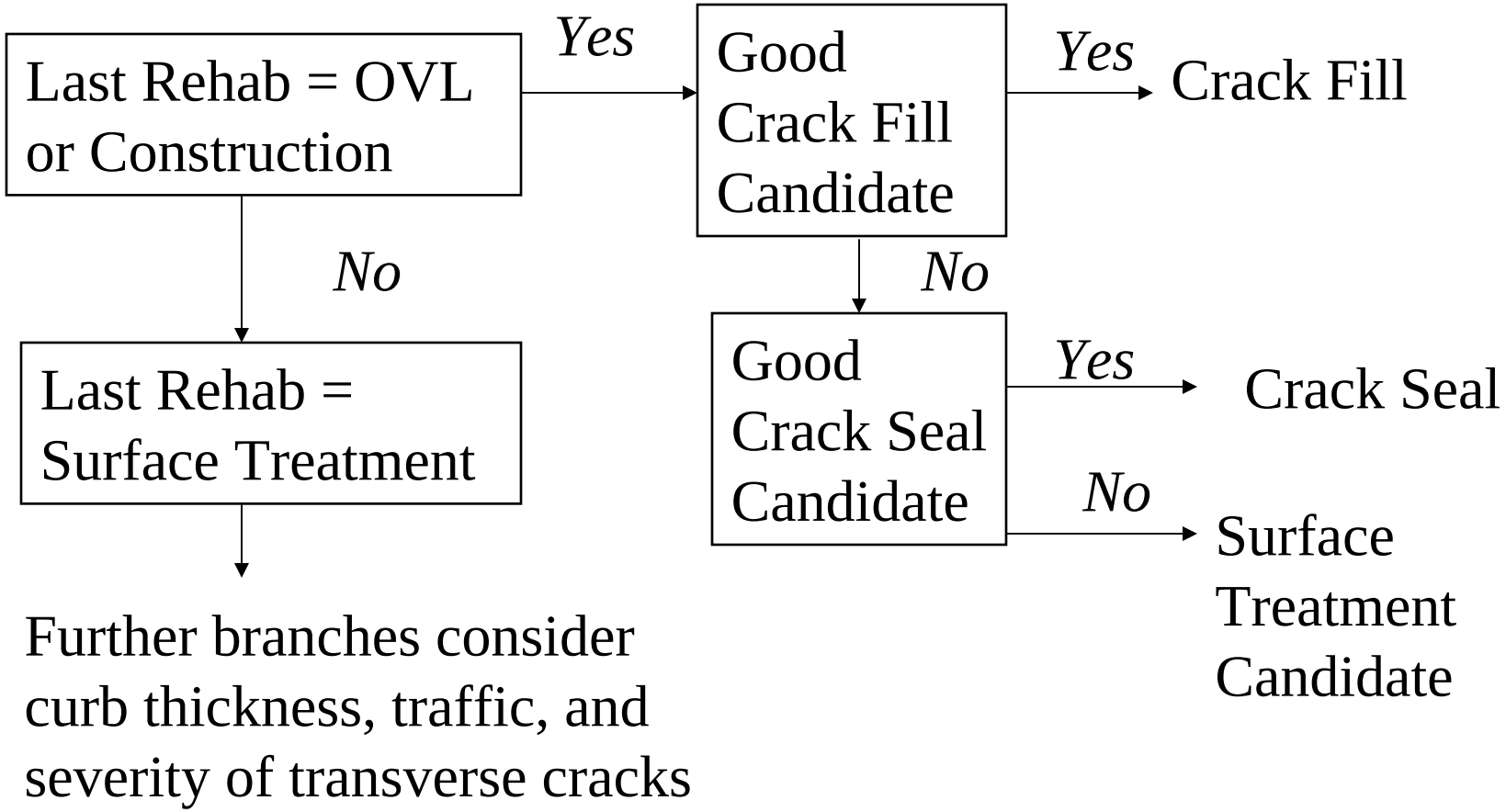
Treatment Rules

- Treatment Feasibility Rules
  - Decision trees
  - Treatment cycles
- Treatment Reset Rules
- Construction Cost Rules

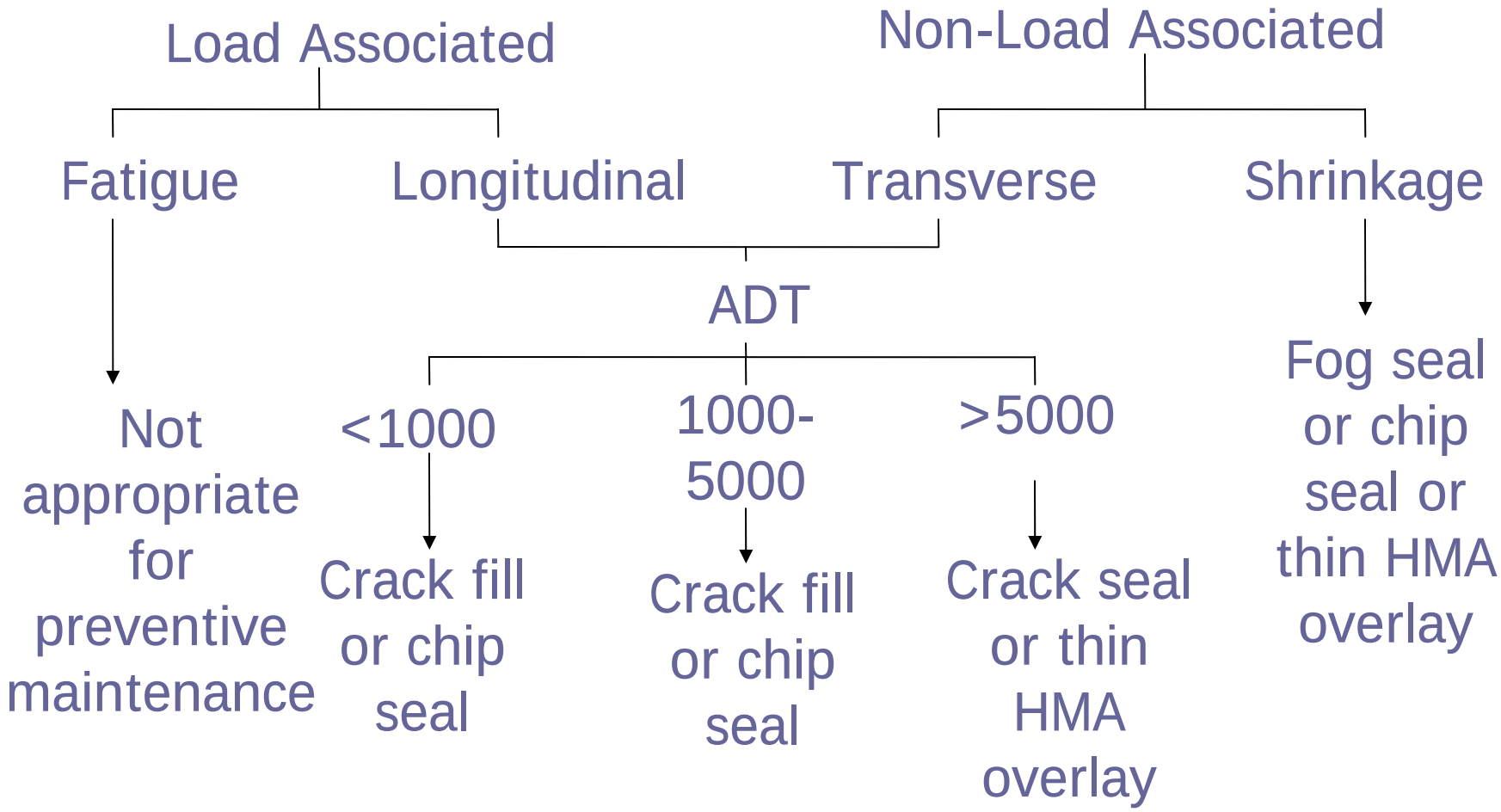
Minnesota Decision Tree – Part 1



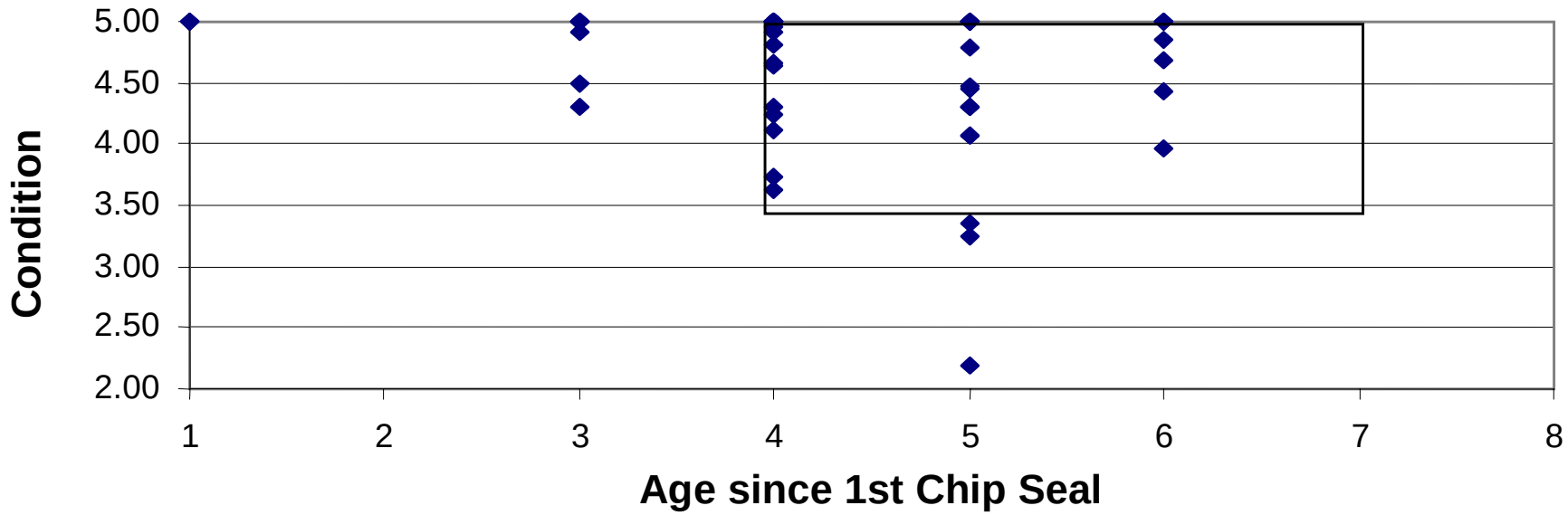
Minnesota Decision Tree – Part 2



Decision Tree for Cracking



Checking Treatment Triggers



Block Cracking

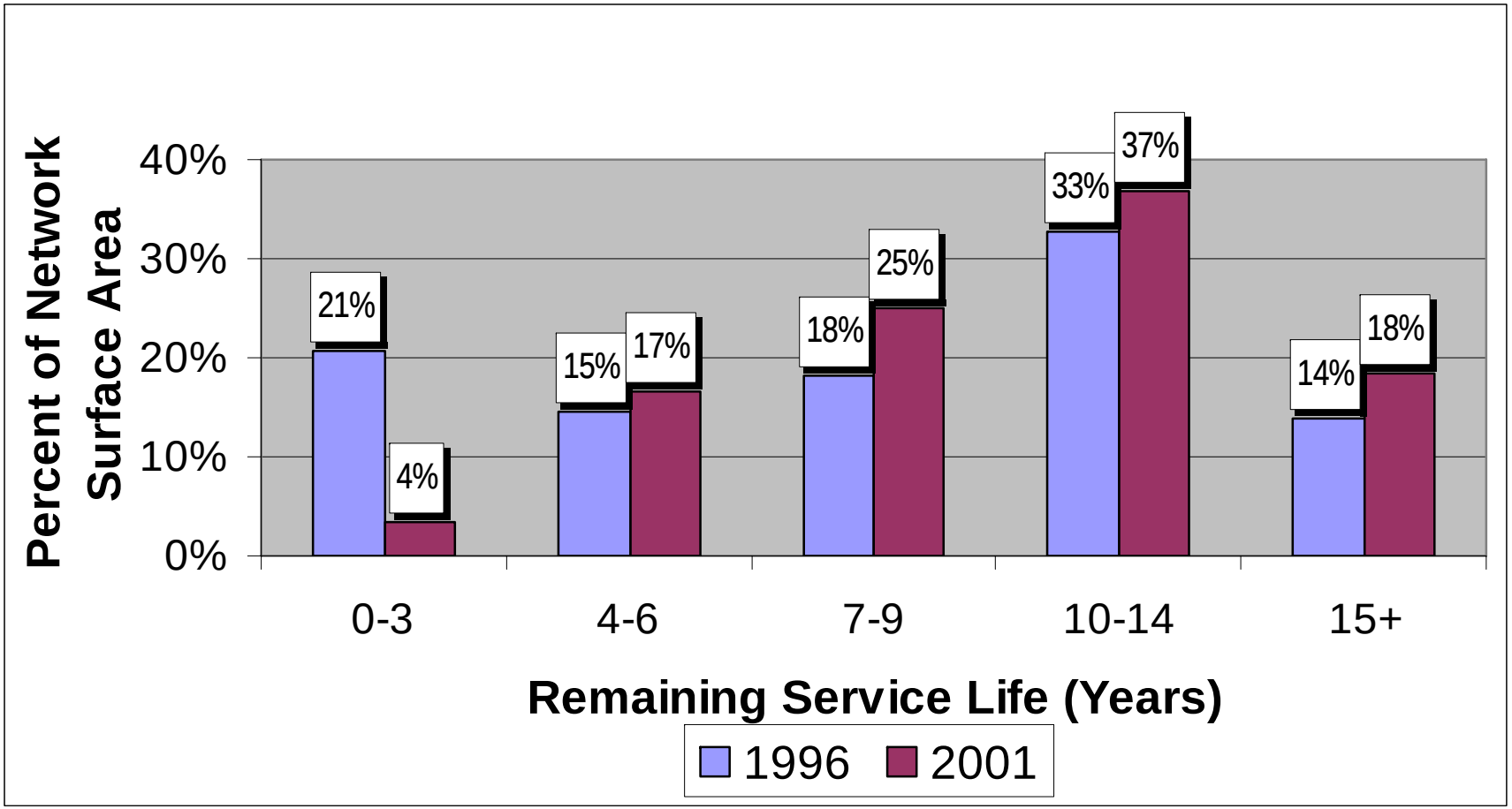
Impact of Maintenance on IRI

Activity	Mean Change in IRI	Adjusted Mean Change in IRI
Joint and crack filling	-0.294	-0.432
Joint and crack sealing	-0.225	-0.340
Full depth patching	-0.515	-0.570
Microsurfacing	-0.292	-0.324

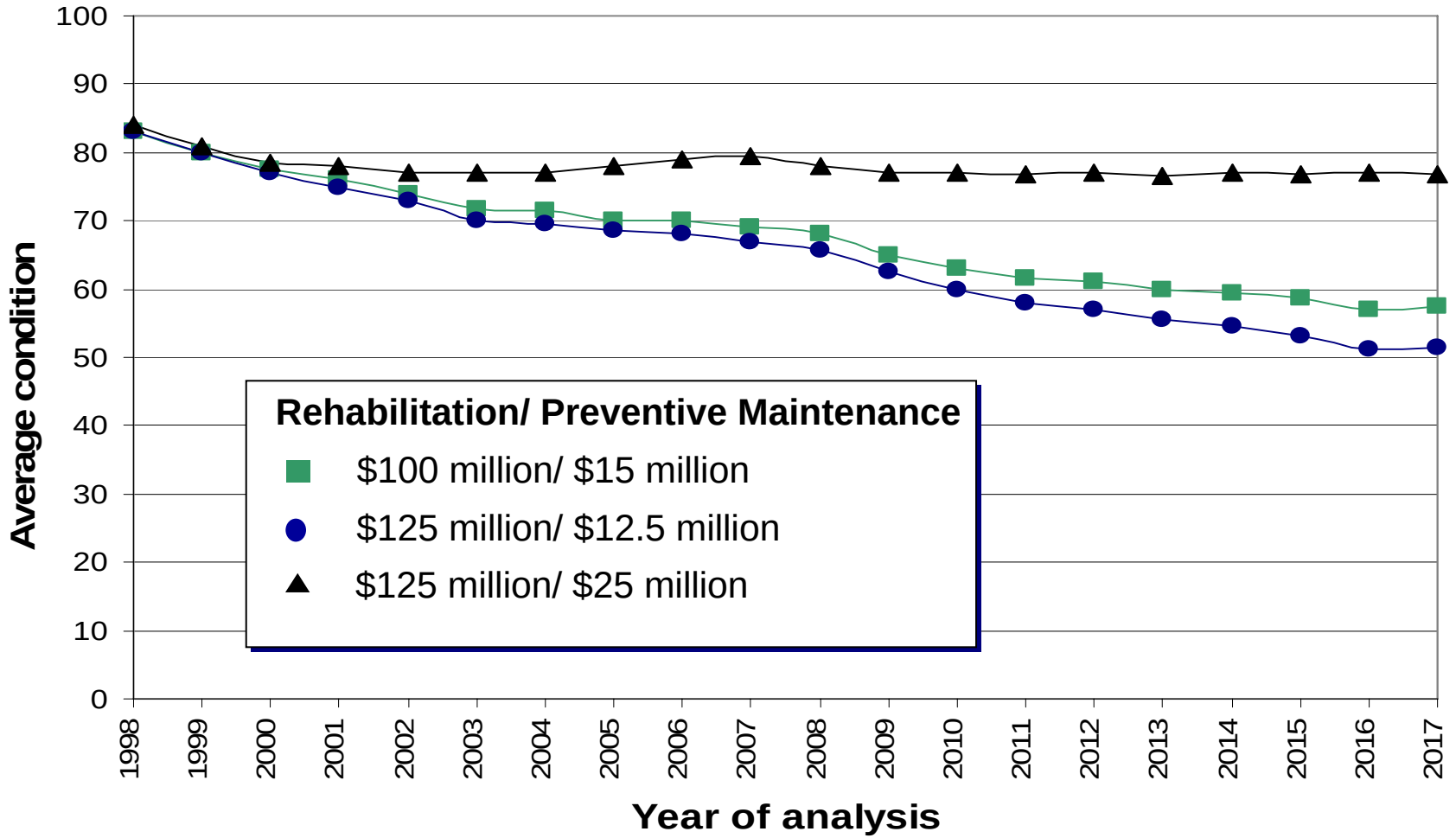
Impact of Maintenance on a Condition Index

Description	Mean Observed Change in PCI	Mean Change in PCI After Correction
Full-depth patching ACC/PCC	1.08	3.50
ACC partial-depth patching	1.00	5.72
Microsurfacing	2.10	4.76
Pavement fog seal	1.00	6.47

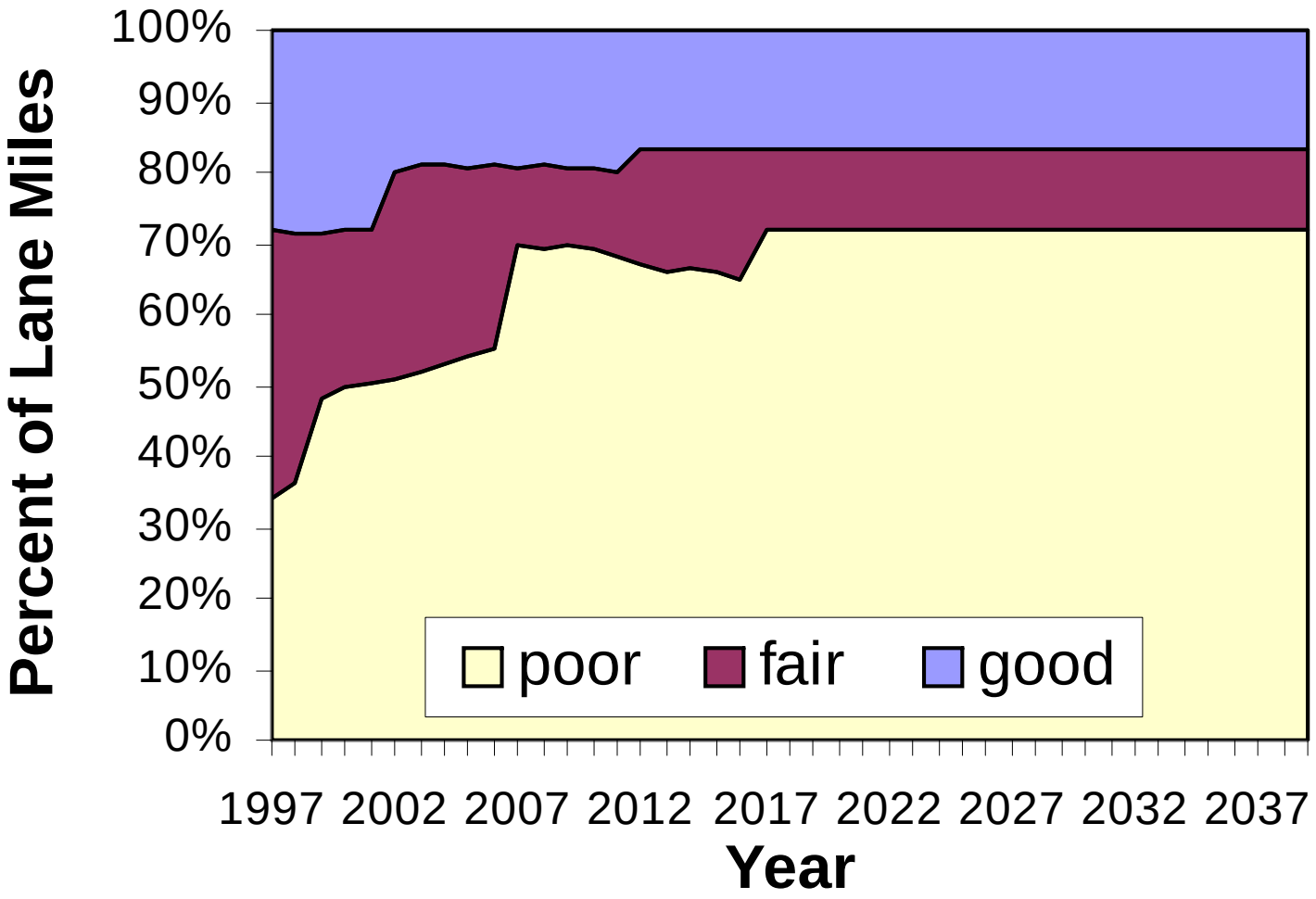
Ogden City, Utah



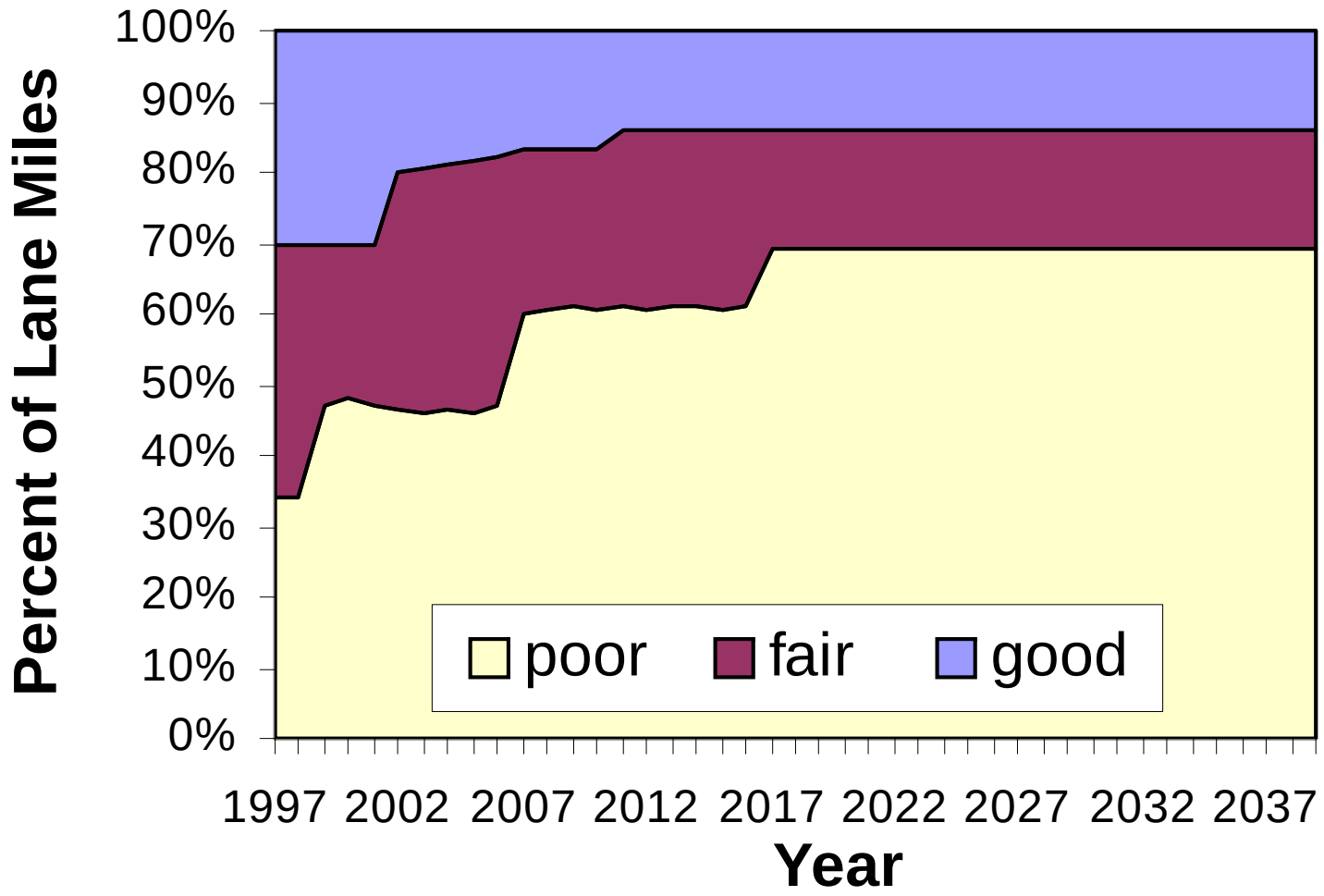
Indiana Department of Transportation - Interstates



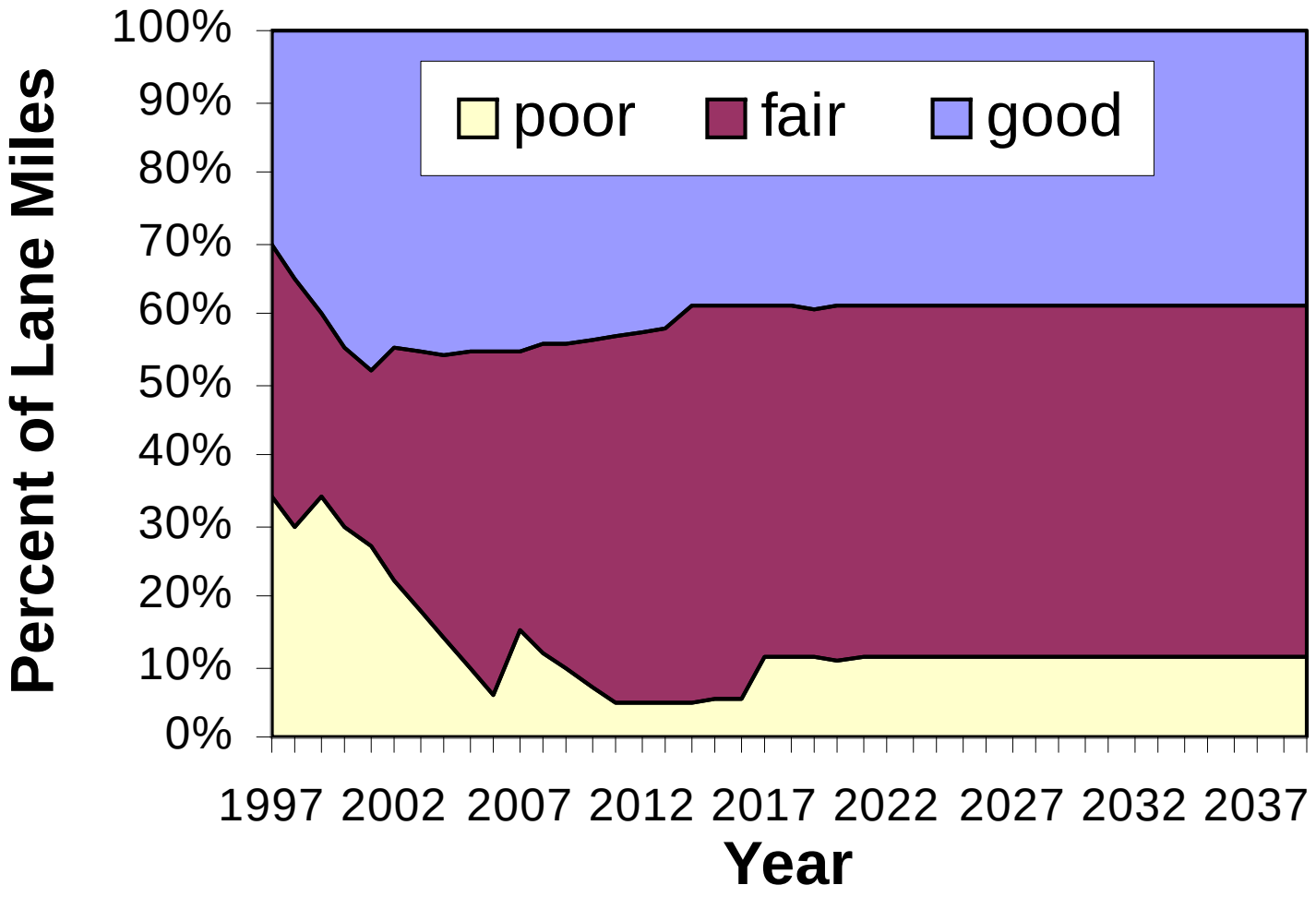
MDOT - Reconstruction Only

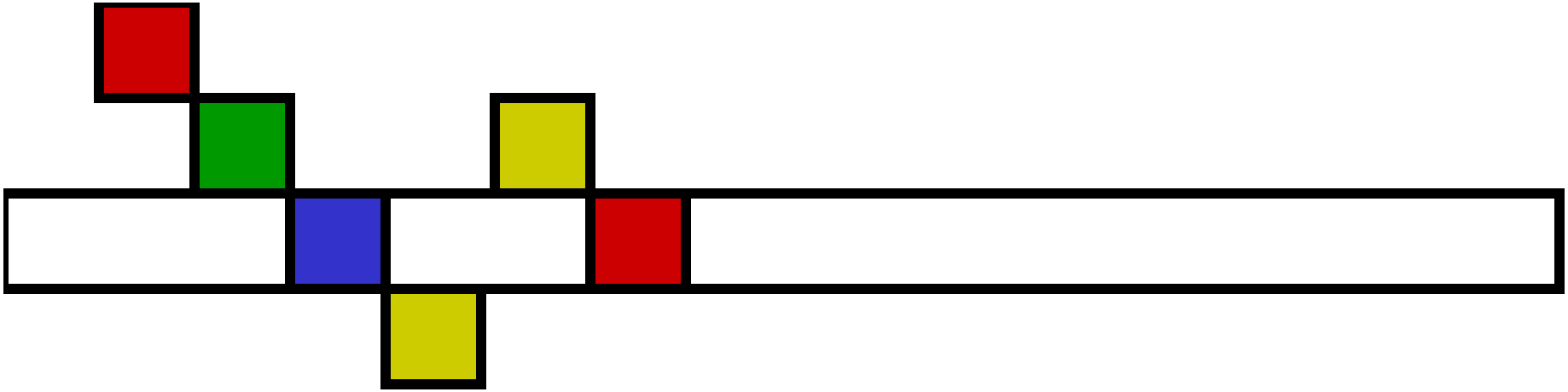


MDOT - Reconstruction and Rehabilitation



MDOT - With Preventive Maintenance





Incorporating Pavement Preservation into Strategic Decisions

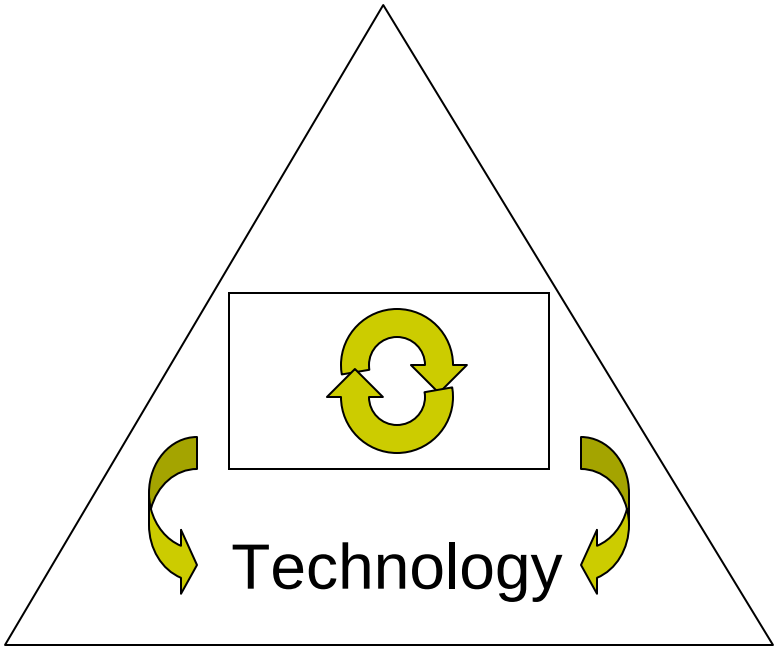
Module 5

Strategic-Level Issues

- The establishment of performance criteria for various road classifications
- The distribution of funding levels by district, including both targeted and actual funding levels
- The evaluation of trade-offs between the expansion of the network versus preservation of existing systems

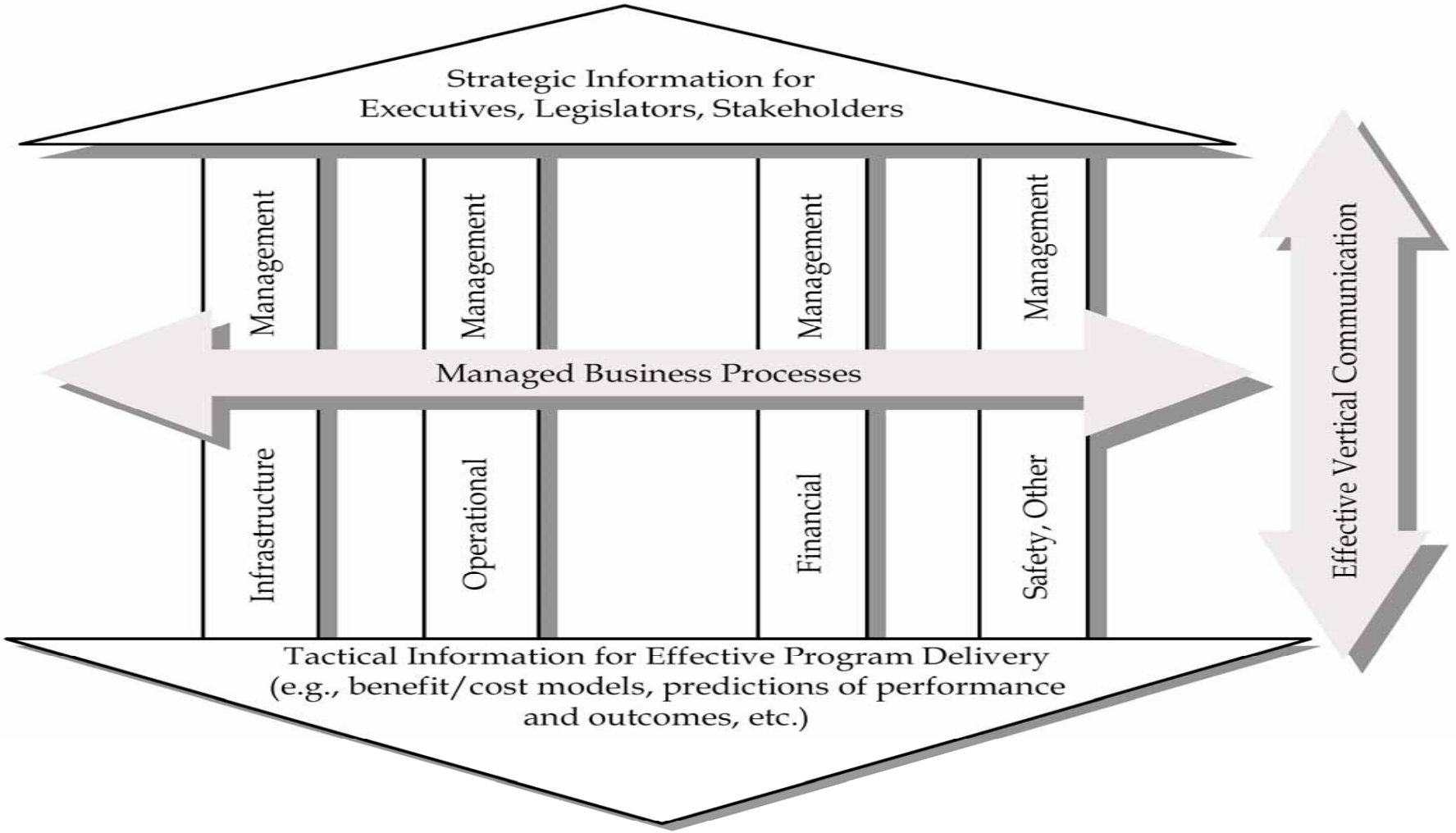
Strategic Management Framework

Goals, Policies, and Budgets



Integration

Technical Information


Strategic Information for
Executives, Legislators, Stakeholders
Management
Management
Management
Management
Managed Business Processes
Infrastructure
Operational
Financial
Safety, Other
Effective Vertical Communication
Tactical Information for Effective Program Delivery
(e.g., benefit/cost models, predictions of performance
and outcomes, etc.)

Remaining Service Life

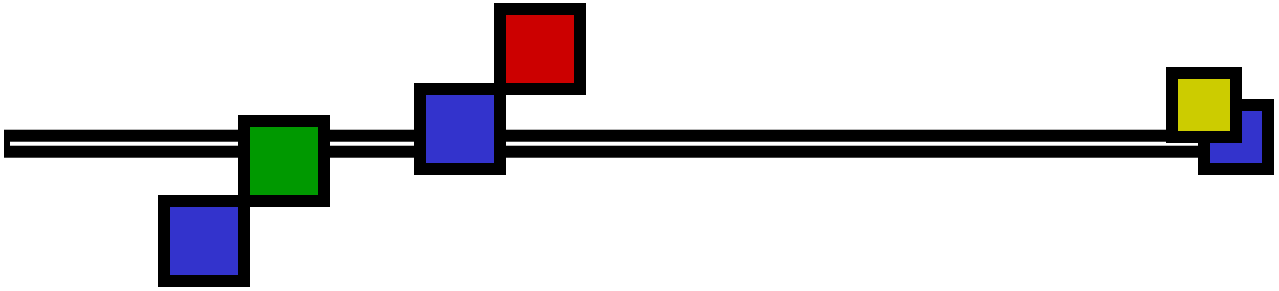
0 years

Remaining Service Life

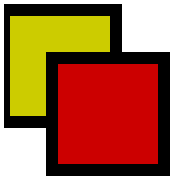
8 years

Legislative Involvement

- Pennsylvania DOT: "...Governor now has a maintenance-first philosophy, and he is putting his money where his mouth is"
- North Carolina DOT: Requires reporting of conditions and costs
- California DOT: Reduce backlog from 14,300 lane miles to 5,500 lane miles

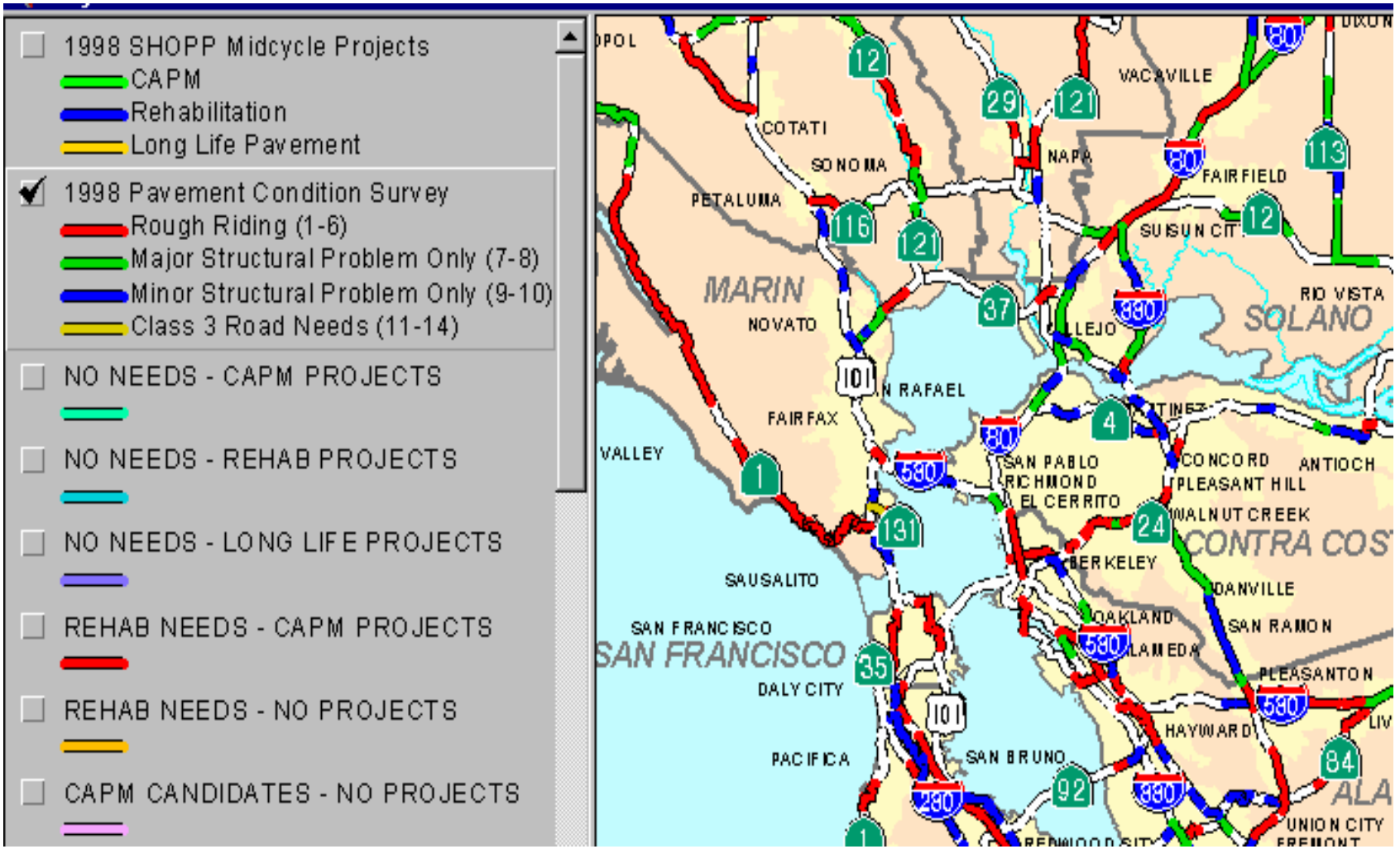


Establishing Goals and Budgets



- Indicate the objective for the program in terms of what will be achieved and when it will be accomplished
- Example: Michigan set a 10-year goal for 95% of its expressways and 85% of its non-expressways to be in fair or good condition
- Monitor the progress towards the goal

CALTRANS GIS Map



NCDOT Maintenance Performance Measures - Primary

ELEMENT 1			Service Level					Acceptable Level of Service
Roadway Pavement			A	B	C	D	F	
Activities	Condition Indicators	Performance Measures	Threshold	Threshold	Threshold	Threshold	Threshold	
Pavement Maintenance	Pavement Condition Rating	PCR	98	93	86	70	< 70	C

ELEMENT 2			Service Level					Acceptable Level of Service
Unpaved Shoulders and Ditches			A	B	C	D	F	
Activities	Condition Indicators	Performance Measures	Threshold	Threshold	Threshold	Threshold	Threshold	
Low Shoulder	Low $\geq$ 2 inches	FT	1%	5%	8%	11%	> 11%	C
High Shoulder	High $\geq$ 2 inch	FT	1%	4%	6%	10%	> 10%	C
Lateral Ditches	Blocked $\geq$ 50% & not funct. as designed	FT	2%	6%	9%	12%	> 12%	C
Lateral Ditch Erosion	Eroded $\geq$ 1 ft	FT	1%	2%	3%	4%	> 4%	A

Statewide Average - Primary System

Maintenance Activity	Level of Service				
	+ A -	+ B -	+ C -	+ D -	+ F -
Pavement					
Pavement				■	
Unpaved Shoulders and Ditches					
Low Shoulder					■
High Shoulder					■
Lateral Ditches		■			
Lateral Ditch Erosion	■				
Drainage					
Crossline Pipe					■
Driveway Pipe					■
Curb & Gutter			■		
Catch Basin & Drop Inlet					■
Other Drainage Features					■
Roadside					
Mowing		■			
Brush & Tree Control				■	
Litter & Debris			■		
Slope		■			
Guardrail			■		
Traffic Control Devices					
Traffic Signs				■	
Pavement Striping					■
Words & Symbols					■
Pavement Markers					■
Environmental					
Turf Condition				■	
Misc. Vegetation Management			■		

Minnesota DOT

- Set a funding goal of $40 million based on information provided by the pavement management system
- Established procedures for distributing money to the districts and assisting the districts with project and treatment selection

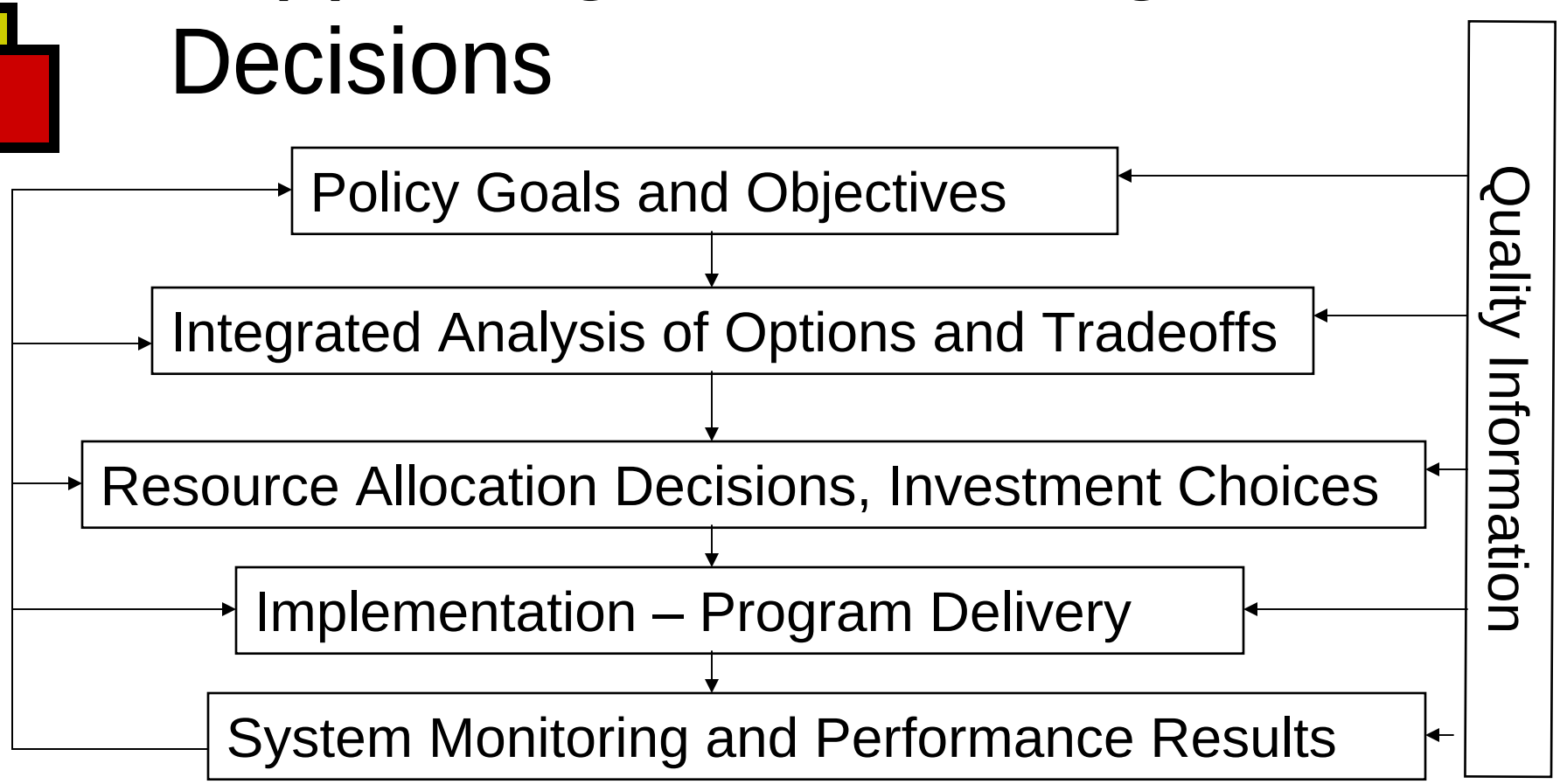
Transportation Asset Management

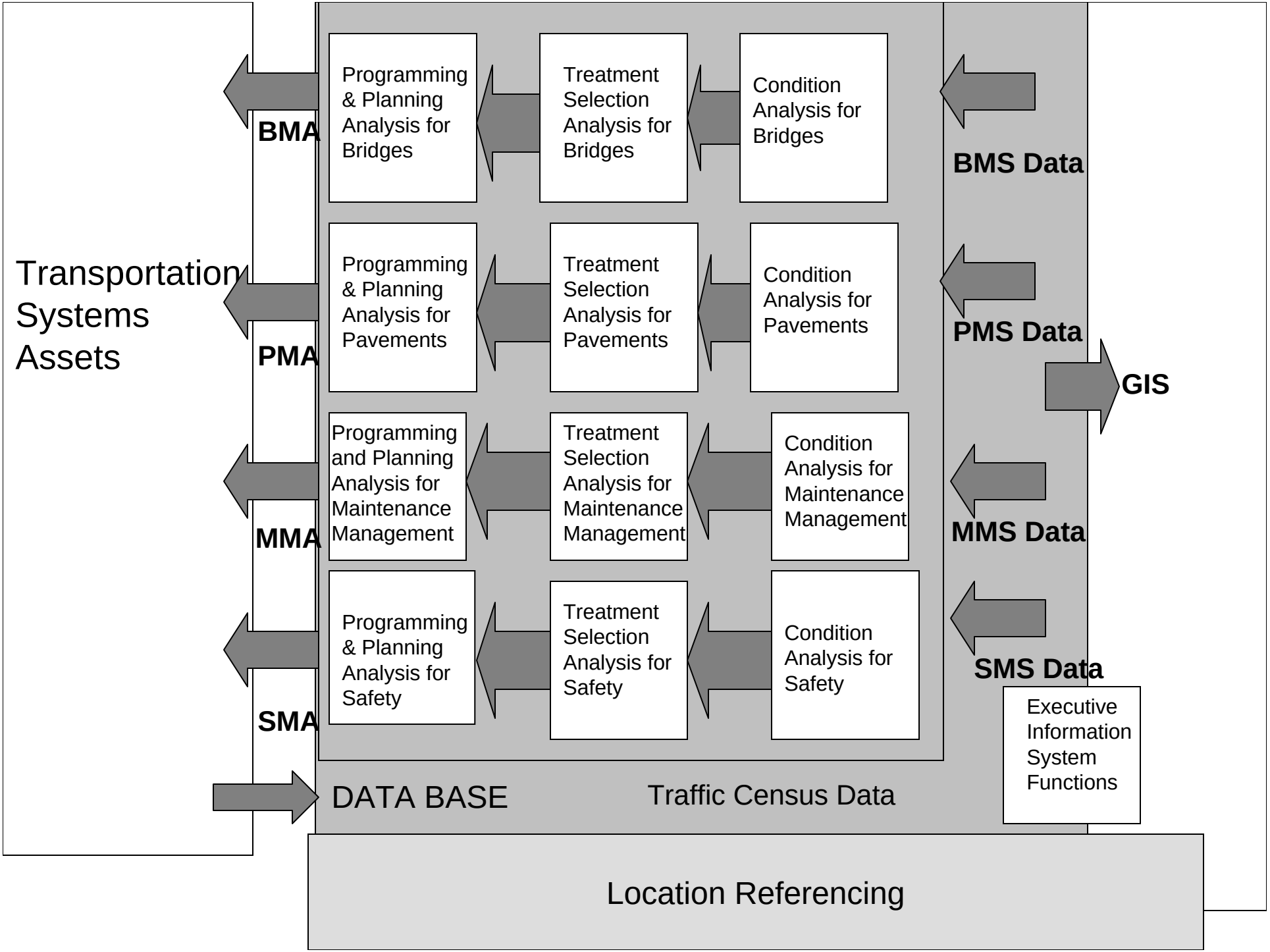
- Defined as a strategic approach to allocating resources for the preservation, operation, and management of our Nation's transportation infrastructure
- FHWA emphasis on the use of asset management concepts for system preservation activities

NY State Transportation Commissioner

- “The citizens and taxpayers that use our transportation system expect excellence, integrity, reliability, and sustainability to be reflected in the decisions public officials implement on their behalf. ...More use of technical tools to quantify the economic efficiency of proposed investment alternatives will help transportation executives meet these expectations.”

Role of Management Systems in Supporting Asset Management Decisions




Transportation Systems Assets
BMA
PMA
MMA
SMA
Programming & Planning Analysis for Bridges
Treatment Selection Analysis for Bridges
Condition Analysis for Bridges
Programming & Planning Analysis for Pavements
Treatment Selection Analysis for Pavements
Condition Analysis for Pavements
Programming and Planning Analysis for Maintenance Management
Treatment Selection Analysis for Maintenance Management
Condition Analysis for Maintenance Management
Programming & Planning Analysis for Safety
Treatment Selection Analysis for Safety
Condition Analysis for Safety
BMS Data
PMS Data
GIS
MMS Data
SMS Data
Executive Information System Functions
DATA BASE
Traffic Census Data
Location Referencing

Implementation Concepts

Module 6

Implementation Issues

- Technical issues
- Institutional issues
- Organizational issues

Inability to Track Maintenance

MP 10

MP 25

Code: 1200 Pothole Patching

Material Used:

Equipment Used:

Labor Hours:

Multiple Referencing Systems

MP 12

MP 12.0135

MP 12 + 01

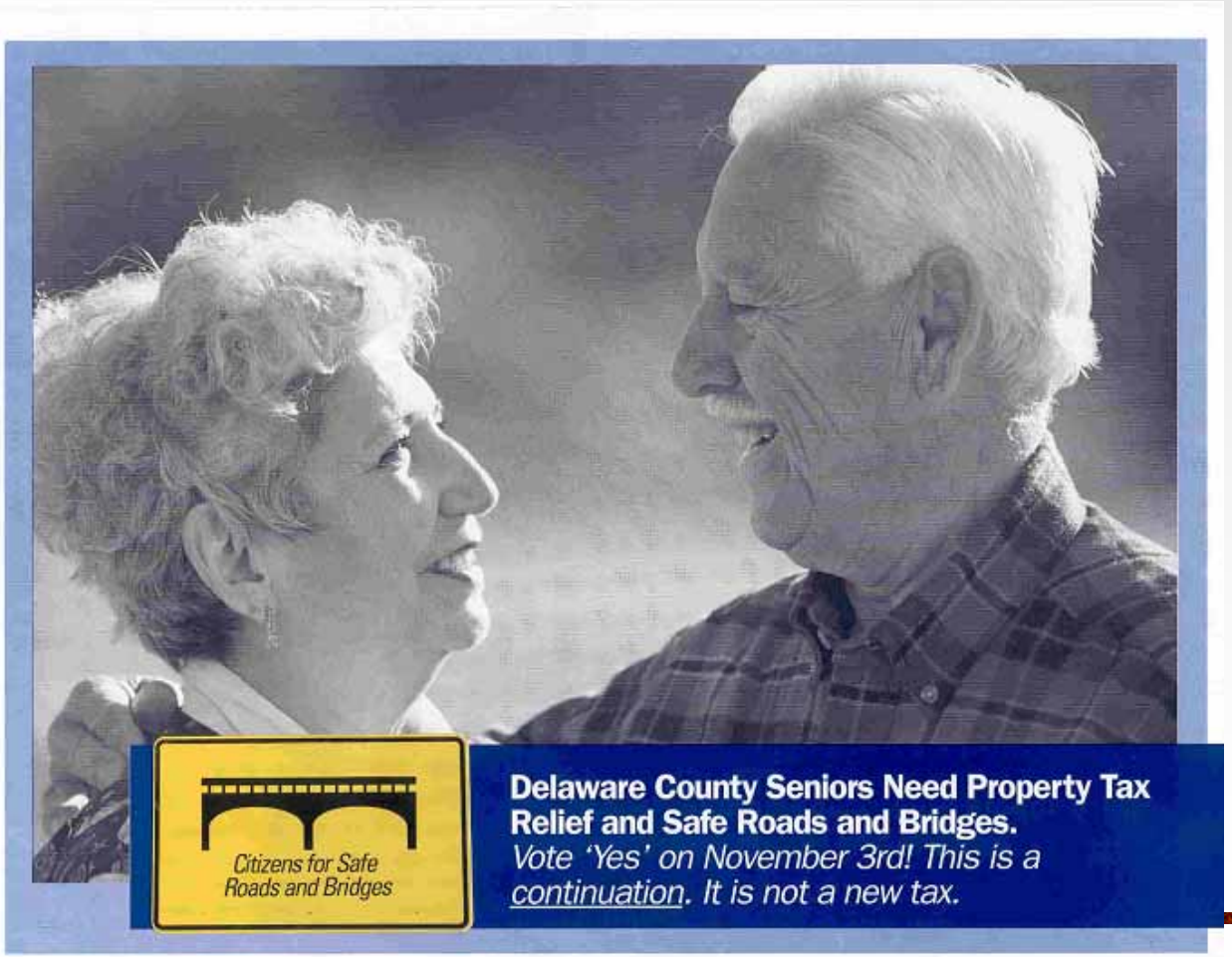
Guidelines for Selecting a Common Reference System

- Pick a system that is attribute and application neutral
- Get help and do it quickly
- Leverage other efforts

Lack of Support for Early Intervention

- Shorten the time between project identification and construction
- Public perception issues

Delaware County, Ohio



Alabama DOT
Ribbon Cutting

PennDOT Press Release

"…we continuously strive to be as cost-effective as possible with every dollar we have available. … we will continue to explore new technologies that will help us do a better job for our customer. By preserving roads with the right type of treatment at the right time we can keep costs down and provide the biggest benefit possible to our customers."

Lack of Performance Data

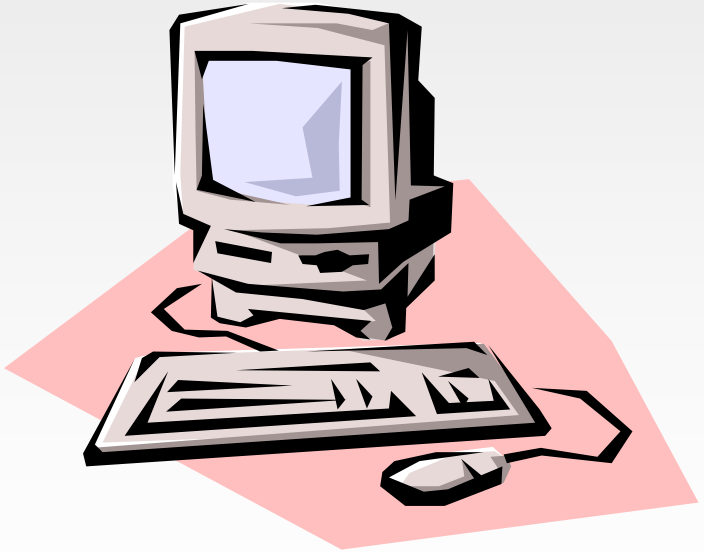
- Treatment histories
- Treatment objective
  - Preventive
  - Stop-gap
- Treatment cost
- Do-nothing performance curves

Observations on Pavement Management Databases

- A pavement management analysis limits the amount of data stored
- Subsurface pavement thickness and material information is often missing
- Traffic load data is missing
- Other useful information is missing

Lack of Integrated Databases

- Multiple sources of data within an agency
- Data integration
  - Data warehousing
  - Linking databases



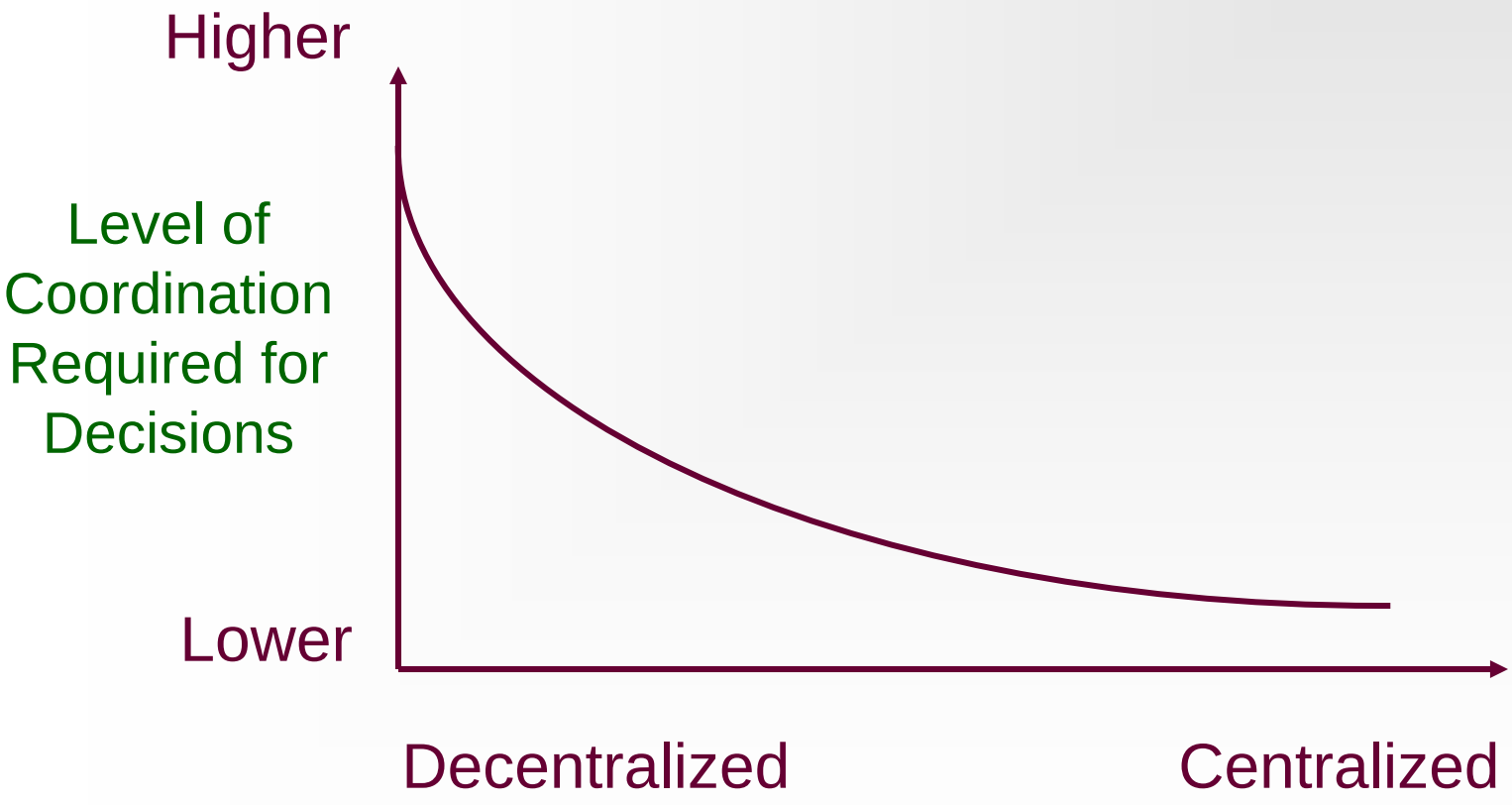
Duplication of Effort

- Improve efficiency and consistency
- Example: Level of Service (LOS) and pavement condition surveys

Understanding the Pavement Management System

- Understand the decision process
- Understand the impact maintenance activities have on treatment selection
- Be sure decisions are being made at the appropriate level

Organizational Structure Issues



Developing an Action Plan

- Benchmark existing practices
- Identify steps needed to be taken
- Prioritize the steps
- Prepare the action plan

Benchmarking Practices

	Strongly Disagree			Strongly Agree
A1: Agency pavement preservation policies are supported through the use of pavement management activities	1	2	3	4
A2: The agency's capital maintenance funding allocations for roads are based on an assessment of pavement needs	1	2	3	4

Identify and Prioritize Actions

- Where do gaps exist between good practice and agency practice?
- What steps can the agency take to reduce the gaps?
- Which issues are organizational issues and which are local issues?
- Which actions will have the greatest immediate benefit to the agency?

Guidelines

- Start small and build gradually
- Involve as many stakeholders as possible
- Recognize change doesn't happen immediately
- Promote the plan and build acceptance
- Document and promote progress

Success Stories: Organizational Structure

- NCDOT: Pavement Preservation Engineer
- Pavement Management Engineers in districts (Utah, Virginia)

Success Stories: Contracting Issues

- SDDOT: First chip application
- MDOT: Reduced design and developed warranties

Success Stories: Technical Issues

- Iowa DOT: Effects of preventive maintenance
- MnDOT: Network-level decision trees and review of preventive treatment selection
- MDOT: Single referencing system
- Integrating maintenance management and pavement management systems
- Data warehousing
- Manuals of Practice

Long-Term Research

- Performance studies
- Technology transfer/sharing results
- Data integration issues

Maintaining an Integrated Approach

- Develop a feedback loop
- Link Manuals of Practice to pavement management treatment selection
- Develop a steering committee
- Diagram relationships between sources of data and users
- Other ideas?

Summary and Wrap-Up

Module 7

Future Efforts

- FHWA's Expert Task Group (ETG)
- National Center for Pavement Preservation
- Regional/State Preservation Groups
- AASHTO Subcommittee on Maintenance – Pavement Task Force
- Outreach Efforts
- Foundation for Pavement Preservation (FP^2)
- Others

Key Points

- Importance of preventive maintenance
- Role of pavement management in supporting a preventive maintenance program at the project, network, and strategic levels
- Integration is a key to developing coordinated pavement preservation plans