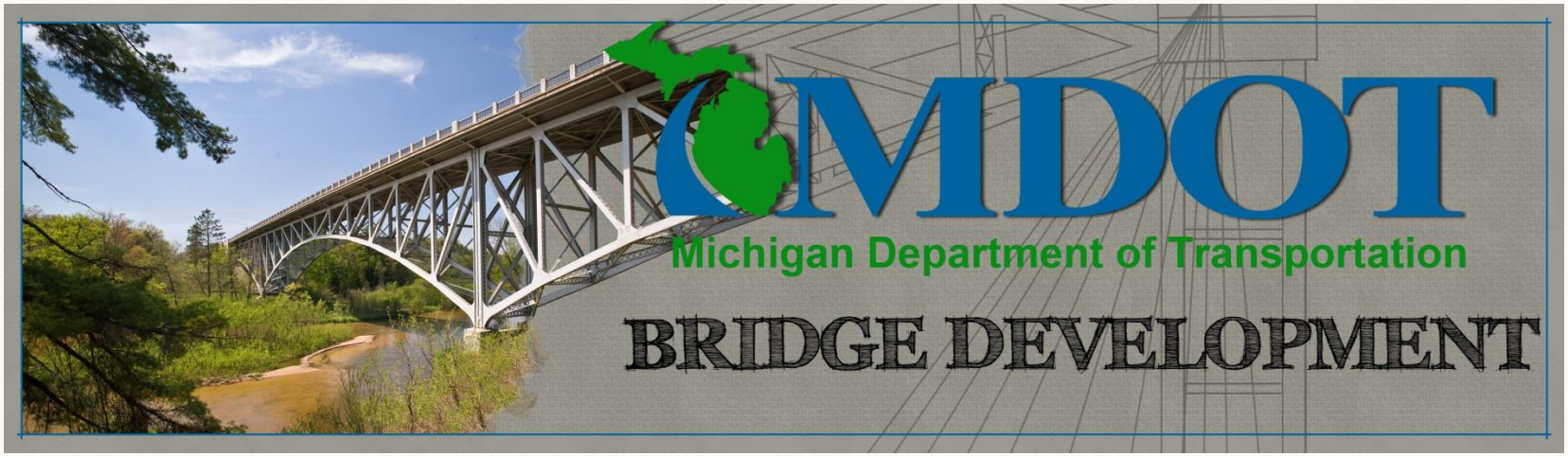


Preservation as Part of a Bridge Management System (BMS)

Dave Juntunen
Michigan DOT Bridge Development Engineer

October 3, 2016 Midwest Bridge Preservation Partnership

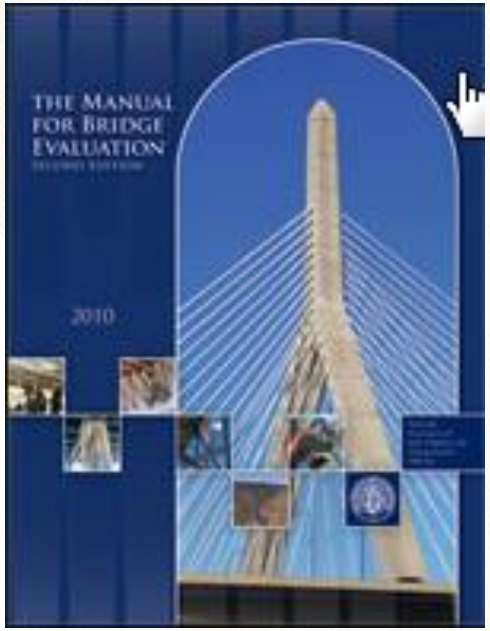
Milwaukee, Wisconsin

BMS Questions

- What is considered a Good Bridge Management System?
  - How much money do you need to spend on Preservation?
  - How do you prioritize your projects?
  - Is your strategy effective?

AASHTO Manual for Bridge Evaluation

- Update Chapter 3 – Bridge Management Systems



SECTION 3: BRIDGE MANAGEMENT SYSTEMS

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Objectives of a BMS

- Meet strategic objectives by connecting inventory management and project selection to agency strategic goals through a data driven process.
- Meet the needs of both upper management, where it is a strategic planning tool, and technical decision makers, where it is an engineering tool.
- It strives to find the optimum use of funding by enabling decision-makers to understand the essential trade-offs

National Goals and Performance Measures

MAP-21 (Moving Ahead for Progress in the 21st Century)

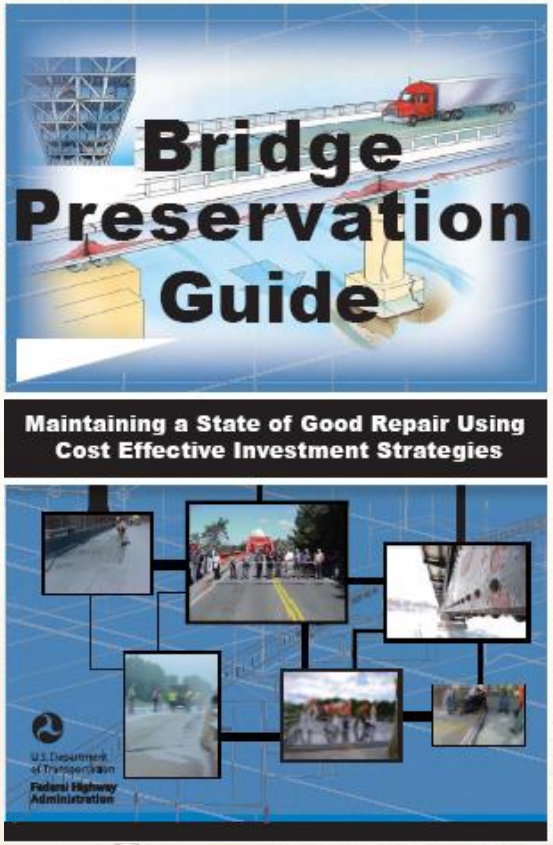
- ***No more than 10% of the total bridge deck area in a State on the National Highway System can be classified as structurally deficient for a period of 3 years without a penalty being imposed.*** **Title 23, U.S.C. §1119(f)(2)(A)**

- **A State shall develop a risk-based asset management plan for the National Highway System to improve or preserve the condition of the assets and the performance of the system.**

- ***States must maintain the highway infrastructure asset system in a state of good repair.*** **Title 23, U.S.C. §1119(b)(2)**

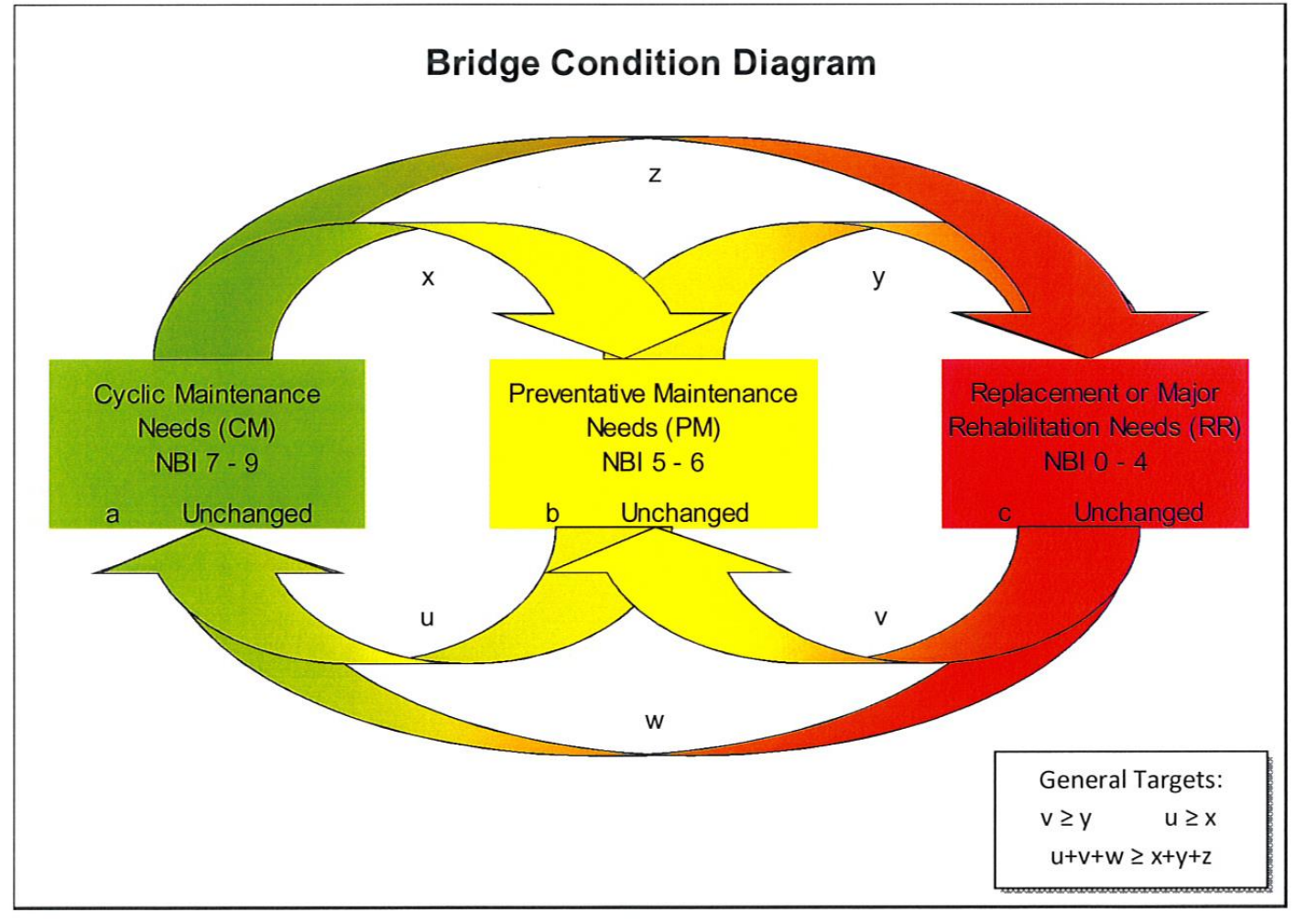
Ultimate Goal – Maintain Bridges in a "State of Good Repair"

Definition – State of Good Repair[1]: The existing physical conditions of bridge elements, components or entire bridges are such that the bridges (a) are functioning as designed and (b) are sustained through regular maintenance, preservation, and replacement programs.

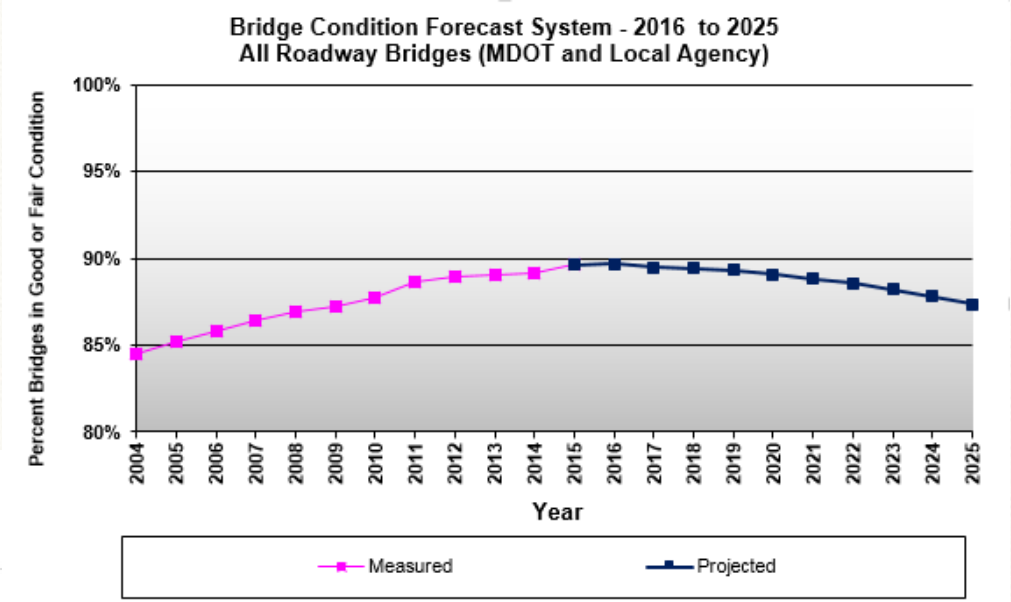


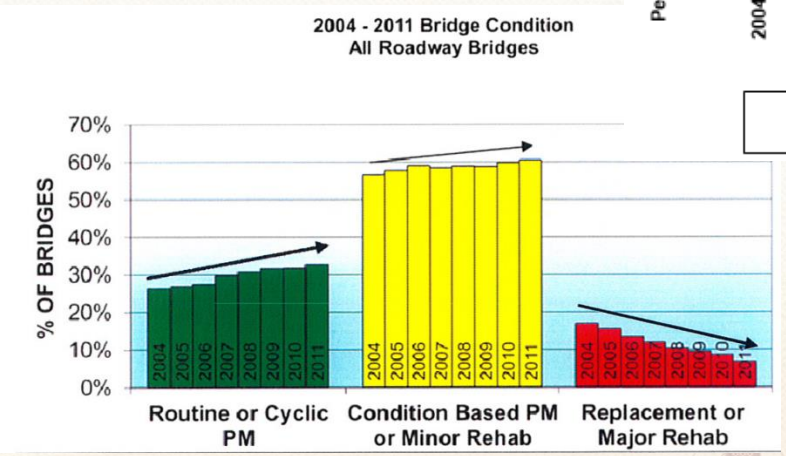
1 – FHWA Bridge Preservation Guide

AASHTO SCOBS Recommended Performance Measure Based Upon Bridge Preservation Needs



Network or Program Level Assessment





Bridge or Project Level Assessment

SECTION 3: BRIDGE MANAGEMENT SYSTEMS

TABLE OF CONTENTS

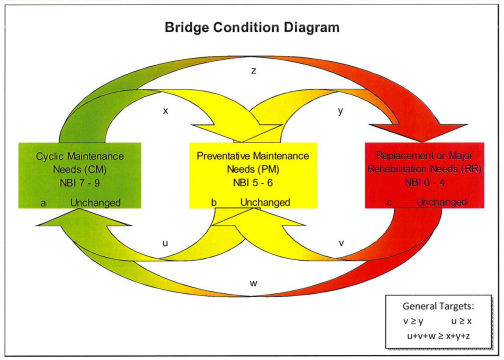
Talking about today

Objectives for Michigan DOT Bridge Management

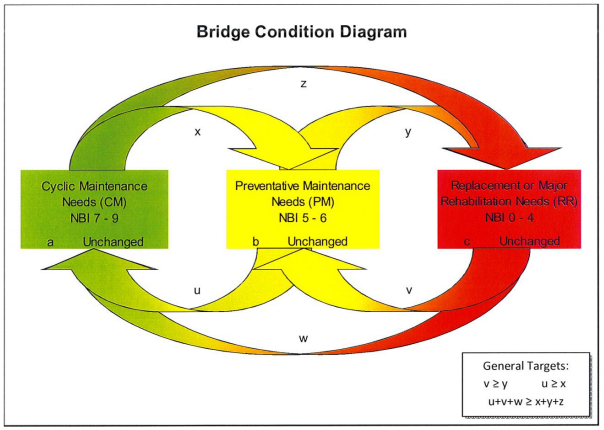
- Deteriorate the network five years
- For every bridge not programmed
  - Tell what the bridge's needs are
  - Provide and estimate of cost for the work
  - What category of work does the bridge fall in
    - Preservation
    - Rehabilitation
    - Replacement

Agency Rules

- The intent of the rules is to translate agency practices and their effects on bridge, program, and network le recommendations into the system's modeling approach.
- Cyclic Rules
  - Action and Interval
  - Example - “Wash steel beam bridges once each year.”
- Conditional Rules
  - Action taken as the result of the condition of and element or component
  - Example - Replace seals in strip seal expansion joints when quantity in Condition State 2 (fair) exceeds 20%, or quantity in Condition State 3 is greater than 0%
  - Conditional rules most often need to be considered concurrently with related elements that could impact how the rules should be applied.

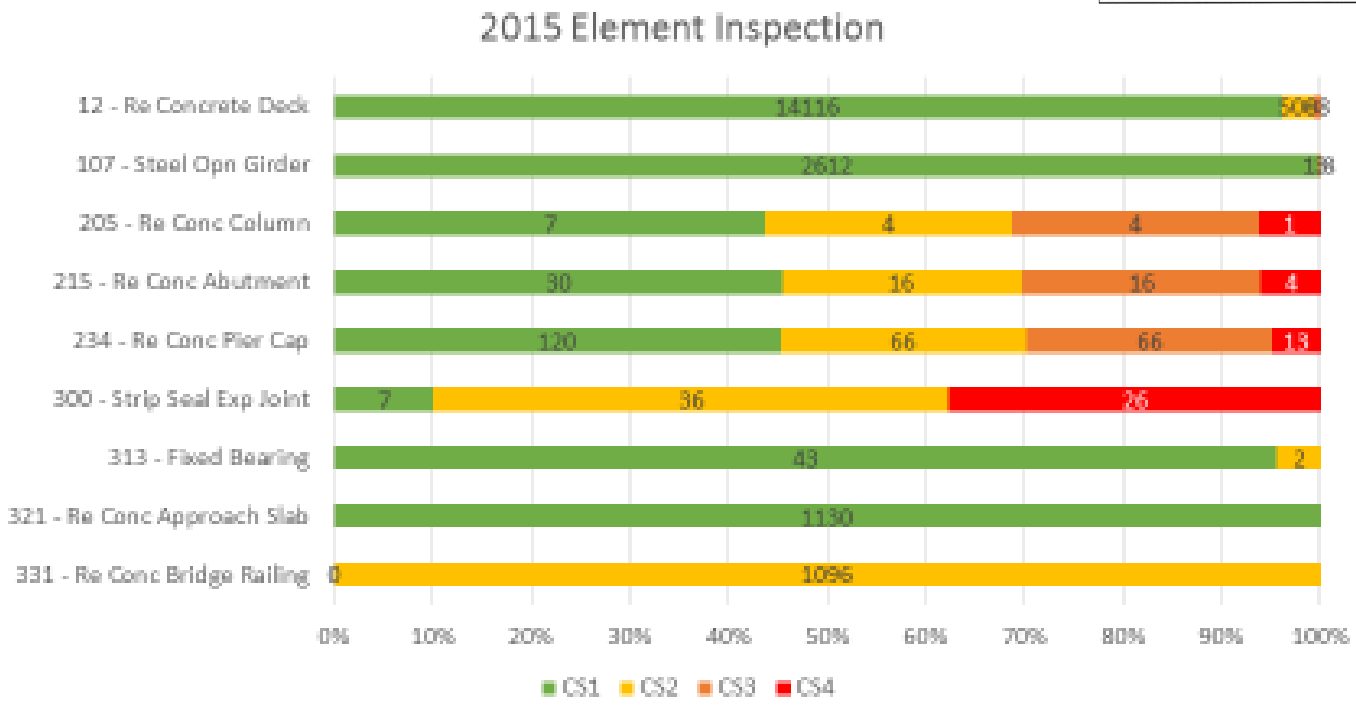


Imagine This Bridge



2C 402 – West Temple Off-ramp Over 2nd West

Deck NBI	Super NBI	Sub NBI
7 - Good	6 - Satisfactory	4 - Poor



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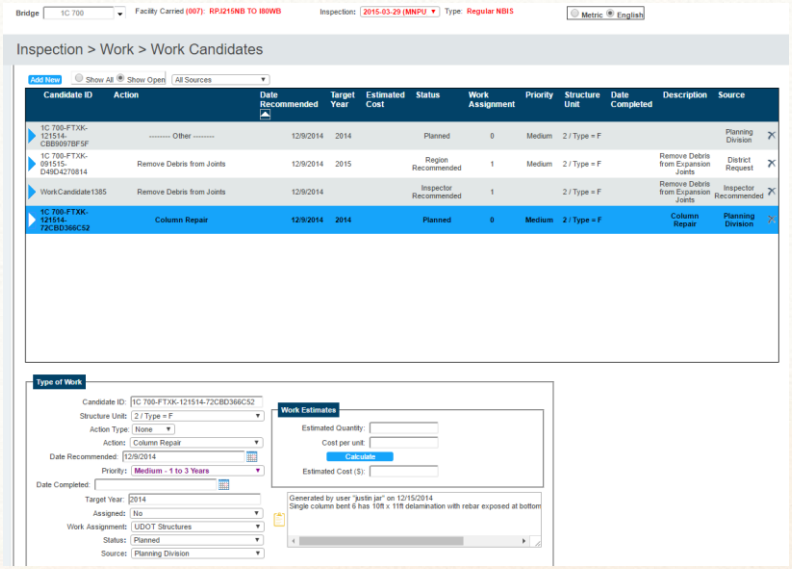
BRIDGE DEVELOPMENT

Different Analysis Approach / Decision Support

- **Bottom Up**
  - Inspector Driven Based on current data (work candidates)



Different Analysis Approach / Decision Support

- **Top Down**
  - Deteriorate the entire network over your programming time frame, and try to balance the best option for each bridge with the best option for your whole network, increasing or decreasing work on any one bridge in order to make the most progress toward your performance measures.

How to we Prioritize Preservation?

Programs > Program Planning

Rehab Culvert

Assigned Projects

Segment: All Year: All

Project Name	Category	Automatic	Cost	Utility	Utility Benefit	Benefit/Cost ($k)	Cost ($k) / Benefit	Year	Frozen	Status
004817(Rehab Deck)	No Category	Yes	$56,531	75.6	5.25	0.0929	$10.77	2016	No	Proposed
018205(Preserve Deck)	No Category	Yes	$52,565	79.71	4.17	0.0793	$12.61	2016	No	Proposed
011856(Preserve Deck)	No Category	Yes	$66,610	87.54	5.14	0.0772	$12.96	2016	No	Proposed
009267(Preserve Deck)	No Category	Yes	$59,310	74.52	4.48	0.0755	$13.24	2016	No	Proposed
008124(Rehab Deck)	No Category	Yes	$63,120	77.7	5.16	0.0817	$12.23	2016	No	Proposed
006810(Rehab Deck, Preserve Super)	No Category	Yes	$51,298	80.96	5.28	0.1029	$9.72	2016	No	Proposed
005851(Rehab Deck)	No Category	Yes	$53,493	80.87	5.81	0.1086	$9.21	2016	No	Proposed
003218(Rehab Deck, Rehab Sub)	No Category	Yes	$55,538	75.81	6.83	0.123	$8.13	2016	No	Proposed
010764(Rehab Deck, Preserve Super)	No Category	Yes	$50,476	75.46	4.08	0.0808	$12.37	2016	No	Proposed
009268(Rehab Deck)	No Category	Yes	$68,971	75.61	6.37	0.0924	$10.83	2016	No	Proposed
015539(Rehab Deck)	No Category	Yes	$53,573	85.96	3.62	0.0676	$14.80	2017	No	Proposed
013568(Rehab Culvert)	No Category	Yes	$70,274	85.18	4.75	0.0676	$14.79	2017	No	Proposed
006812(Rehab Deck)	No Category	Yes	$70,469	76.47	4.8	0.0681	$14.68	2017	No	Proposed
011464(Preserve Deck)	No Category	Yes	$76,415	87.52	5.14	0.0673	$14.87	2017	No	Proposed
011820(Preserve Deck)	No Category	Yes	$63,045	84.51	4.28	0.0679	$14.73	2017	No	Proposed
005852(Rehab Deck)	No Category	Yes	$81,960	81.51	5.87	0.0716	$13.96	2017	No	Proposed
010042(Preserve Deck)	No Category	Yes	$54,250	83.46	3.77	0.0695	$14.39	2017	No	Proposed
000467(Rehab Culvert)	No Category	Yes	$54,893	73.17	4.04	0.0736	$13.59	2017	No	Proposed
010204(Preserve Deck)	No Category	Yes	$57,945	77.81	4.38	0.0756	$13.23	2017	No	Proposed
009964(Preserve Deck)	No Category	Yes	$70,785	77.58	4.63	0.0654	$15.29	2018	No	Proposed
012620(Preserve Deck)	No Category	Yes	$80,185	78.29	5.14	0.0641	$15.60	2018	No	Proposed
012320(Rehab Deck)	No Category	Yes	$53,575	78.05	4.04	0.0754	$13.26	2018	No	Proposed
003029(Rehab Deck, Preserve Super, Rehab Sub)	No Category	Yes	$57,431	77.88	4.37	0.0761	$13.14	2018	No	Proposed
008125(Rehab Deck)	No Category	Yes	$50,947	77.48	5.22	0.1025	$9.76	2018	No	Proposed
006471(Rehab Deck)	No Category	Yes	$60,463	76.75	3.84	0.0635	$15.75	2018	No	Proposed
008518(Rehab Deck)	No Category	Yes	$50,200	78.13	4.23	0.0843	$11.87	2018	No	Proposed
008527(Rehab Deck)	No Category	Yes	$50,015	74.94	3.73	0.0746	$13.41	2018	No	Proposed
008173(Preserve Deck)	No Category	Yes	$55,065	83.32	3.56	0.0647	$15.47	2018	No	Proposed

Items per page: 50

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Different Analysis Approach / Decision Support

- **Middle Out**
  - Deteriorate Inspection data and evaluate multiple possible work activities (possibly including inspector recommendations) over your programming time frame to give you the best option for your bridge at a detailed level

Life Cycle Analysis

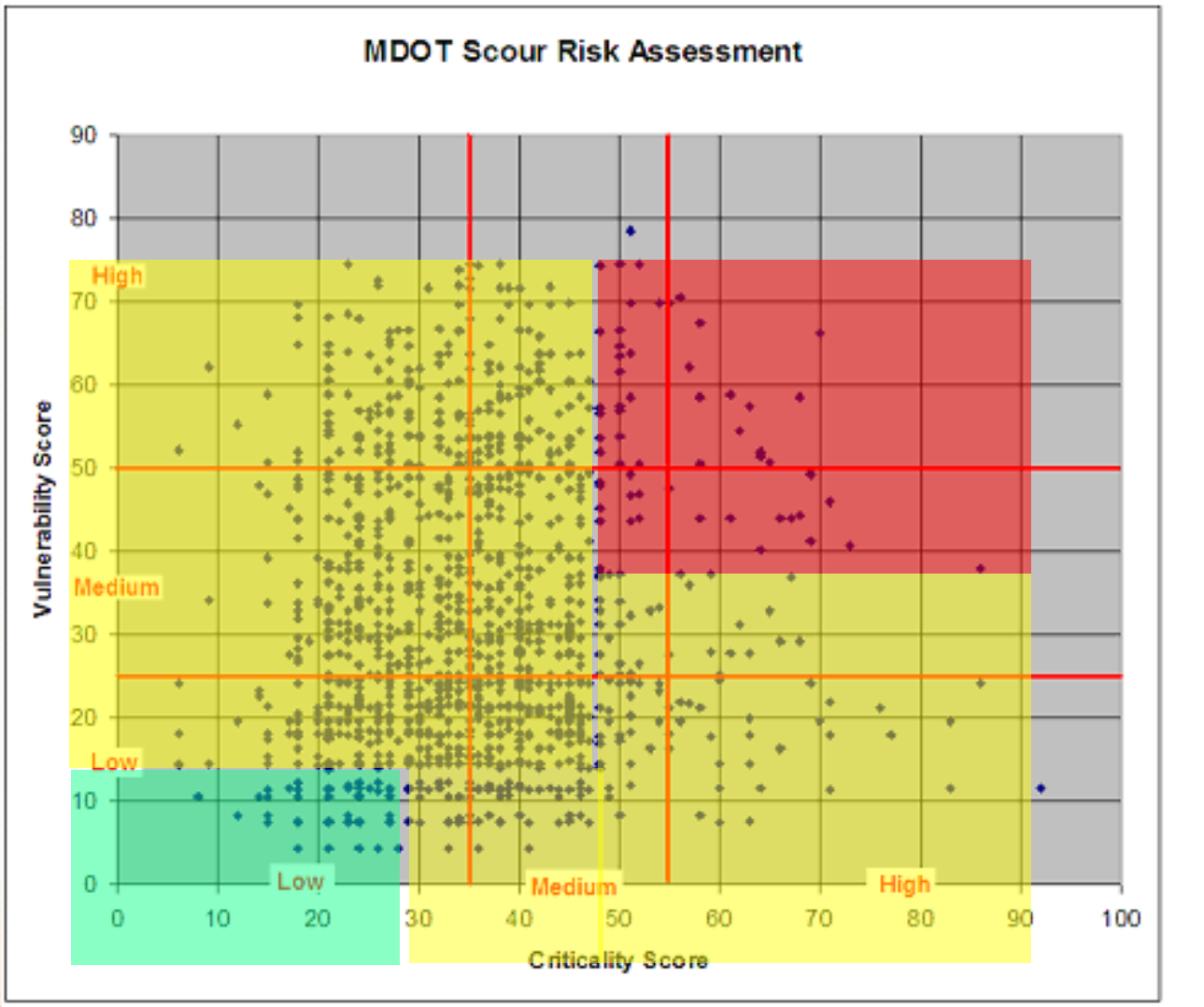
- Compare fixes to a bridge
- When to do the work

Policy Rules

Name	Condition	Action	Up	Down	Top	Bottom
Preserve Deck	((Health Index of Category 'Decks/Slabs' Must Be Greater Than Or Equal To Number Value 50 **AND** Health Index of Category 'Decks/Slabs' Must Be Less Than Or Equal To Number Value 90) **AND** (Health Index of Element '510 - Wearing Surfaces' Must Be Less Than Or Equal To Number Value 30))	Preserve Deck - Network		↓		⤓	✕ ✎
Rehab Deck	(Repeat every 15 or more years **AND** Health Index of Category 'Decks/Slabs' Must Be Less Than Or Equal To Number Value 70 **AND** Health Index of Category 'Decks/Slabs' Must Be Greater Than Or Equal To Number Value 50)	Rehab Deck - Network	↑	↓	⤒	⤓	✕ ✎
Deck Replace	(Health Index of Category 'Decks/Slabs' Must Be Less Than Number Value 50 **AND** Health Index of Category 'Superstructure' Must Be Greater Than Number Value 60 **AND** Health Index of Category 'Substructure' Must Be Greater Than Number Value 60)	Replace Deck - Network	↑	↓	⤒	⤓	✕ ✎
Apply Wearing Surface	((Health Index of Category 'Decks/Slabs' Must Be Greater Than Or Equal To Number Value 50 **AND** Health Index of Category 'Decks/Slabs' Must Be Less Than Or Equal To Number Value 100) **AND** (Field '510 - Wearing Surfaces' Is Null))	Place Wearing Surface - Network	↑		⤒		✕ ✎

Add Rule

Program Level Risk Assessment



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BRIDGE DEVELOPMENT

Multi-Objective Optimization

- Ability to compare many competing objectives
  - Preservation
  - Safety
    - Examples, seismic, scour, …
  - Modernization
  - Needs of the road program
  - …..

Decision Support

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.

Your BMS Tool Needs to be Flexible and Responsive

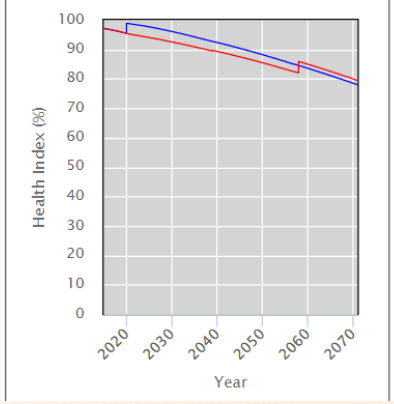
Analysis > LCCA

Index	Date	Year	Action Name	Orig. Cost	NPV Cost	Prior Action H.I.	After Action H.I.
1	2020	5	Column Repair, Profile Rotomilling	$2,580,595	$2,205,903	95.49	98.92
2	2021	6	Paint Sub - Network, Paint Super - Network, Place Wearing Surface - Network	$1,268,070	$1,042,261	98.65	98.65
3	2039	24	Preserve Deck - Network	$1,293,891	$524,966	92.67	92.74
4	2057	42	Preserve Deck - Network	$1,293,891	$259,138	84.93	85.00
Residual:				$16,141,458	$1,866,849		
Agency Life-Cycle Cost:					$4,032,268		
User Life-Cycle Cost:					$0		
Total Life-Cycle Cost:					$2,165,419		

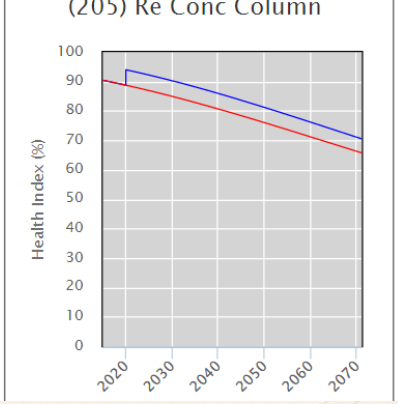
Charts

General Chart

Bridge Health Index



Element Chart



Effects on Each Element

Year: 2016

Element	Str. Unit	Env.	Quantity	Units	Starting Conditions	Effect	Ending Conditions
(12) Re Concrete Deck	101	Sev.(4)	43,129.70	sq.ft			
(107) Steel Opn Girder/Beam	101	Low(2)	5,687.30	ft			
(161) Stl Pin Pin/Han both	101	Sev.(4)	16.00	each			
(205) Re Conc Column	101	Mod.(3)	7.00	each			
(215) Re Conc Abutment	101	Low(2)	60.00	ft			
(231) Steel Pier Cap	101	Low(2)	22.50	ft			
(234) Re Conc Pier Cap	101	Low(2)	172.00	ft			
(300) Strip Seal Exp Joint	101	Sev.(4)	120.00	ft			
(311) Moveable	101	Low(2)	16.00	each			

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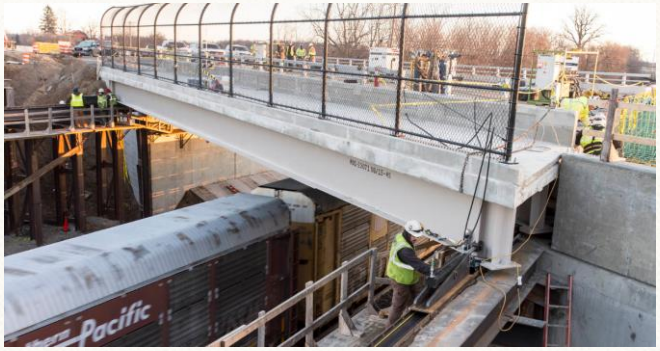
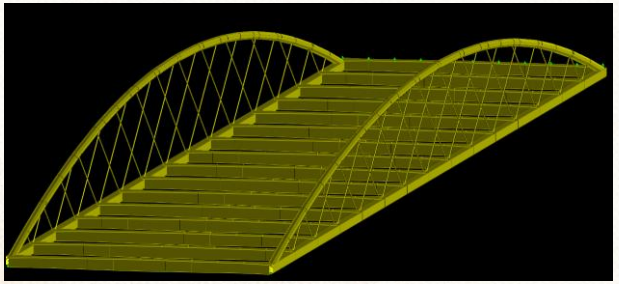
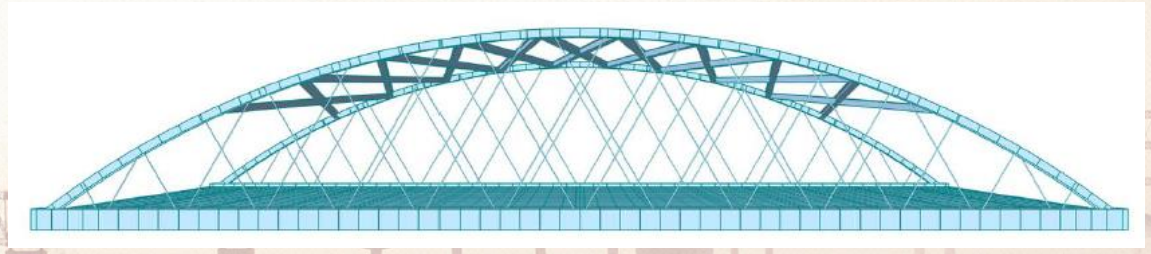
MDOT - Increase our capacity to innovate!







Thank You!

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