SELECTING A PREVENTIVE MAINTENANCE TREATMENT FOR FLEXIBLE PAVEMENTS

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Presentation Outline

- Background and Objectives
- Establishing a Preventive Maintenance Program
- Framework for Treatment Selection and Timing
- Analysis to Determine the Most Effective Treatment
- Summary

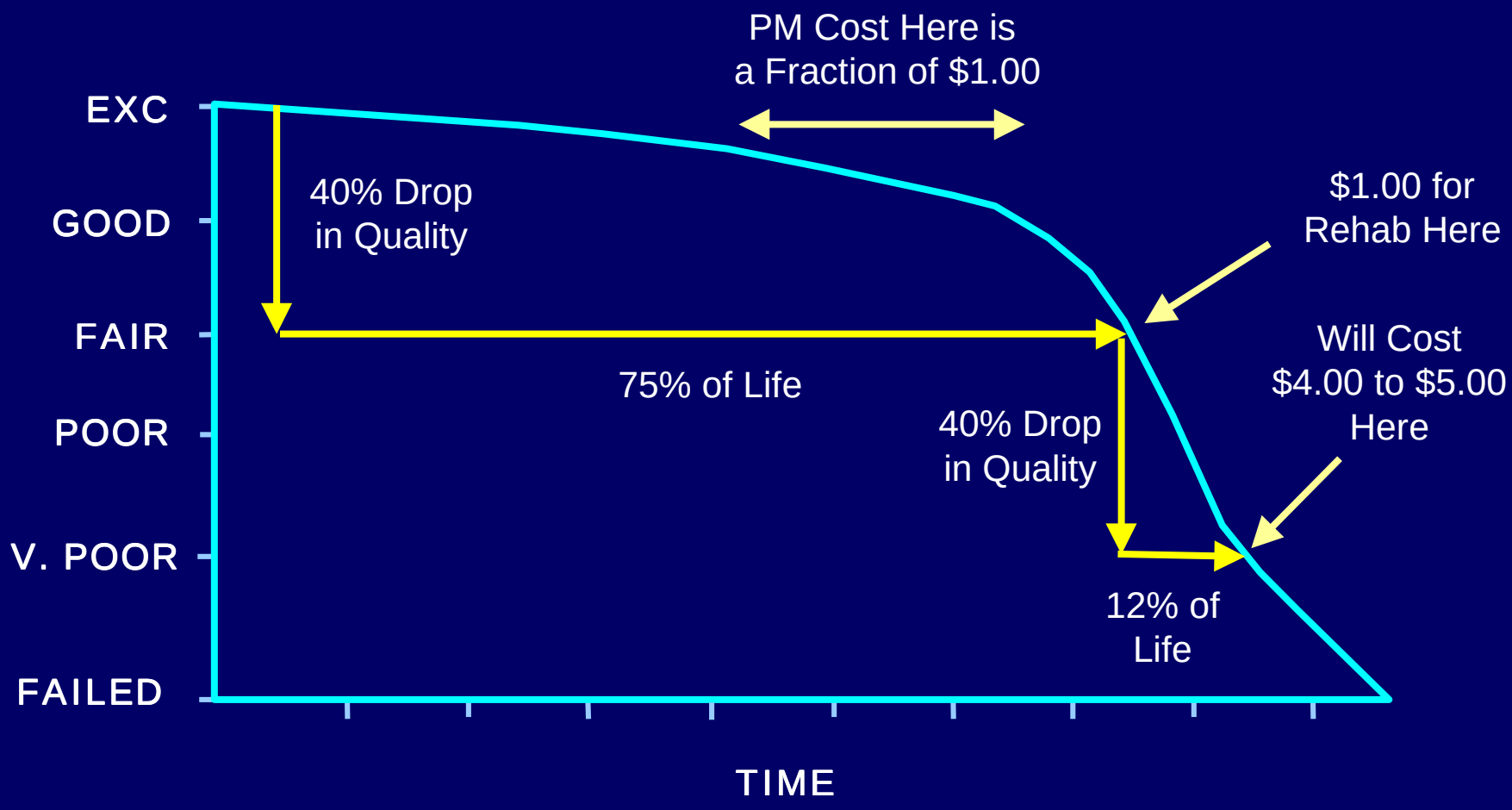
Background

- Pavement Management Systems
  - Most Agencies have one
  - Usually contain maintenance component
- Limitations
  - Models to determine cost effective treatment
  - Most don’t contain proper treatment timing

Background (continued)

- Types of Pavement Maintenance
  - Preventive (Proactive)
    - **Arrest light deterioration**
    - **Retard progressive failures**
    - **Reduce need for corrective maintenance**
    - **“Right” treatment at the “right” time!**
  - Corrective (Reactive)
    - **After deficiency occurs**
    - **More expensive**
  - Emergency

Typical Variation of Pavement of Pavement Condition as a Function of Time



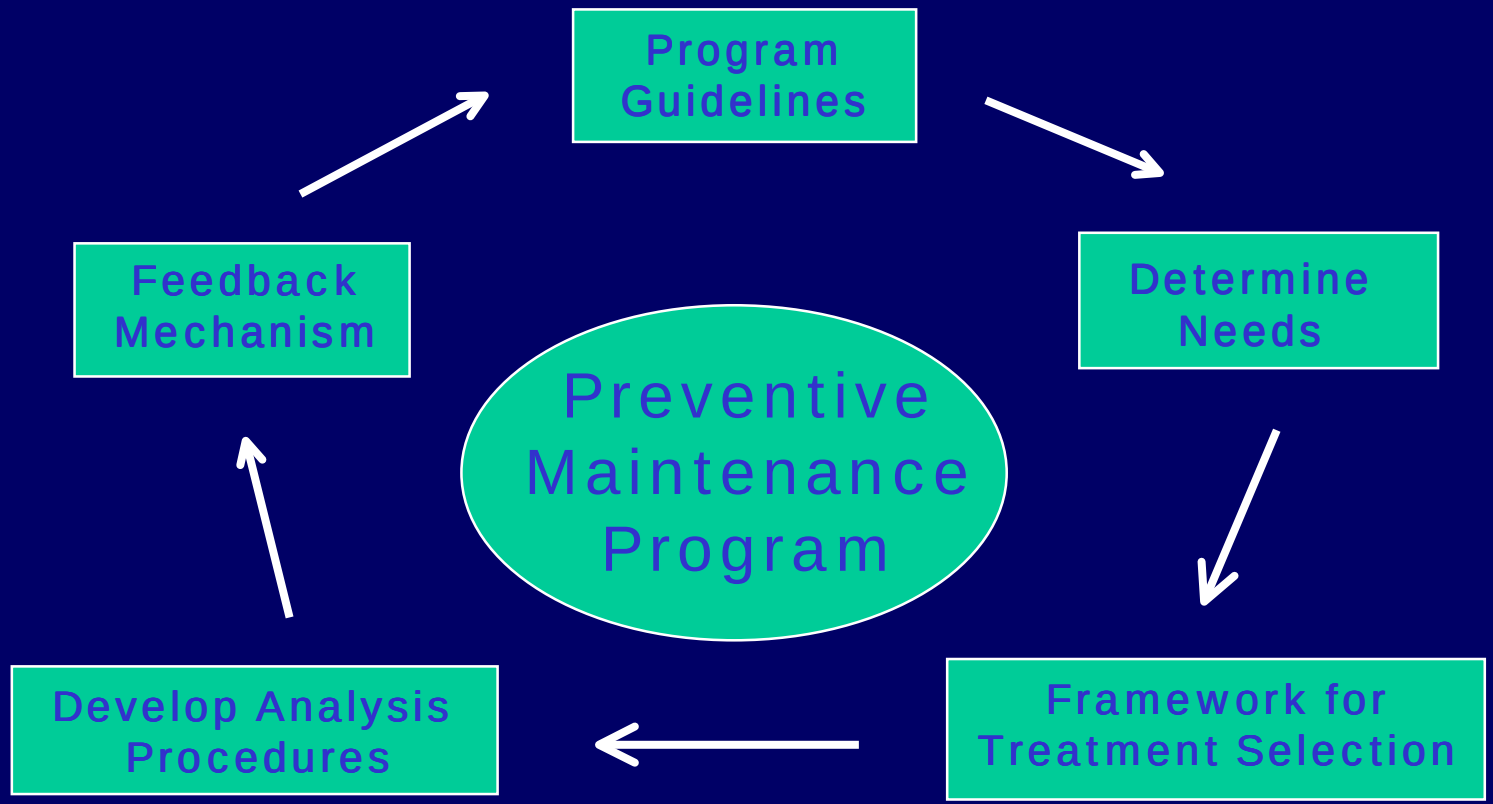
Study Objectives

- Review existing practices related to selection of appropriate PM strategies
- Develop a framework for selection of the most appropriate PM treatments
- Prepare Summary Report

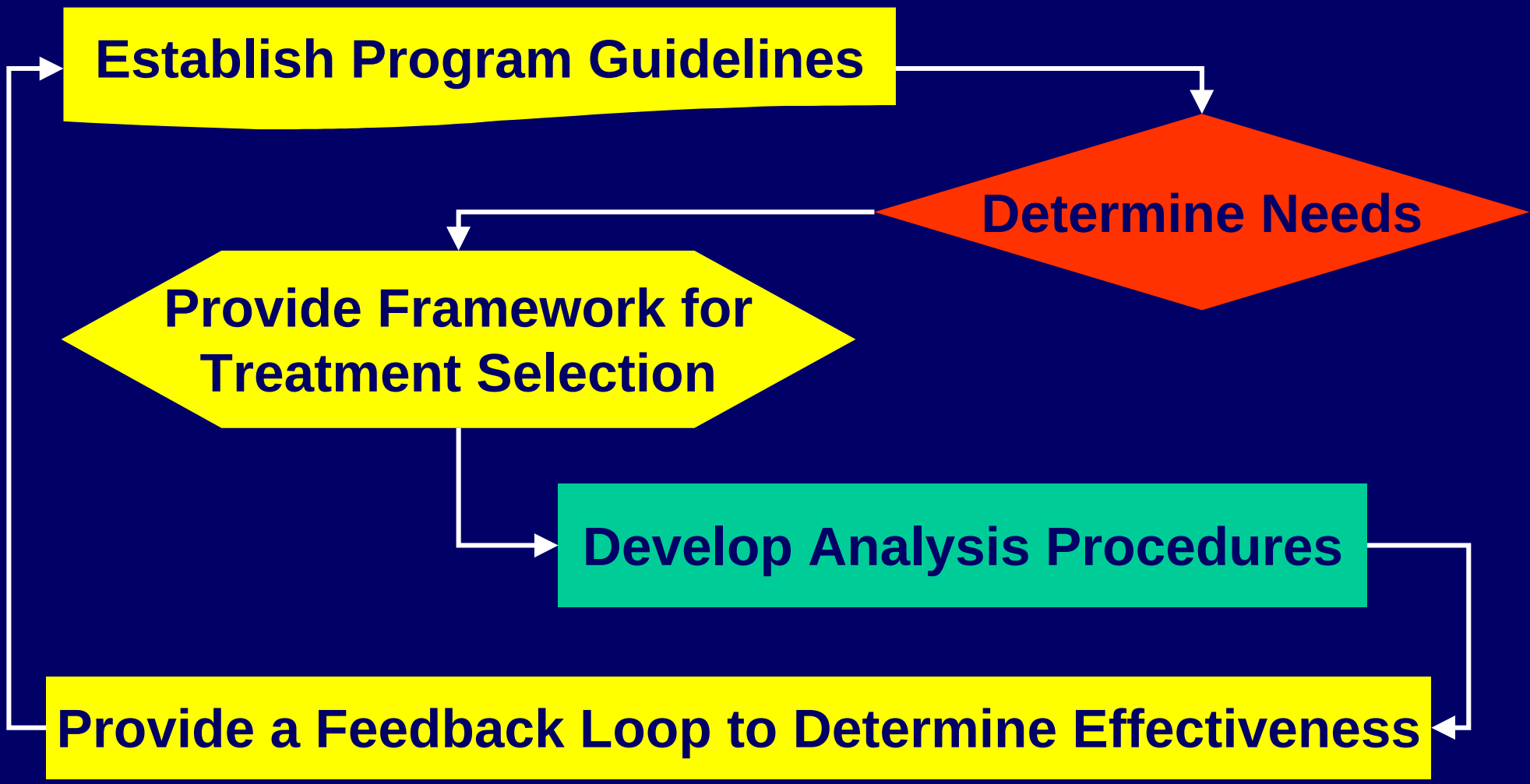
Establishing a Preventive Maintenance Program

- Number of Technical Components BUT!
- Two most important are non-technical
  - Agency Top Management Commitment
  - Customer Education Program

Elements of a Preventive Maintenance Program



Elements Flowchart



1. Establish Program Guidelines

- “Policy Manual”
- Contains overall strategies and goals
  - Safety issues
  - Environmental issues
- Program coordinator named
- Technical elements
- Feedback loop

2. Determine Maintenance Needs

- Condition Survey
  - Trained observers
  - Automated vehicles
  - Non-destructive testing (FWD, Friction)
  - Cores, slabs
- Project data
  - Location, ADT, % trucks, environment, etc.

3. Framework for Treatment Selection

- The “right” treatment at the “right” time on the “right” project
- Amen!

4. Develop Analysis Procedures for the Most Effective Treatment

- A number of procedures for determining cost effectiveness exist and should be used
- Cost should be part of the decision process but not the only consideration
- Use of decision trees is a viable method

5. Feedback Mechanism

- Generally a weakness in many management processes
  - “The boss doesn’t want to hear bad news” syndrome
- Need to know how the system is working
- A tool to adjust the program when needed

Preventive Maintenance Treatments

- Can be effective if used under proper conditions to address distress
- Types of Flexible Pavement distress include:
  - Rutting
  - Cracking (fatigue, block, thermal, etc.)
  - Bleeding
  - Raveling

Crack Sealing

- Used to prevent water and incompressibles from entering the pavement
- Cracks are often routed
- Sealants are only effective for a few years

Fog Seal

- Application of diluted emulsion to enrich the surface
- Primarily used to address raveling, oxidation, and seal minor surface cracks
- Expected life not greater than 3 to 4 years

Chip Seal

- Used to waterproof the surface, seal small cracks and improve surface friction
- Normally used on low-volume roadways, but have been used on high-volume facilities

Thin Cold-Mix Seal

- Treatments include slurry seals, micro-surfacing and cape seals
- Used to fill cracks, increase frictional resistance and improve ride quality

Thin Hot-Mix Overlay

- Treatments include dense-, open and gap-graded mixes
- Used to improve ride quality, increase frictional resistance and correct surface irregularities

Unit Costs and Expected Life

Treatment	Unit Cost ($/SY)	Expected Life (years)
Crack Seals	1.00	1 – 3
Fog Seals	0.45	2 – 4
Slurry Seals	0.90	3 – 7
Microsurfacing	1.25	3 – 9
Chip Seals	0.85	3 – 7
Thin HM Overlay	1.75	2 – 10

Framework for Treatment Selection and Timing

- Data/criteria used for developing tools
- Decision tools for treatment selection
  - Decision Trees
  - Decision Matrices
- Benefits/limitations of decision tools
- Optimum timing of treatments

Data/Criteria Considered in Developing Tools

- Pavement type and construction history
- Functional classification or traffic level
- Pavement condition index
- Specific type of deterioration present
- Geometric issues
- Environmental conditions
- Unit costs ?
- Expected life ?

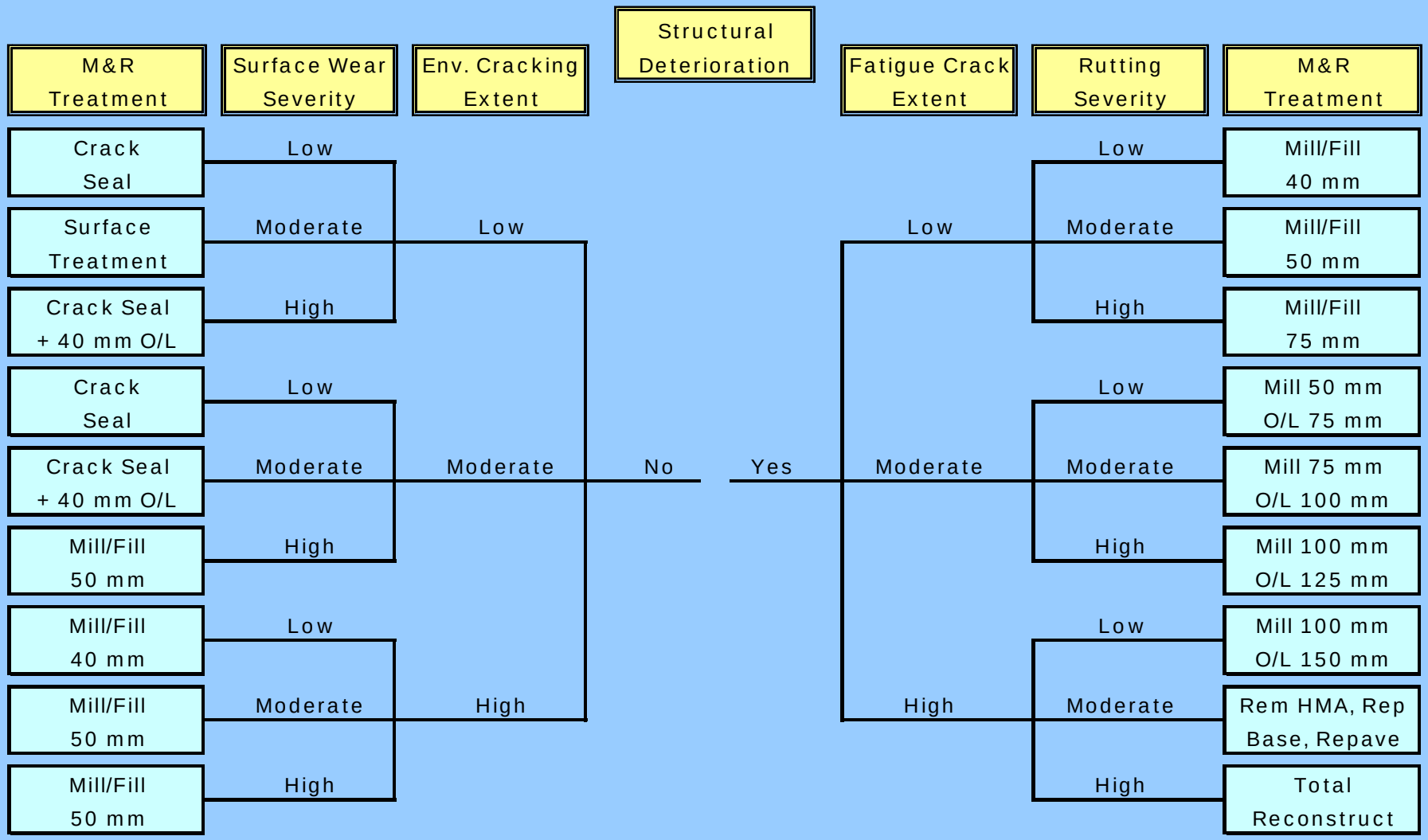
Other Potential Criteria

- Availability of qualified contractors
- Availability of materials
- Time (of year) of construction
- Pavement noise
- Facility downtime
- Surface friction

Typical Decision Tools

- Decision trees
- Decision matrices

Example HMA Decision Tree



Example HMA Decision Matrix

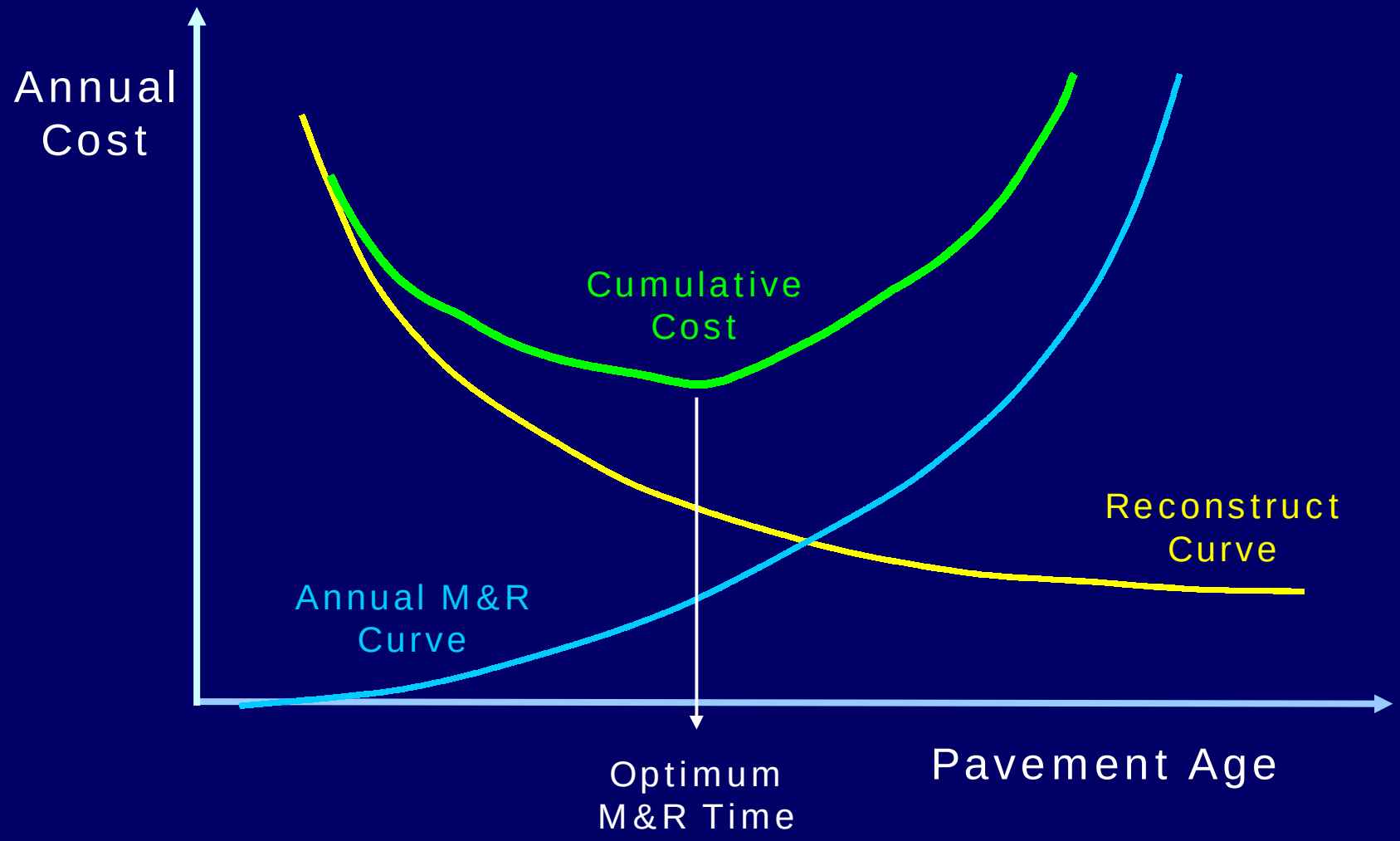
Distress	Severity	Treatment Number and Type												
		Do Nothing	Spot Repair	Seal Coat	Crack Filling	Cold Recycle	Rut Fill	Surface Mill	Thin Overlay	Thick Overlay	Part Mill & O/L	FD Mill & O/L	Reconstruct	Micro Surface
Flushing/ Bleeding	Moderate	N/A	RL	RL										
	Severe							RL	RL		10-12			RL
Non-Structural Cracking	Minor	N/A	3-5		3-5									
	Moderate		3-5		3-5				6-9		8-10			
	Severe									8-12	8-10	12-15	FL	
Insufficient Structure	Minor		RL			5-8	2-6		4-8					2-6
	Moderate						2-6		4-8	8-12		12-15	FL	2-6
	Severe									8-12		12-15	FL	
Bad Ride	Minor	N/A	RL					RL						
	Moderate							RL	8-10		10-12			
	Severe							RL		12-15	10-12			
Unstable Base & Subgrade	Minor		RL				2-6		4-8					2-6
	Moderate					5-8	2-6		4-8	8-12		12-15		
	Severe									8-12	10-12	12-15	FL	
Unstable Mix	Minor						2-6				6-10	8-12		5-8
	Moderate											8-12	FL	
	Severe											8-12	FL	
Aged Pavement	Minor		08-Apr	3-6			2-6							
	Moderate					5-10	2-6		6-10	8-12	8-12			
	Severe									8-12	8-12	12-15	FL	
Surface Raveling	Minor	N/A												
	Moderate			3-6										
	Severe								8-12					

Benefits and Limitations

- Makes use of experience
- Works well for local conditions
- Good project level tool

- Transferability
- Limits innovation
- Difficult to consider multiple factors
- Difficult to consider multiple distresses
- Avoids thorough LCC analysis
- Not good for network level evaluation

Optimum Timing



Analysis to Determine the Most Effective Treatment

- Determine cost and life expectancy data for YOUR agency to reflect local conditions
  - Previous projects
  - Pavement Management records
- Perform cost effectiveness evaluation
  - Number of different approaches exist
  - Use Equivalent Annual Cost-simple and effective

EQUIVALENT ANNUAL COST

$$\textit{Equivalent Annual Cost (EAC)} = \frac{\textit{unit cost of treatment}}{\textit{expected life, years}}$$

Decision Matrix

- Useful to analyze several variables
- Can take several forms
- Preparation is easy
  - Select potential treatments
  - Compute equivalent annual cost
  - Identify project specific conditions
  - Develop rating factors for each condition
  - Rate the importance of each
  - Compute total score

Example Decision Matrix

- Assumptions
  - Project PCI is 70
  - Cracking low to moderate
  - Surface condition variable
  - Ride quality marginal
  - Projected traffic, 5 years, less than 5K ADT
  - Two lanes, suburban, feeder to strip shopping center
  - Desired life is 7 years

Example Decision Matrix (continued)

- Rating factors
  - Customer satisfaction
  - Performance
  - Constructability

Treatment Analysis Worksheet

RATING FACTOR		SCORING FACTOR		RATING FACTOR		TOTAL SCORE
PERFORMANCE EVALUATION						
____%	Expected Life	_____	X	_____	=	_____
____%	Seasonal Effects	_____	X	_____	=	_____
____%	Pavement Structure Influence	_____	X	_____	=	_____
____%	Influence of Existing Pavement Condition	_____	X	_____	=	_____
CONSTRUCTABILITY						
____%	Cost Effectiveness (EAC)	_____	X	_____	=	_____
____%	Availability of Quality Contractors	_____	X	_____	=	_____
____%	Availability of Quality Materials	_____	X	_____	=	_____
CUSTOMER SATISFACTION						
____%	Traffic Disruption	_____	X	_____	=	_____
____%	Noise	_____	X	_____	=	_____
____%	Surface Friction	_____	X	_____	=	_____

RATING FACTOR: PERCENT OF IMPACT ON TREATMENT DECISION (Total must equal 100%)

SCORING FACTOR:
5 = Exceptional
4 = Good
3 = Average
2 = Below Average
1 = Unsatisfactory

Example Rating Factors

Treatment/ Factor	Thin HMA	Slurry Seal	Chip Seal	Micro-surfacing
Existing Conditions	3	1	4	2
Quality Materials	3	2	2	3
Pavement Structure	4	3	3	3
Expected Life	5	3	3	4
Qualified Contractor	4	4	5	2
Weather Limitations	5	4	3	4

Total Ranking for Project

Treatment	Total Score
Thin HMA Overlay	3.40
Slurry Seal	3.50
Chip Seal	3.35
Microsurfacing	3.75

Example Decision Matrix

- Rating factors
  - For any given project, the number and types of factors will vary
  - Should be developed for each agency, the same as the EAC factor
  - Factors can be weighted to account for differences between treatments for a the same characteristic

Computing Rankings

- Factors are computed and scores for each treatment are derived
- Treatment with highest score is considered the most effective treatment for the specific project

Summary

- Preventive maintenance is the only effective way to manage pavements
- Simple, logical process for determining the the most effective treatment for a specific pavement has been presented
- Recognizing the type and cause of pavement distress is fundamental to the approach

Summary (continued)

- Agencies must develop cost and life data for various maintenance treatments
- A number of factors must be accounted for in determining the most effective treatment
- Cost needs to be considered but must not be the only consideration
- Good engineering principles should guide the selection of the treatment