MBE Chapter 3 Highlights

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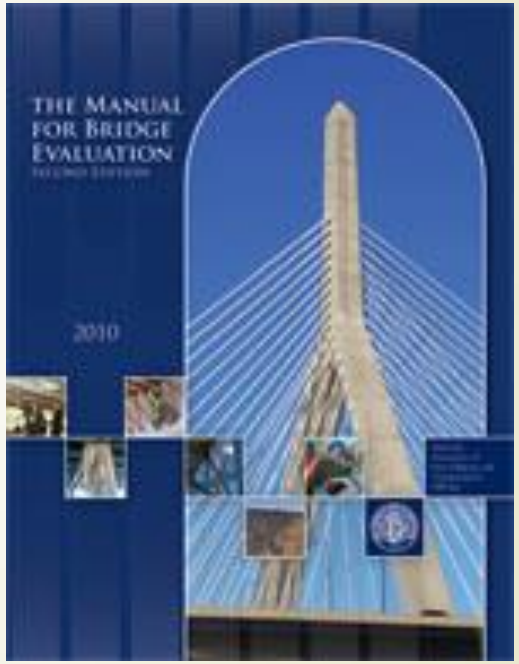
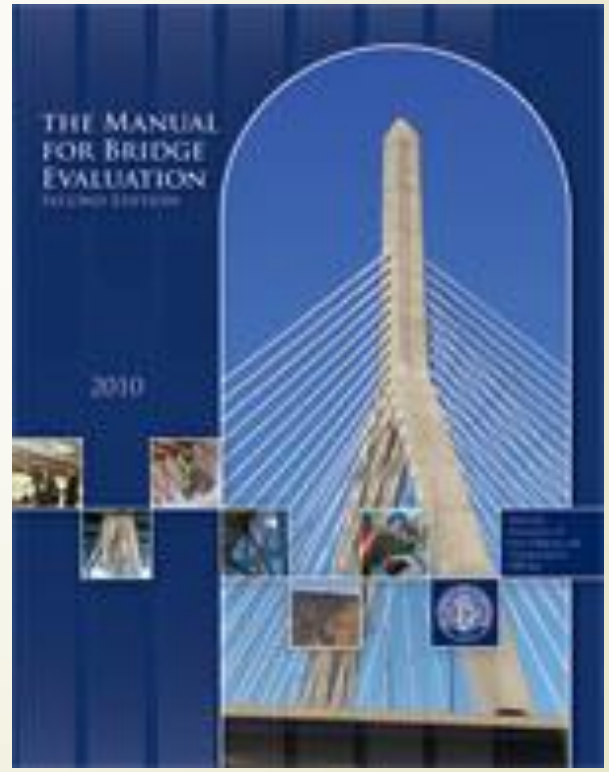
AASHTO Manual For Bridge Evaluation: Section 3, Bridge Management Systems

- AASHTO SCOBS T-18 (Bridge Evaluation and Management) has recently updated Section 3, "Bridge Management Systems
  - Approved at the 2017 AASHTO SCOBS meeting



AASHTO Manual For Bridge Evaluation: Section 3, Bridge Management Systems

3.2 - Objectives of Bridge Management Systems
3.3 - Components of a Bridge Management System
- 3.3.1- Information Management
  - 3.3.1.1- Bridge Inventory, General Condition Ratings and Bridge Element Ratings
    - 3.3.1.1.1 - Bridge Inventory
    - 3.3.1.1.2 - General Condition Ratings
    - 3.3.1.1.3 - Bridge Element Ratings
  - 3.3.1.2 - Agency Performance Measures
  - 3.3.1.3 - Preservation and Improvement Action Data
  - 3.3.1.4 - Cost Data and Financial Plans
- 3.3.2 - Data Integration
  - 3.3.2.1 - Data Analysis
  - 3.3.2.2 - Risk Assessment
  - 3.3.2.3 - Agency Rules
  - 3.3.2.4 - Cost/Benefit Analysis
    - 3.3.2.4.1 - Condition Driven Cost/Benefit Analysis
    - 3.3.2.4.2 - Improvement Cost/Benefit Analysis
    - 3.3.2.4.3 - Life-Cycle Cost/Benefit Analysis
  - 3.3.2.5 - Prioritization and Optimization
    - 3.3.2.5.1 Multi-Objective Optimization
- 3.3.3—Decision Support



A BMS provides three components to support bridge asset management:

Information Management

Data Analysis

Decision Support

Information Management:

"A BMS requires comprehensive, connected and well organized relational databases that are capable of supporting the various analyses involved in bridge management and reporting this information in a way that can be readily understood by various stakeholders."

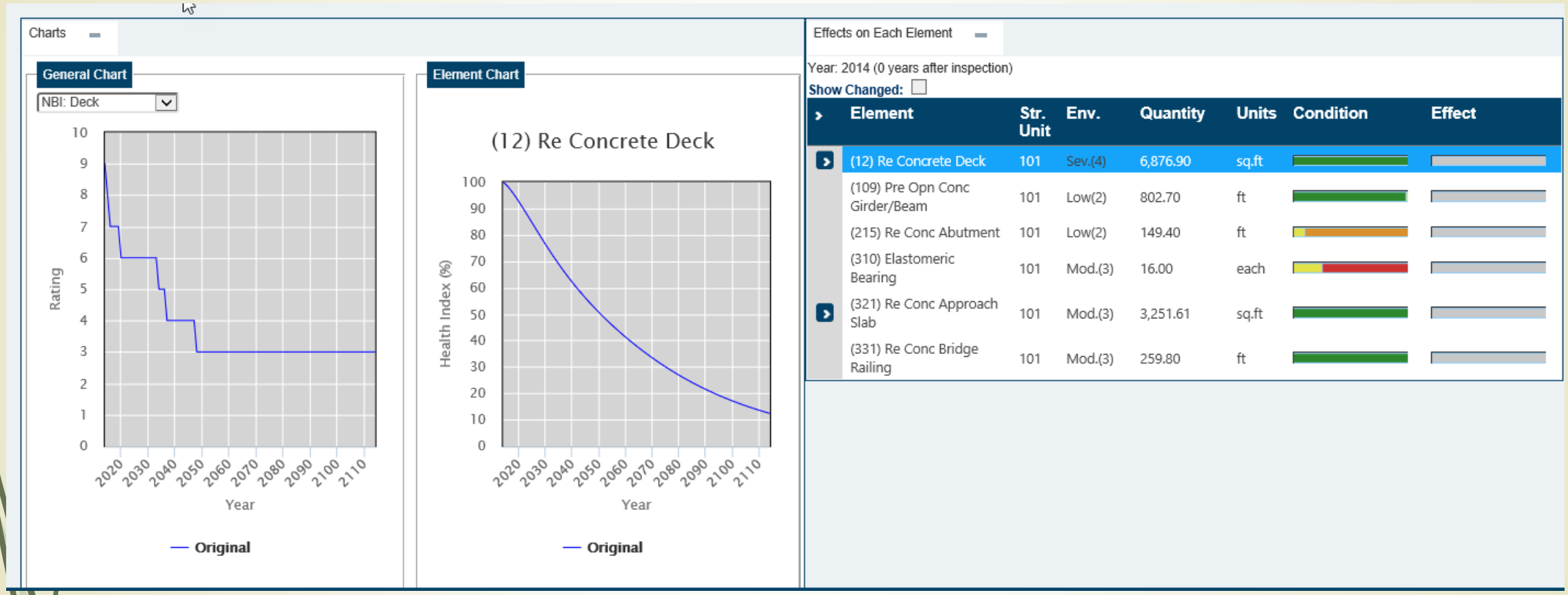
Information Management:

- Bridge Inventory
- General Condition Rating
- Bridge Element Rating
- Agency Performance Measures
- Preservation and Improvement Action Data
- Cost Data and Financial Plan

Data Analysis/Integration

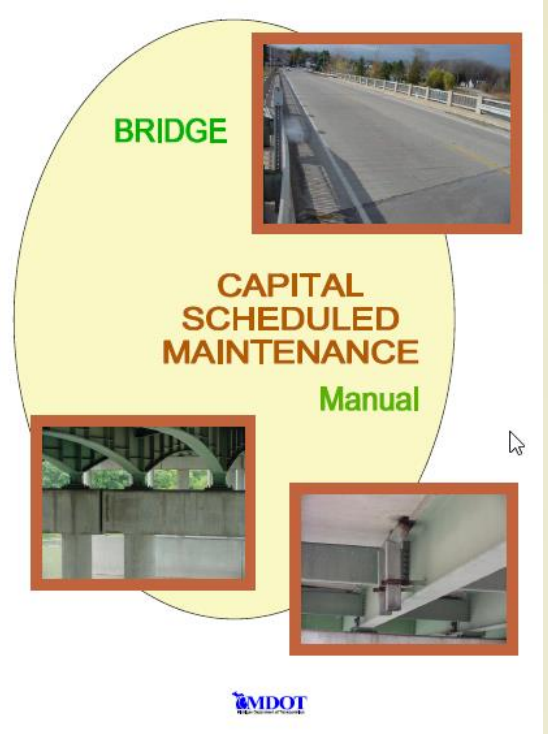
- Deterioration
- Risk Assessment
- Agency Rules
- Cost/Benefit Analysis
  - Condition Driven
  - Improvement
  - Life-Cycle

Data Analysis - Deterioration



Agency Rules

- Cyclic
  - Example – Do bridge washing when ….
- Condition
  - Example - Replace seals in strip seal expansion joints when quantity in Condition State 2 (fair) exceeds 20%
  - Conditional rules most often need to be considered concurrently with related elements that could impact how the rules should be applied.



AASHTOWare BrM Bridge Management

Agency Rules - Work Recommendations

BRIDGE DECK PRESERVATION MATRIX – Decks with Uncoated "Black" Rebar

DECK CONDITION STATE				REPAIR OPTIONS	POTENTIAL RESULT TO DECK BSIR		ANTICIPATED FIX LIFE
Top Surface		Bottom Surface					
BSIR #58a	Deficiencies % (a)	BSIR #58b	Deficiencies % (b)		Top Surface BSIR #58a	Bottom Surface BSIR #58b	
≥ 5	N/A	N/A	N/A	Hold (c) Seal Cracks/Healer Sealer (d)	No Change	No Change	1 to 4 years
	≤ 5%	> 5	≤ 2%	Epoxy Overlay	8, 9	No Change	10 to 15 years
	≤ 10%	≥ 4	≤ 25%	Deck Patch (e)	Up by 1 pt.	No Change	3 to 10 years
4 or 5	10% to 25%	5 or 6	≤ 10%	Deep Concrete Overlay (h)	8, 9	No Change	25 to 30 years
		4	10% to 25%	Shallow Concrete Overlay (h, i)	8, 9	No Change	20 to 25 years
				HMA Overlay with water-proofing membrane (f, h, i)	8, 9	No Change	8 to 10 years
		2 or 3	> 25%	HMA Cap (g, h, i)	8, 9	No Change	2 to 4 years
≤ 3	>25%	> 5	< 2%	Deep Concrete Overlay (h)	8, 9	No Change	20 to 25 years
		4 or 5	2% to 25%	Shallow Concrete Overlay (h, i)	8, 9	No Change	10 years
				HMA Overlay with water-proofing membrane (f, h, i)	8, 9	No Change	5 to 7 years
		2 or 3	>25%	HMA Cap (g, h, i)	8, 9	No Change	1 to 3 years
				Replacement Deck with Epoxy Coated Rebar (ECR)	9	9	60+ years

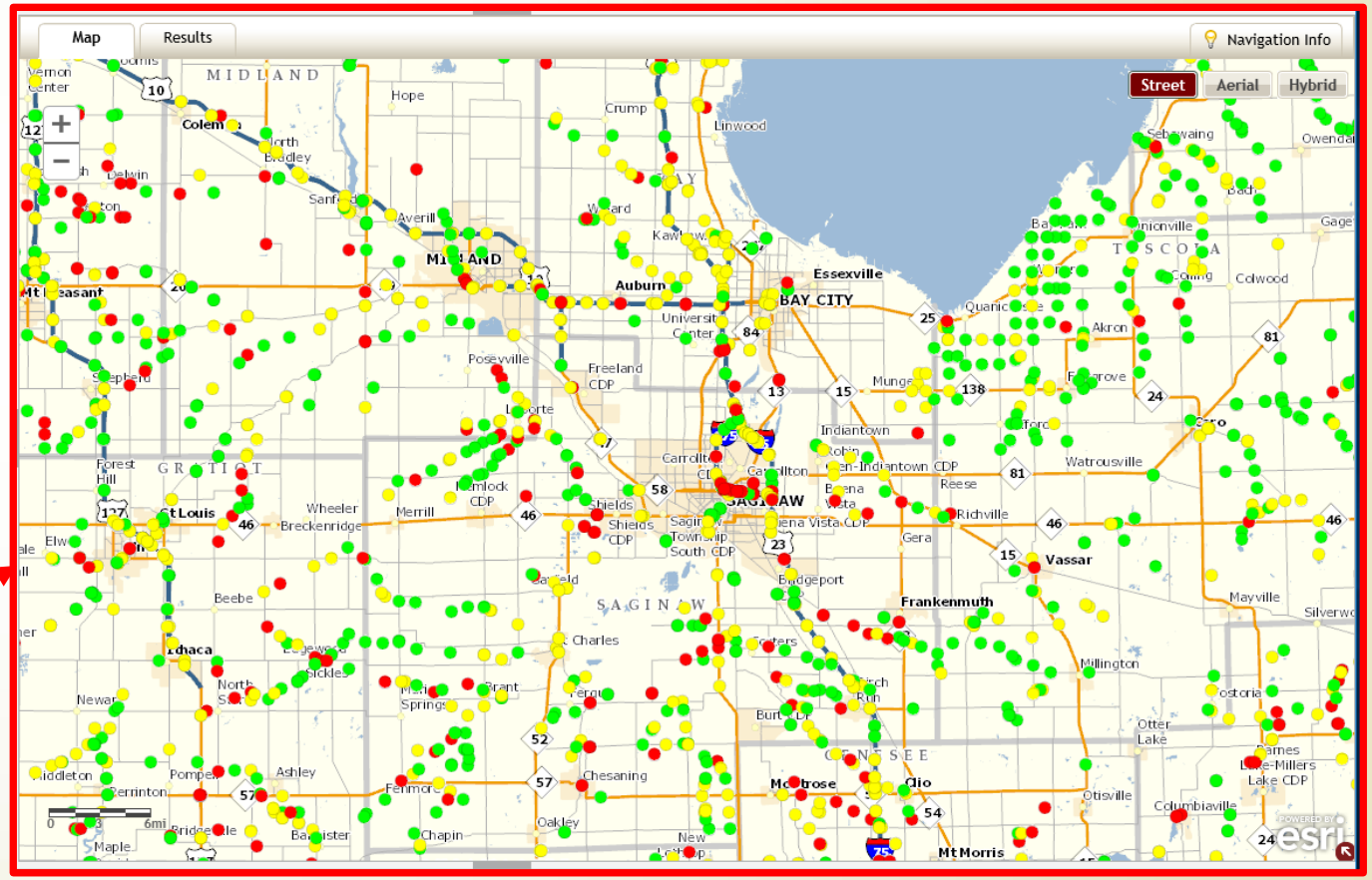
(a) Percent of deck surface area that is spalled, delaminated, or patched with temporary patch material.
(b) Percent of deck underside area that is spalled, delaminated or map cracked.
(c) The "Hold" option implies that there is on-going maintenance of filling potholes with cold patch and scaling of incipient spalls.
(d) Seal cracks when cracks are easily visible and minimal map cracking. Apply healer sealer when crack density is too great to seal individually by hand. Sustains the current condition longer.
(e) Crack sealing can also be used to seal the perimeter of deck patches.
(f) Hot Mix Asphalt overlay with waterproofing membrane. Deck patching required prior to placement of waterproofing membrane.
(g) Hot Mix Asphalt cap without waterproofing membrane for ride quality improvement. Deck should be scheduled for replacement in the 5 year plan.
(h) If bridge crosses over traveled lanes and the deck contains slag aggregate, do deck replacement.
(i) When deck bottom surface is rated poor (or worse) and may have loose or delaminated concrete over traveled lanes, an in-depth inspection should be scheduled. Any loose or delaminated concrete should be scaled off and false decking should be placed over traveled lanes where there is potential for additional concrete to become loose.

Bridge Deck Preservation Matrix June 8, 2011 Rev

- Deck Top Surface
  - 47% Poor
- Deck Bottom Surface
  - 3% Poor
- Repair Chosen
  - Deep Concrete Overlay

Decision Support

MBE Chapter 3 – Quote, "A BMS should meet the needs of both upper management, where it is a strategic planning tool, and technical decision makers, where it is an engineering tool.

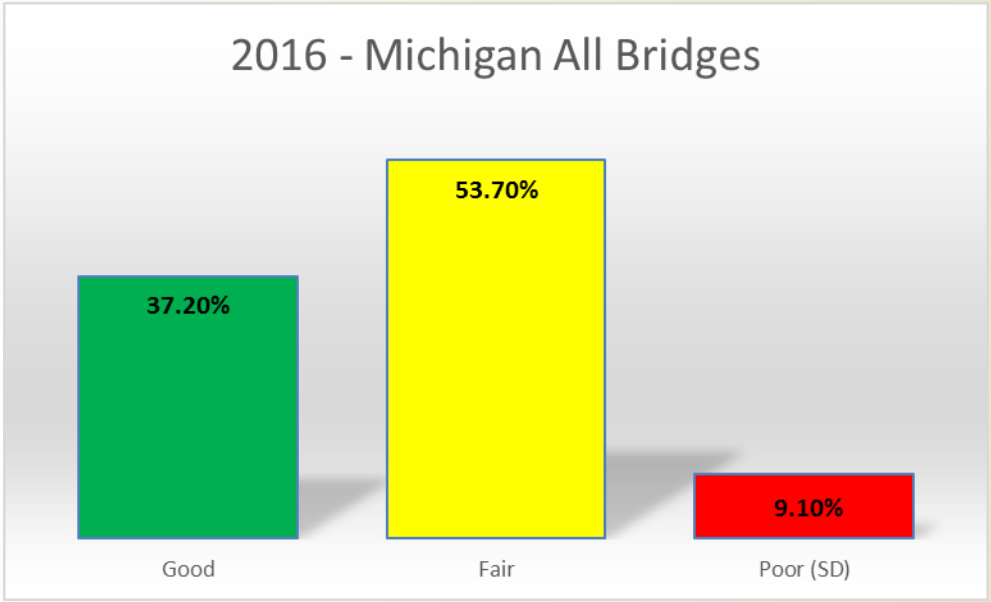


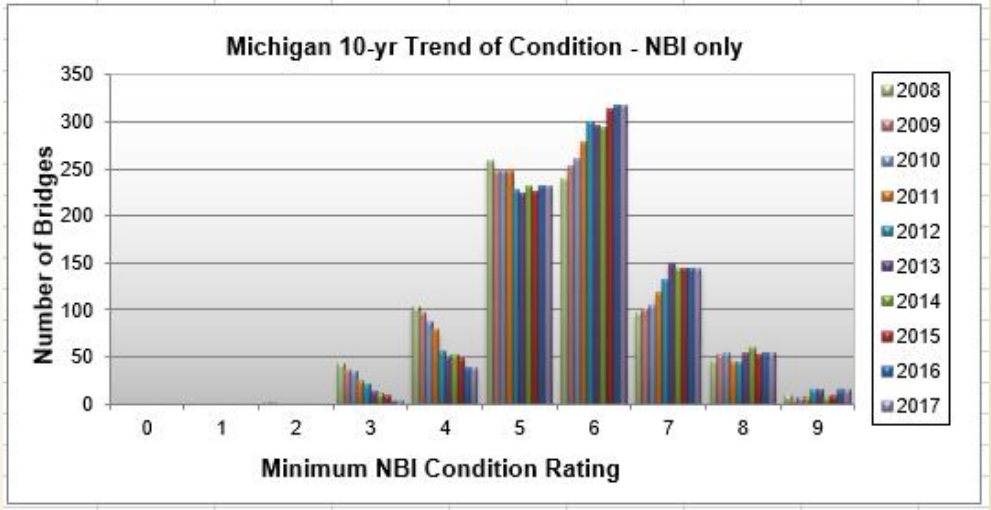
Network Level and Project Level Management.

Network Management of Bridges

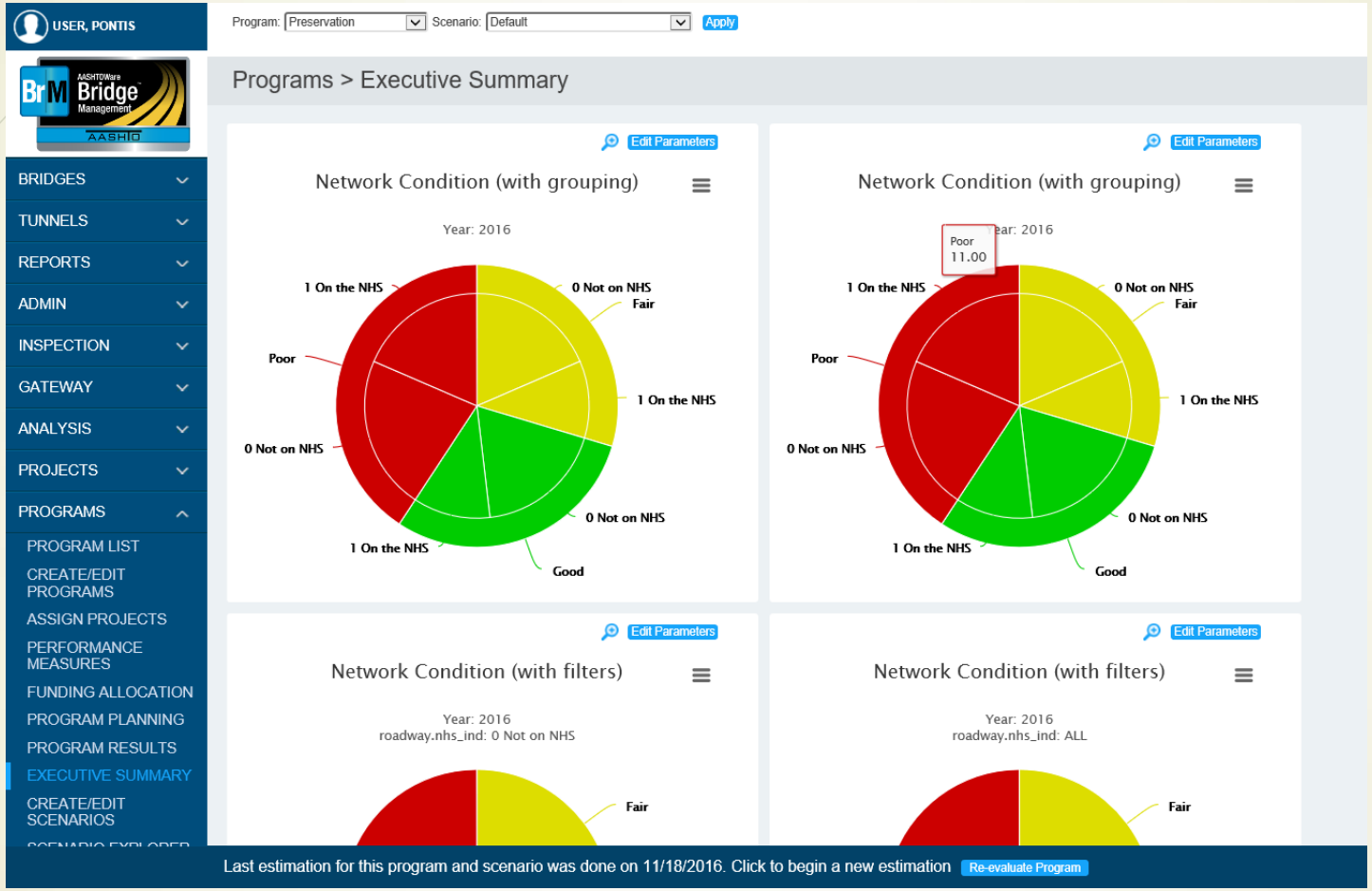
- Bridge Inventory
  - General Condition Ratings
    - National Bridge Inventory (NBI)
  - Bridge Element Ratings - AASHTO Manual for Bridge Element Inspection (MBEI)
- Performance Measures
  - National Performance Measures (FHWA)
    - Report Good (NBI 7-9), Poor (0-4) by Deck Area (Fair (5-6) is calculated)
  - **State Defined Performance Measures**

Monitoring Trends



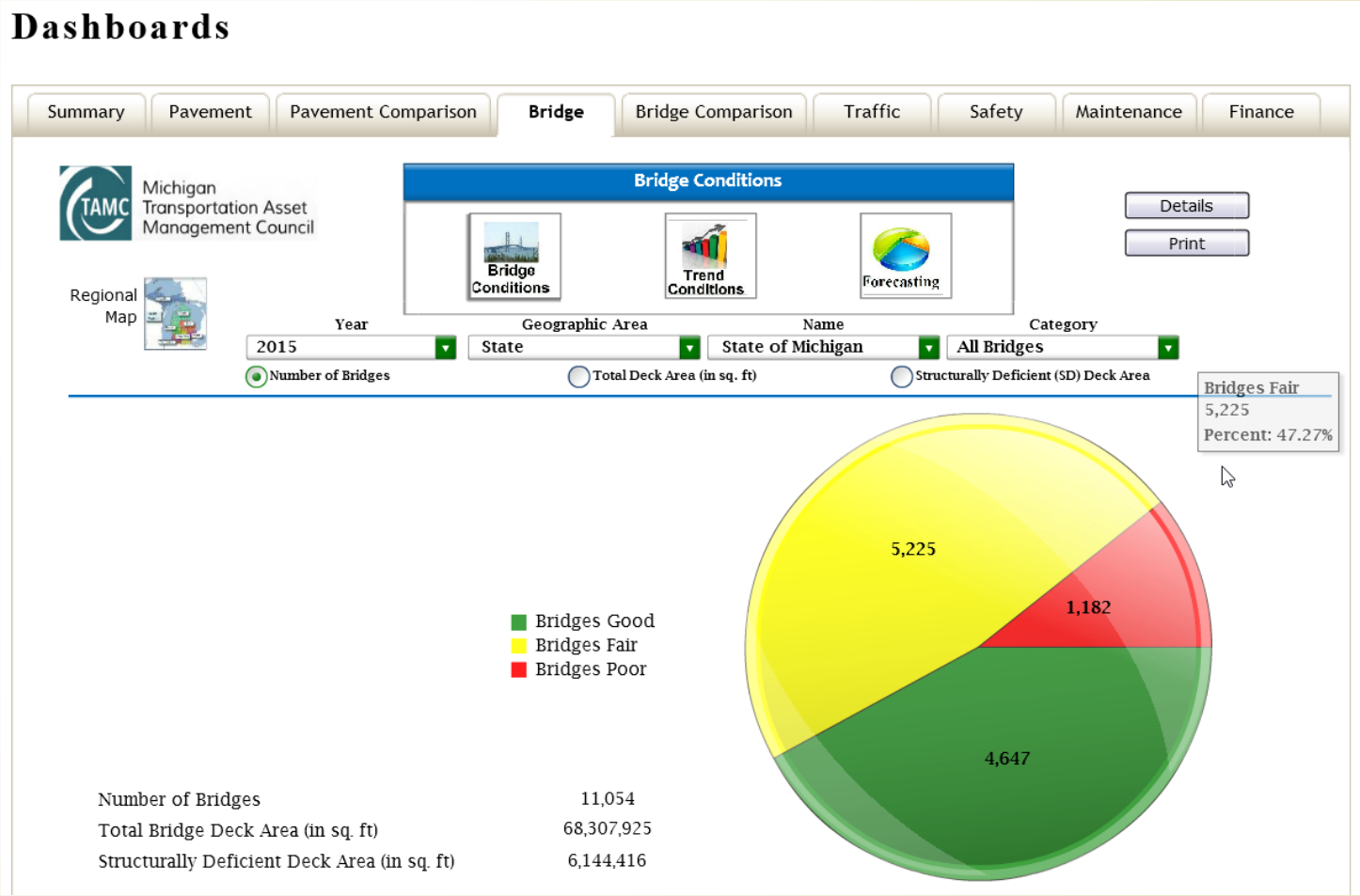


Network Management of Bridges

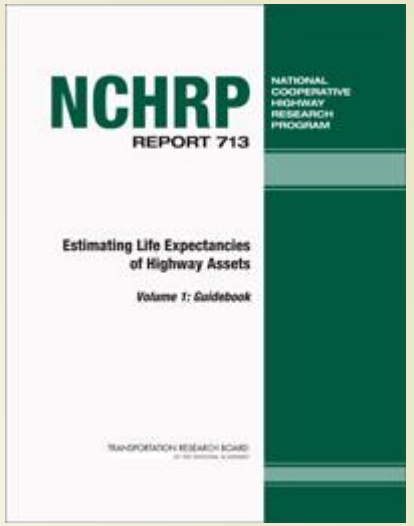


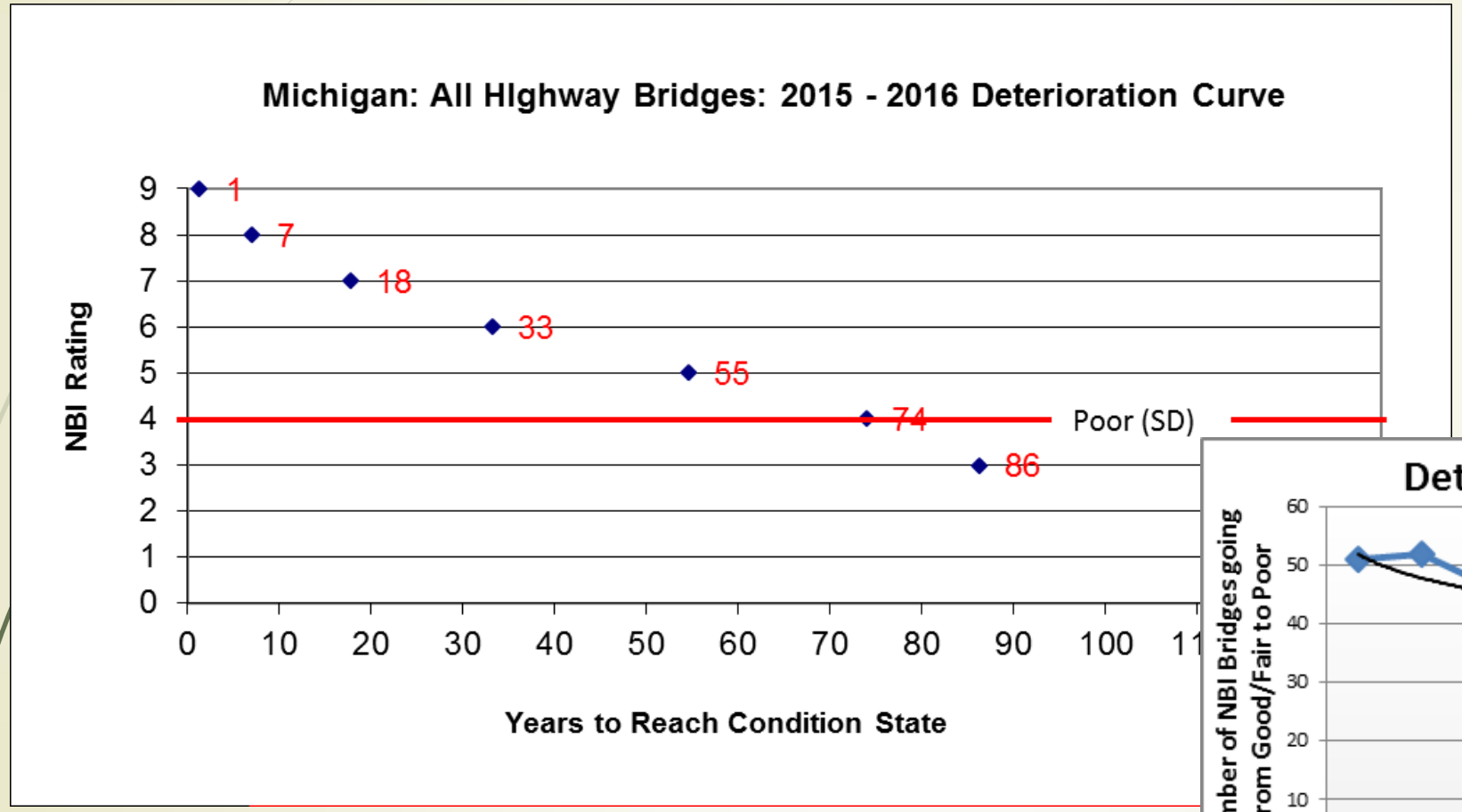
State Defined Performance Measures

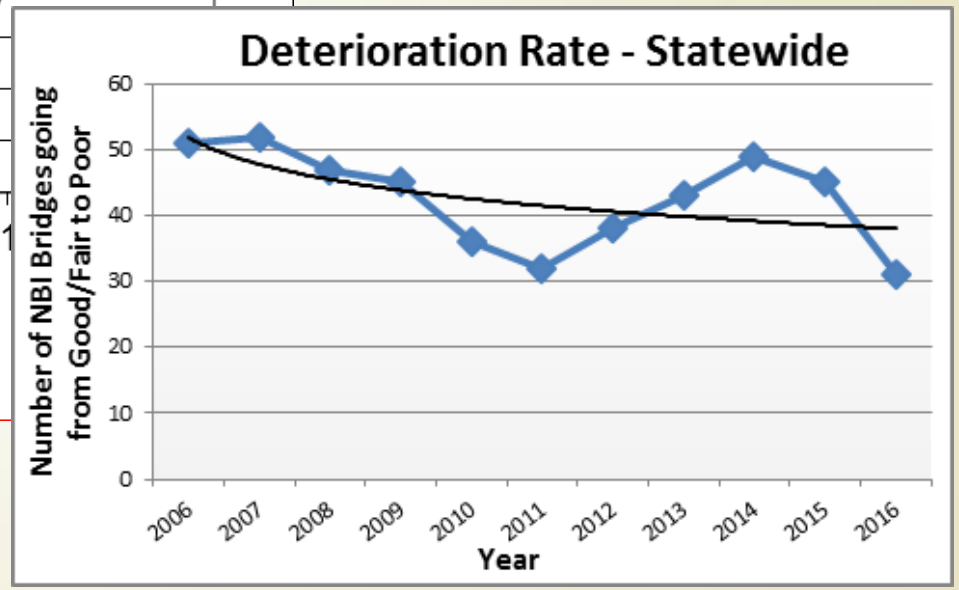
- Michigan Performance Measures
  - Take care of all critical needs
  - Freeway 95% Good or Fair
  - Non-Freeway 85% Good or Fair
  - Reduce the number of scour critical bridges carrying the interstate
  - **Reduce reactionary actions on our bridges**



Deterioration Modeling







Bridge Related Cost Models

- Project Costs
  - Direct
  - Indirect
    - Mobilization
    - Traffic Control

- Michigan Averages
  - Preventive Maintenance Cost = $550,000 per bridge project
  - Rehabilitation Cost = $1,400,000 per bridge project
  - Replacement Cost = $4,200,000 per bridge project

Strategy, Funding and Agency Rules

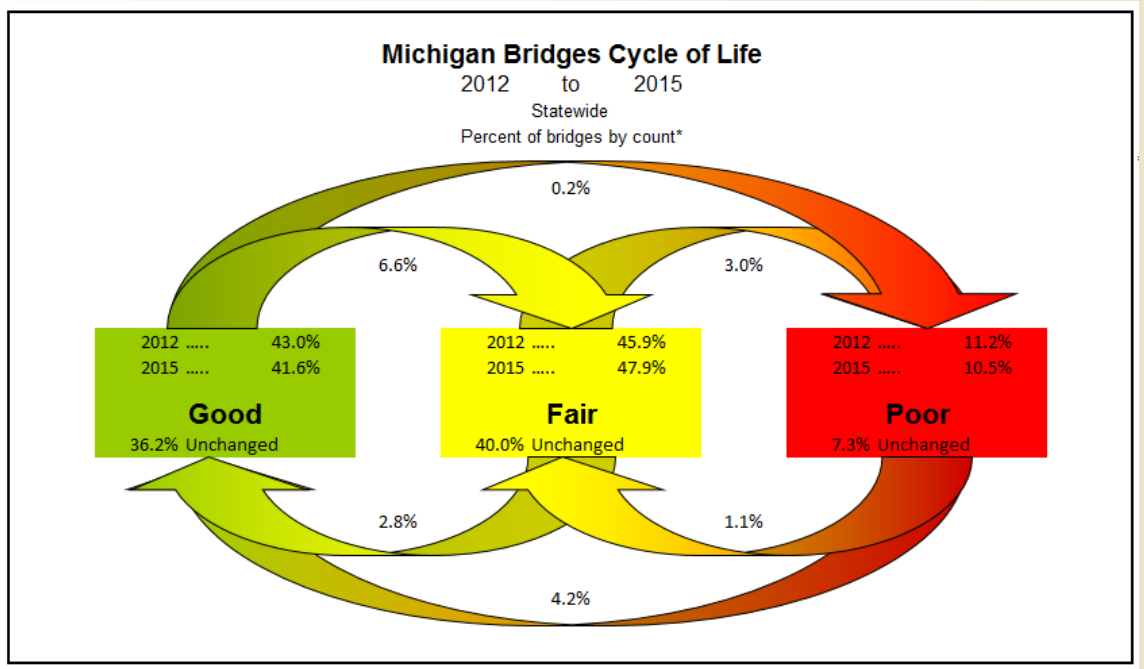
- "In order for a BMS to make bridge level decisions consistent with agency practice, agency rules need to be developed. The intent of the rules is to translate agency practices and their effects on bridge, program and network level recommendations into the system's modeling approach. These rules should be intuitive and reflect agency business practice and policy ."
- "Rules may be applied at the bridge, program, or network level…. Program level rules may reflect varying performance measure goals or funding constraints while network rules cover standard agency practice."

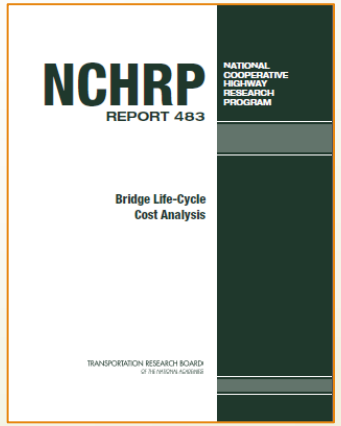
Project Level Bridge Management

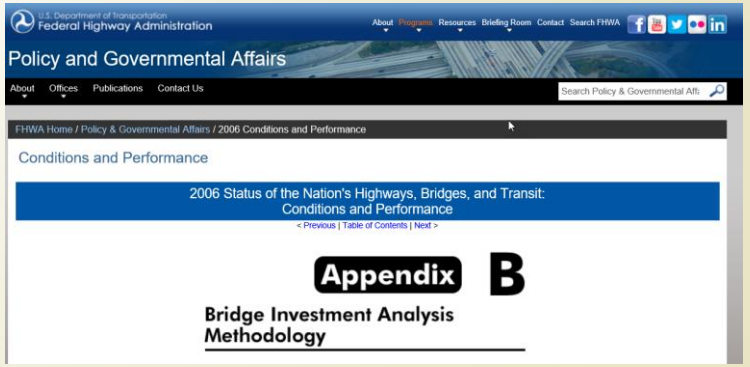
- "Advanced BMS analyses requires a more detailed condition assessment to predict and prioritize bridge repair, preservation, or replacement actions."

Project Level Bridge Management

- Detailed Bridge Decisions
  - Bridge Element Ratings - AASHTO Manual for Bridge Element Inspection (MBEI)
    - National Bridge Elements (NBEs)
    - Bridge Management Elements (BMEs)
    - Agency-Defined Elements (ADEs)
- Project **Prioritization**
  - Cost/Benefit Analysis
  - Risk Assessment
  - Managing Fair Bridges
    - Remaining Service Life or Time to Poor
  - Multi-objective **Optimization**



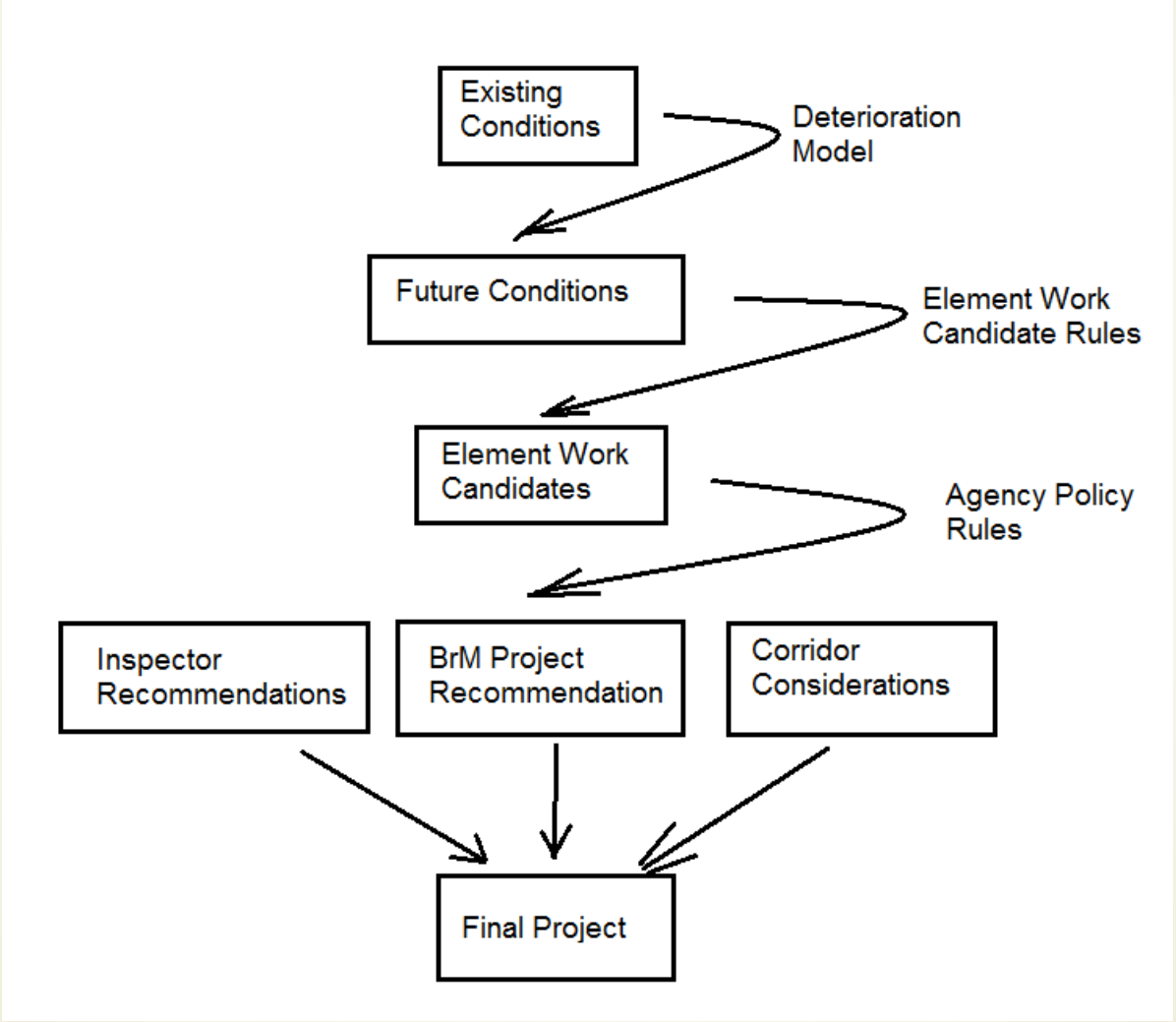




Michigan's Project Level Objectives of our BMS

- For every bridge not already programed, deteriorate the network five years, then using bridge elements and the AASHTOWare BrM software, indicate what the needs are for that bridge, what category of work it fits into, and estimate the cost for the work.

Project Level BMS Process Overview

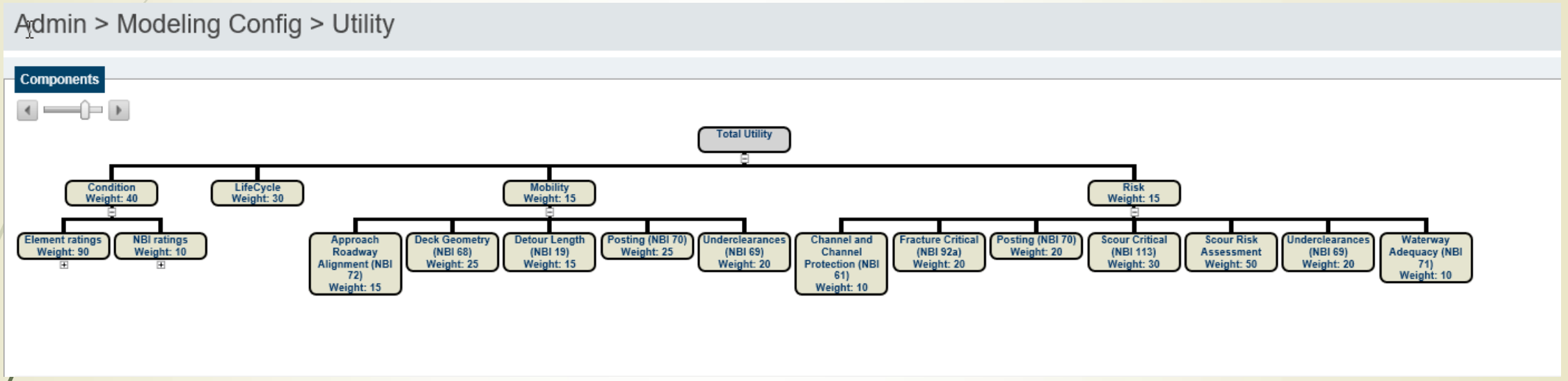


Multi-objective Optimization

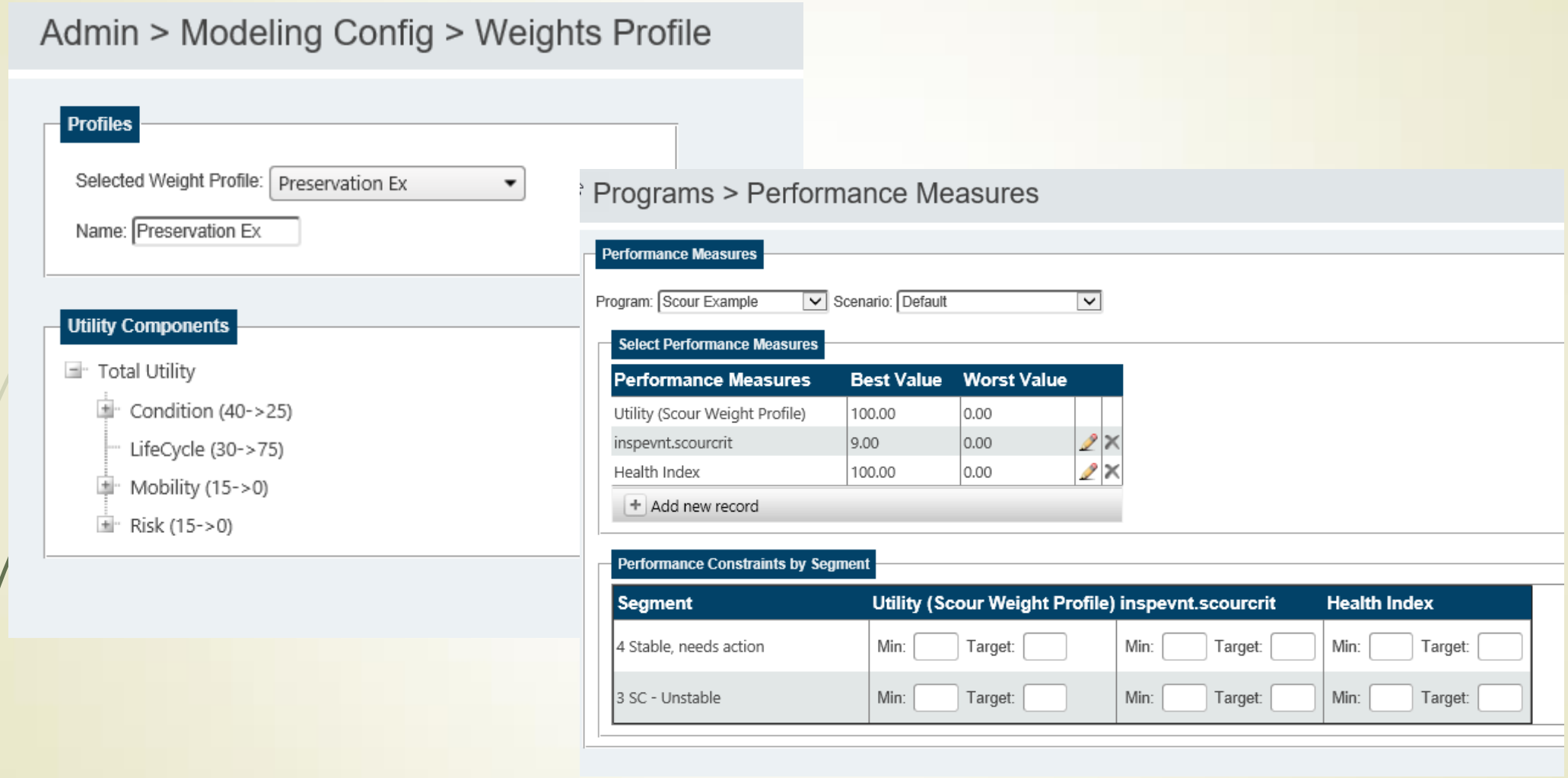
- "The purpose of optimization at the network level is to select a set of bridge projects in such a way that the total benefit derived from the implementation of all of the selected projects is maximized (costs and risks are minimized). The ability to establish project priorities and optimally allocate limited funds over a predefined planning horizon, both short- and long-run, is a fundamental part of a BMS."

- "Bridge owners often need to consider multiple performance criteria and constraints, such as bridge condition, life cycle costs, safety, traffic flow disruption, and vulnerability when making decisions and prioritizing projects. They may need to analyze trade-offs between these performance criteria."

Multi-objective Optimization



Multi-objective Optimization



Multi-objective Optimization

- Michigan Bridge Multi-Objectives
  - Meet and maintain freeway bridge condition goal (95%) good or fair
  - Reduce scour critical bridges carrying the interstate.
  - Make bridges more resilient to reactive activities resulting from advanced deterioration. (Reduce need to close traffic lanes because of advanced bridge deterioration.)

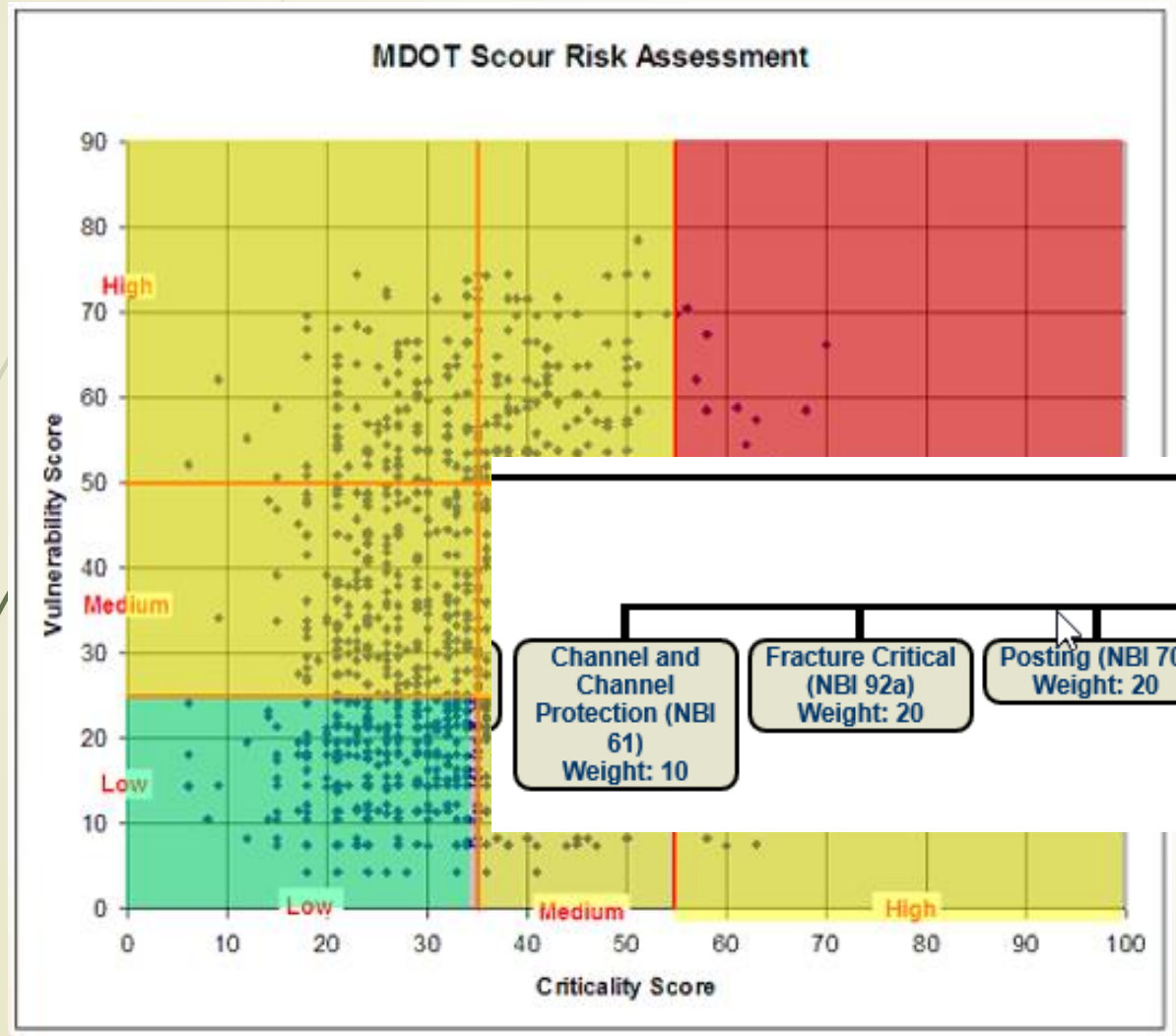
Risk Assessment

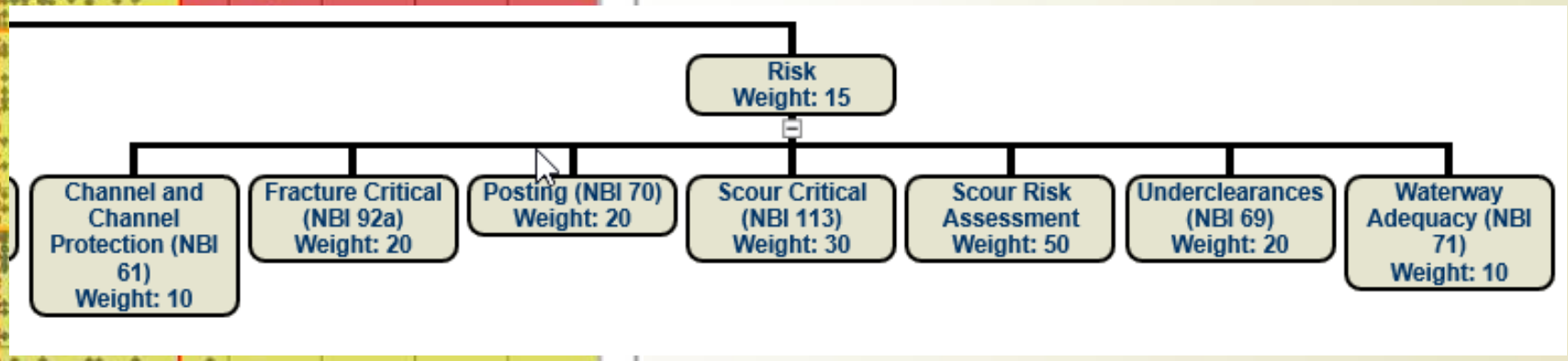
- "Risk may be understood as the potential for unplanned adverse events to impact one or more transportation facilities in a way that causes unacceptable transportation system performance according to any or all of the agency's performance objectives. In bridge management, the primary concern is disruption of expected or designed service levels, which may cause injuries or property damage, loss of mobility, and immediate expenditures or long-term excess costs."

Risk Assessment

- Risk assessment evaluates the likelihood and consequence of adverse events. The likelihood of the event includes the probability of the event occurring and may include the vulnerability of the structure to the event. The consequence of the adverse event would quantify the damage to the structure, the impact on the flow of people and goods in the transportation network and the importance (criticality) of the structure."

Risk Assessment





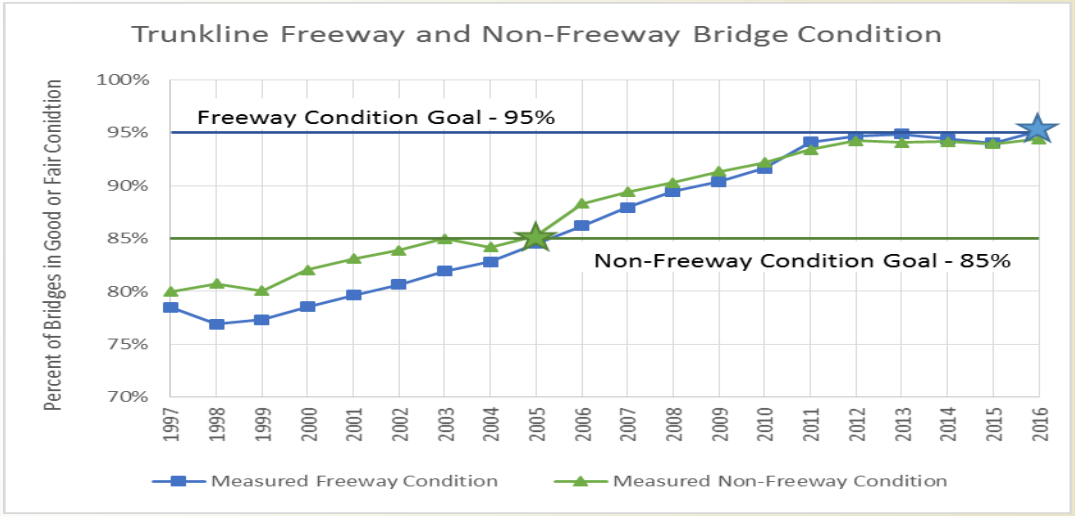
Function of a BMS

- "The function of a BMS is to provide bridge information and data analysis capabilities to improve the decision-making abilities of bridge managers. A BMS should not make decisions. Bridges cannot be managed without the practical, experienced, and knowledgeable input of the engineer/manager. A BMS is never used in practice to find one best policy among the possible choices. Instead, managers should use the BMS as a tool to evaluate various policy initiatives, often referred to as "what if" analysis. The available choices may relate to network-level decisions or project-level decisions."

A BMS is Decision Support

- The function of a BMS is to provide bridge information and data analysis capabilities to improve the decision-making abilities of bridge managers.
- Bridges cannot be managed without the practical, experienced, and knowledgeable input of the engineer/manager.
- Managers should use the BMS as a tool to evaluate various policy initiatives, often referred to as "what if" analysis.
- The available choices may relate to network-level decisions or project-level decisions.

Bridge Management Works!



BMS - The many things you learn on the journey are as valuable as the finished product.

Thank You!