MODULE 10

PRIORITIZATION

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Instructional Objectives

- Describe the objectives of a multi-year prioritization analysis.
- Understand the differences between other multi-year analysis techniques.
- Describe the components of a multi-year prioritization analysis.
- Understand the use of a multi-year prioritization analysis as part of an agency's project selection process.

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What Is Multi-Year Prioritization?

- A method of allocating limited resources in an efficient and cost-effective way over a multi-year period, through an evaluation of long-term impacts

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Benefits Provided By MYP

- Forecast future conditions
- Analyze timing options
- Evaluate strategy effectiveness
- Perform economic analyses
- Use of objective measures for prioritizing needs
- Project future needs

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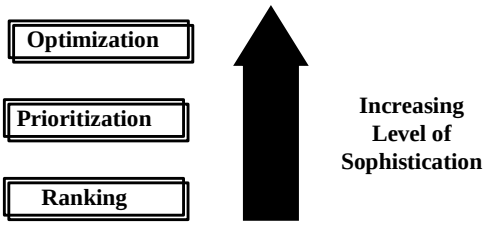
Analysis Techniques



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Ranking

- Simplest approach
- Rank projects in accordance with agency guidelines
- Match ranked list to funding levels
- Repeat each year

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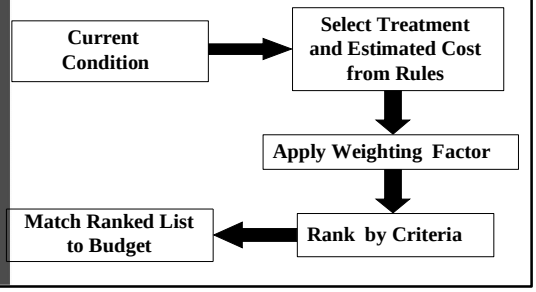
Ranking



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Ranking Example

Section	Condition Level	Treatment	Cost (mil)
67A	67	Minor	1
67B	82	PM	0.5
67C	52	Major	3
14A	71	Minor	2
14B	74	Minor	1.5
Univ1	85	PM	0.5

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Results for $4 Million Budget

Section ID	Ranking	Condition Level	Treatment	Cost ($millions)
67C	1	52	Major	3
67A	2	67	Minor	1
14A	3	71	Minor	2
14B	4	74	Minor	1.5
67B	5	82	Prev. Maint.	0.5
Univ1	6	85	Prev. Maint.	0.5

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Example With Weighting Factor

Section ID	Ranking	Condition	Traffic	Weight	Cost
14 A	1	71	0.5	36	2
14B	2	74	0.5	37	1.5
67C	3	52	1	52	3
67A	4	67	1	67	1
Univ1	5	85	1	85	0.5
67B	6	82	1.5	123	0.5

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Limitations To Ranking

- Long-term impacts on network are not considered
- Rate of deterioration is not considered
- Economic analysis for alternative strategies not considered

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Ranking = Single-Year Prioritization

- Definition
- Uses
- Limitations

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Multi-Year Prioritization

- Identify best combination over a specified period
- Prioritization techniques

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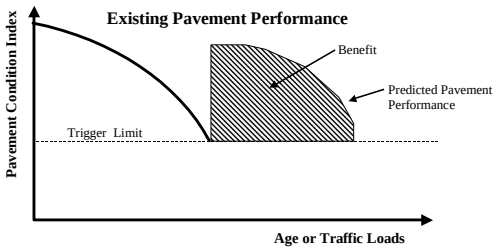
Benefit/Effectiveness Calculation



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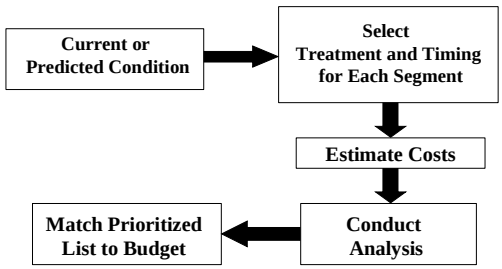
Multi-Year Prioritization (MYP)



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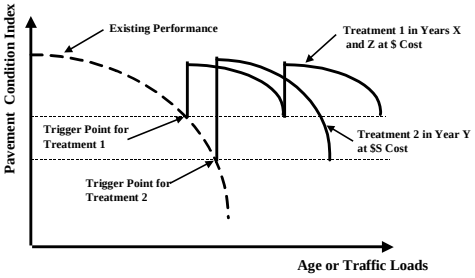
Treatment Options in MYP



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Differences Between MYP and Ranking

- Several feasible treatments can be considered
- Effectiveness of each treatment is considered
- More factors can be used in the analysis
- Solutions closely represent the results of a true optimization analysis

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Advantages/ Disadvantages of MYP

- Advantages
- Disadvantages

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Optimization

- Mathematical programming methods
- Select function to be optimized
- Identify constraints

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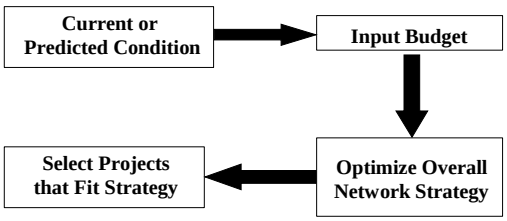
Optimization



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Advantages/ Disadvantages Of Optimization

- Advantages
- Disadvantages

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Benefits of an Objective Process

- Practical Benefits
- Theoretical Benefits

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Why MYP Does Not Succeed

- Management philosophy supports worst-first
- Outside influences affect project selection
- Large backlog of projects

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Factors to Ensure the Success of MYP

- Management must support and understand philosophy
- Recommendations represent normal conditions and are not guaranteed
- Different strategies match different goals
- It should be considered a tool

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MYP Analysis Requirements

- Condition/ inventory information
- Performance models
- Treatment strategies/ conditions
- Analysis tools

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Treatment Strategies

- One or more maintenance or rehabilitation techniques
- Designed to improve or maintain conditions
- Tailored to consider constraints
- Evaluated in terms of cost-effectiveness

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Requirements for Developing a Strategy

- List of strategy guidelines and treatment options
- Costs
- Pavement performance models

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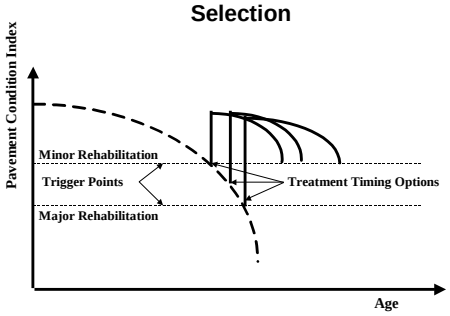
Sample Timing Options for Strategy Selection



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Options in Strategy Development

- Project Selection/ Treatment Selection- simultaneous or not
- Single treatments or multiple treatments

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Single Treatment Strategy

- Most common approach
- Several feasible alternatives may be identified for each section
- Each treatment considered independently
- Most cost-effective treatment generally selected

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Multiple Treatment Strategy

- **Combination of treatments considered for each section**
- **Effectiveness of all treatments is representative of effectiveness of entire strategy**
- **Subsequent treatments affect selection of strategy**

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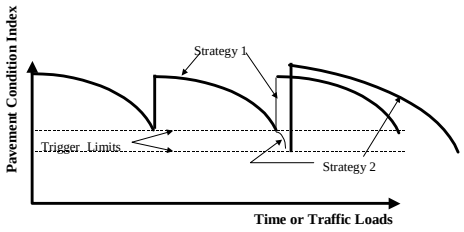
Illustration of Multiple Treatment Strategies



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Requirements For Strategy Development

- **List of all treatments to be considered in analysis**
- **Set of rules that determine when treatments should be considered feasible**

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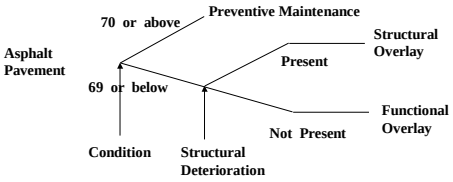
Decision Trees



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Decision Matrix

Treatment Type	Surface Type	Condition Level	Structural Deterioration
Preventive Maintenance	Asphalt Concrete	70-100	N/A
Functional Overlay	Asphalt Concrete	0-69	Not Present
Structural Overlay	Asphalt Concrete	0-69	Present

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Considerations in Developing Decision Trees/ Matrices

- **Decision factors**
- **Availability of data**
- **Ability to predict conditions**
- **Flexibility**

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Programmed Rules

- **Outline criteria for selection of preferred treatment**
- **Set treatment for condition range**
- **Could be transferred into decision matrices or decision trees**

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Types of Treatments Considered

- **Rehabilitation category**
- **Specific treatment**

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Rehabilitation Categories

- **Preventive Maintenance**
- **Minor Rehabilitation**
- **Major Rehabilitation**
- **Reconstruction**

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Specific Treatments

- **Asphalt**
  - Routine Maintenance
  - Surface Seal Coats
  - Milling and Inlays
  - Thin Overlay
  - Thick Overlay
  - Mill and Overlay
  - Reconstruction
- **Concrete**
  - Slab Grinding
  - Full- and Partial-Depth Repairs
  - Crack and Seat
  - Thin-Bonded Overlay
  - Unbonded Overlay
  - Slab Replacement
  - Reconstruction

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Factors to Consider in Developing Treatments

- **Accuracy of cost estimates needed**
- **Ability to differentiate performance characteristics**
- **Level of detail required**
- **Need for selection criteria**

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Prioritization Analysis Components

- **Benefit or effectiveness**
- **Life cycle costs**
- **Benefit/cost ratio or effectiveness ratio**

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Benefits or Effectiveness

- **Effectiveness**
  - Non-Monetary
  - Area under the curve for some traffic value
- **Benefits**
  - Monetary or Non-Monetary
  - Area under the curve for some traffic value

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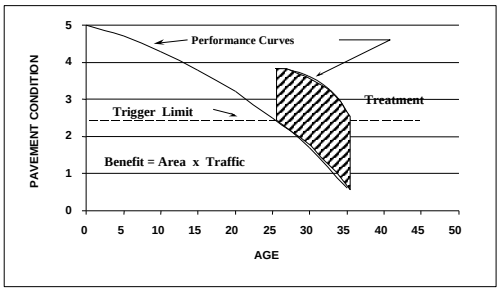
Benefit Calculation



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Costs

- **Agency cost**
- **User cost**
- **Salvage value**
- **Maintenance cost**
- **Other relevant costs over the life of the pavement**

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Prioritization Analysis Techniques

- **Marginal cost-effectiveness analysis**
- **Incremental benefit/cost analysis**
- **Ratio calculation**
  - positive ratio= viable strategy
  - negative ratio= costly strategy

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Marginal Cost-Effectiveness

- **Identify feasible treatments for each analysis period based on projected condition and established trigger levels**
- **Calculate effectiveness (E) of each combination of strategies (area traffic)**
- **Calculate cost (C) of each combination in net present value terms**

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Marginal Cost-Effectiveness (cont.)

- **Calculate cost-effectiveness (CE) of each combination as ratio of E/C, where highest value is best**
- **Select treatment and timing for each section with best CE**
- **Calculate marginal cost-effectiveness (MCE) of all other strategies as follows:**

$$MCE = (E_r - E_s)/(C_r - C_s)$$

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Marginal Cost-Effectiveness (cont.)

- **If MCE is negative, or if E_f is less than E_s, comparative strategy is eliminated from future consideration; if not, it replaces strategy selected in previous step**
- **Process is repeated until no further selections can be made in any year of analysis period**

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Marginal Cost-Effectiveness (MCE) Example

SEG	ALT	Treatment	Eff.	Cost	CE	MCEs
A	1	Seal Coat	1	1	(1/1)=1.0	
	2	1"Overlay	5	2	(5/2)=2.5	
	3	2"Overlay	8	4	(8/4)=2.0	
	4	4"Overlay	11	8	(11/8)=1.4	
B	1	2"Overlay	8	4	(8/4)=2.0	
	2	3"Overlay	10	6	(10/6)=1.7	
	3	4"Overlay	11	8	(11/8)=1.4	
C	1	Joint Seal	3	1	(3/1)=3	
	2	Joint	5	4	(5/4)=1.2	
	3	Repair 3"Overlay	10	6	(10/6)=1.7	
				Total Budget	12	

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MCE Example (cont.)

SEG	ALT	Treatment	Eff.	Cost	CE	MCEs
A	1	Seal Coat	1	1	(1/1)=1.0	
	2	1"Overlay	5	2	(5/2)=2.5	
	3	2"Overlay	8	4	(8/4)=2.0	
	4	4"Overlay	11	8	(11/8)=1.4	
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MCE Example (cont.)

SEG	ALT	Treatment	Eff.	Cost	CE	MCEs
A	**1**	**Seal Coat**	**1**	**1**	**(1/1)=1.0**	
	2	**1"Overlay**	**5**	**2**	**(5/2)=2.5**	
	3	**2"Overlay**	**8**	**4**	**(8/4)=2.0**	
	4	**4"Overlay**	**11**	**8**	**(11/8)=1.4**	
B	**1**	**2"Overlay**	**8**	**4**	**(8/4)=2.0**	
	2	**3"Overlay**	**10**	**6**	**(10/6)=1.7**	
	3	**4"Overlay**	**11**	**8**	**(11/8)=1.4**	
C	**1**	**Joint Seal**	**3**	**1**	**(3/1)=3**	
	2	**Joint**	**5**	**4**	**(5/4)=1.2**	
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MCE Example (cont.)

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	3	**2"Overlay**	**8**	**4**	**(8/4)=2.0**	
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C	**1**	**Joint Seal**	**3**	**1**	**(3/1)=3**	
	2	**Joint**	**5**	**4**	**(5/4)=1.2**	
	3	**Repair 3"Overlay**	**10**	**6**	**(10/6)=1.7**	
				Total Budget	**12**	

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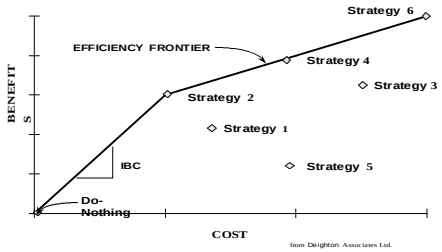
Incremental Benefit/Cost (IBC) Efficiency Frontier



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IBC

- **Equivalent Uniform Annual Benefit (EUAB)**
- **Equivalent Uniform Annual Cost (EUAC)**

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EUAB

Calculate the Equivalent Uniform Annual Benefit

$$EUAB = PVB \quad \frac{[r\,(1+r)^n]}{[(1+r)^n - 1]}$$

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EUAC

Calculate Equivalent Uniform Annual Cost

$$EUAC = PVC \quad \frac{[r\,(1+r)^n]}{[(1+r)^n - 1]}$$

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IBC

Calculate Incremental Benefit/Cost

$$IBC\ j = \frac{(EUAB_j - EUAB_{j-1})}{(EUAC_j - EUAC_{j-1})}$$

Treatment for each section are sorted by increasing EUAC
Negative IBC's are eliminated

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Integration of MYP Into Project Selection

- **List of candidate projects**
- **Foundation for scoping review**
- **Evaluation of trade-offs**
- **Impact analysis**
- **Budget needs**

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Examples of Coordinated Project Selection Efforts

- Evaluation of various treatments
- Identification of sites for scoping visits
- Improved efficiency of pre-construction process
- Fewer scope changes

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Case Study -Indiana DOT (InDOT)

- MYP for interstate system
- One complete programming cycle developed using new software

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InDOT Overview

- Mainframe database
- Data extracted into dROAD database on personal computer
- Incremental benefit/cost analysis
- 5-year analysis, 2 years out
- PMS recommendations used as first cut list for scoping visits

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InDOT PMS Process

- Collect condition data
- Load and analyze data using the PMS software
- Identify proposed new projects
- Conduct scoping visits to define limits and reset priorities
- Set project scope
- Re-analyze projects
- Match projects to budget
- Make necessary revisions

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InDOT Software Tools

- **dROAD**
  - database
  - extracted data from mainframe computer
- **dTIMS**
  - analysis tools

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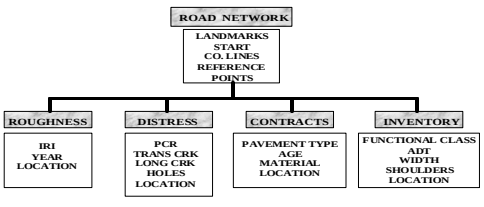
Required Data



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Analysis Groups

- **Groups of pavements with like characteristics**
  - functional class
  - traffic volumes
  - pavement type
- **Used for performance models and for setting analysis conditions**

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Performance Measures

- **Individual condition indices**
  - ride (PSI)
  - rutting (RUT)
  - distress (PCR)
- **Composite index**
  - pavement quality index (PQI)
  - PQI = 0.55PCR + 8.8PSI - 0.25RUT

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Deterioration Models

- **Regression analysis for PSI, PCR, and RUT performance models**
- **Forecasted indices used to calculate future PQI values**

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Performance Models

Functional Class/Surface Type	PSI	PCR	RUT	PQI
Interstate Composite	Q	Q	Q	Q
Interstate Flexible	Q	Q	Q	u
Interstate Crack and Seat	Q	Q	Q	u
Interstate Jointed Concrete	Q	Q		u
Interstate Continuously Reinforced Concrete	Q	Q		u
State Route Composite	u	u	u	u
State Route Asphalt	u	u	u	u
State Route Composite - Low Traffic	u	u	u	u
State Route Asphalt - Low Traffic	u	u	u	u
Other Jointed Concrete	u	u		u
Other Continuously Reinforced Concrete	u	u		u

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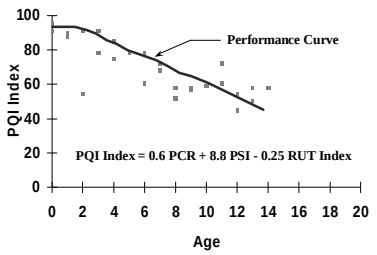
Sample Performance Curve



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Treatment Identification

- **Treatment Type**
  - Mill and thin resurface
  - Structural overlay
  - Crack and seat overlay
  - Patch
  - Replace
- **Reset Values**
- **Costs**
- **Trigger Values**

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Treatment Costs

Interstate Treatments and Cost	
Treatment Type	**Cost per sq yd**
Mill and Resurface	$6.00
Structural Overlay Rural	$50.00
Structural Overlay Urban	$60.00
Crack and Seat Rural	$50.00
Crack and Seat Urban	$60.00
Patch	$5.00
Replace Rural	$66.00
Replace Urban	$77.00

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Treatment Trigger Values

PVMT	COMPOSITE					
PSI	GOOD 5-3.5		FAIR 3.5-2.8		POOR < 2.8	
RUT	GOOD <0.45	BAD >0.45	GOOD <0.45	BAD >0.45	GOOD <0.45	BAD >0.45
PCR						
100-90	NO	R/S	NO	R/S	R/S	4R
90-80	NO	R/S	NO	R/S	R/S	4R
80-70	NO	R/S	R/S	4R	4R	4R
70-60	4R	4R	4R	4R	4R	4R
60-50	4R	4R	4R	4R	RPL	RPL
<50	4R	4R	RPL	RPL	RPL	RPL

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Financial Parameters

- **Budget levels for each year of analysis**
- **Economic factors impacting life cycle costs**

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Analysis Procedures

- **Shifting performance curves**
- **Trigger initial treatments**
- **Calculate reset values**
- **Calculate subsequent condition indices**
- **Trigger subsequent treatments**
- **Calculate costs**
- **Calculate benefits**
- **Calculate IBC**
- **Optimize strategy selection**

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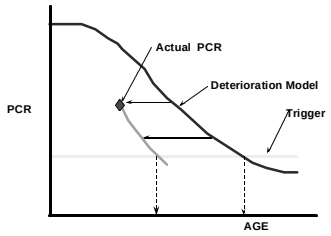
Shifting the Performance Curves



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Other Steps

- **Triggering Initial Treatments**
- **Calculating Reset Values**
- **Calculating Subsequent Condition Indices**
- **Triggering Subsequent Treatments**
- **Calculating Life Cycle Costs**
- **Calculating Benefits**

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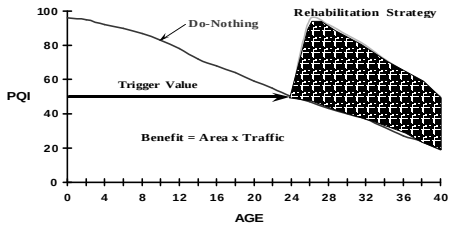
Benefit Calculation



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Other Steps (cont.)

- **Calculating IBC**
  - EUAB
  - EUAC
  - EUAB/EUAC
  - IBC = incremental change in benefits and costs
  - Sorted by increasing IBC

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Program Development Process

- **Tentative program list**
- **Field evaluation packets**
- **Site visits**
- **Revised scopes**
- **Re-analyze results**

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Summary

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Instructional Objectives

- **Understanding use of performance models**
- **Identify common modeling approaches**
- **Understand methods for evaluating reliability**
- **Describe requirements for updating models**