

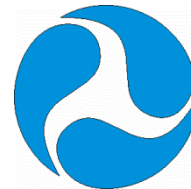
Performance Measures for Bridge Preservation

George Hearn Univ. of Colorado

David Juntunen Bridge Operations Engineer
Michigan Dept. of Transportation

Anwar S. Ahmad Bridge Preservation Engineer
USDOT Federal Highway Administration

Bruce V. Johnson State Bridge Engineer
Oregon Dept. of Transportation



Performance Measures – Approach & Goals

DOTs' Inputs

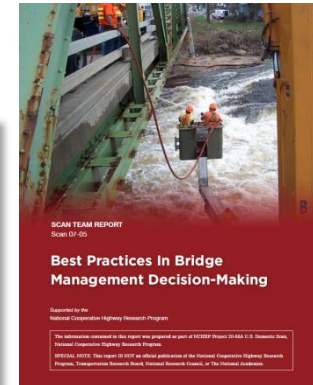
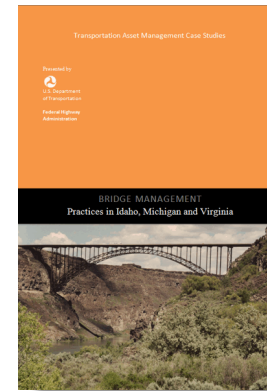
- Questionnaire to US State DOTs
- Scans and Case Studies

Published Practices

- Midwest Transportation Knowledge Network
- Washington DOT Performance Measure Library

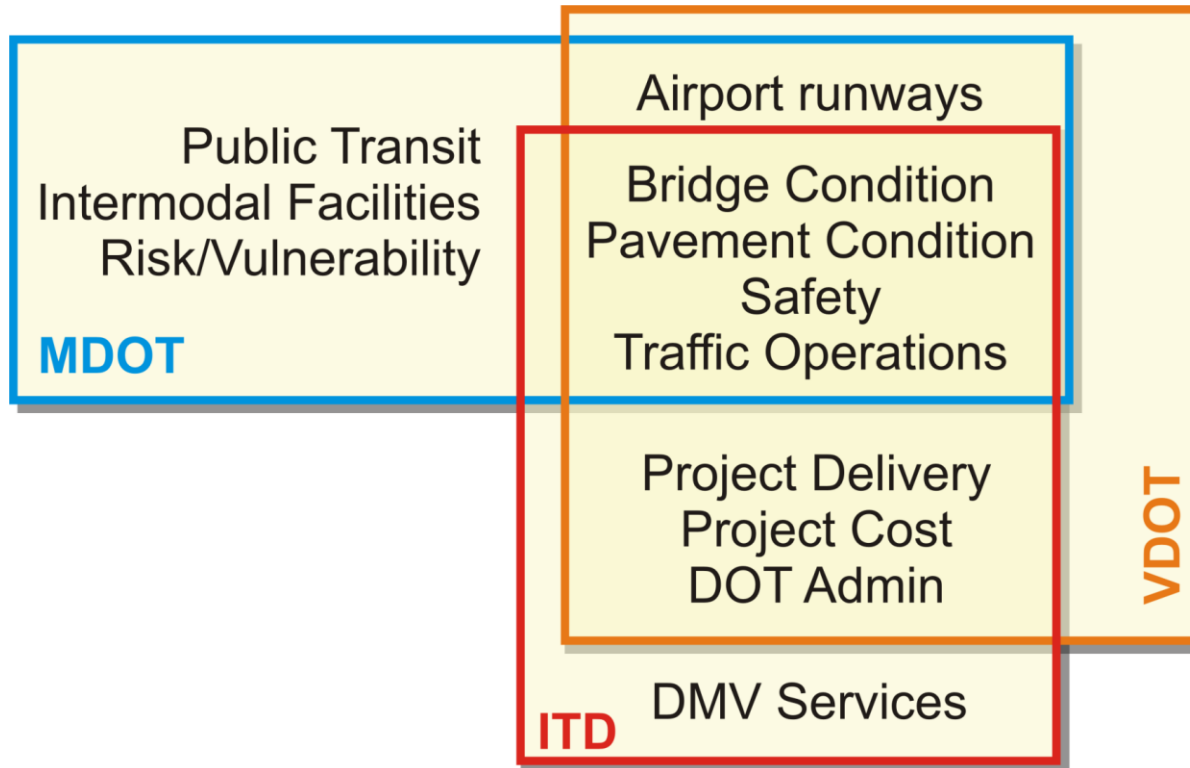
Proposed Performance Measures

- Building on existing data
- Relevant to bridge preservation



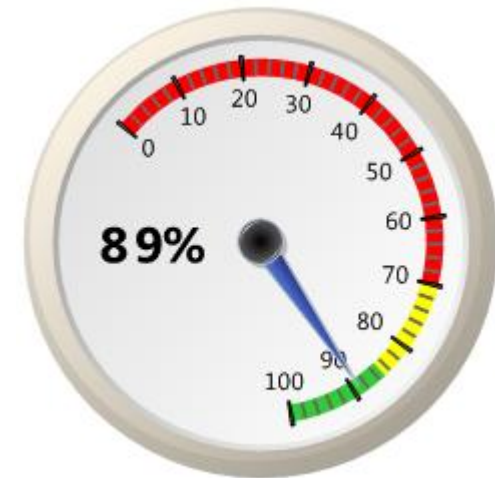
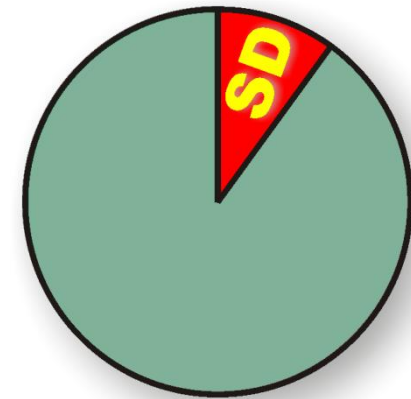
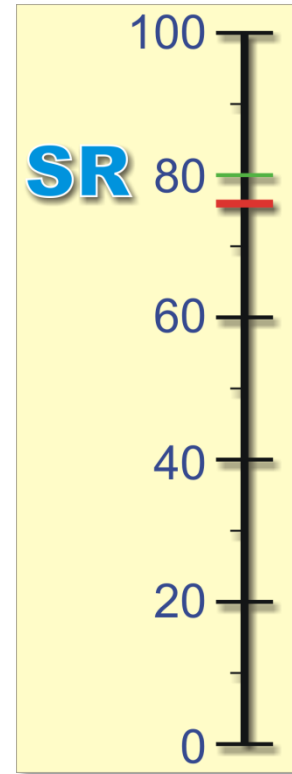
Case study <http://www.fhwa.dot.gov/asset/hif12029/hif12029.pdf>
Scan http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-68A_07-05.pdf
MTKN <http://members.mtkn.org/measures/>
WsDOT <http://www.wsdot.wa.gov/Accountability/Publications/Library.htm>

Performance Measures - Categories

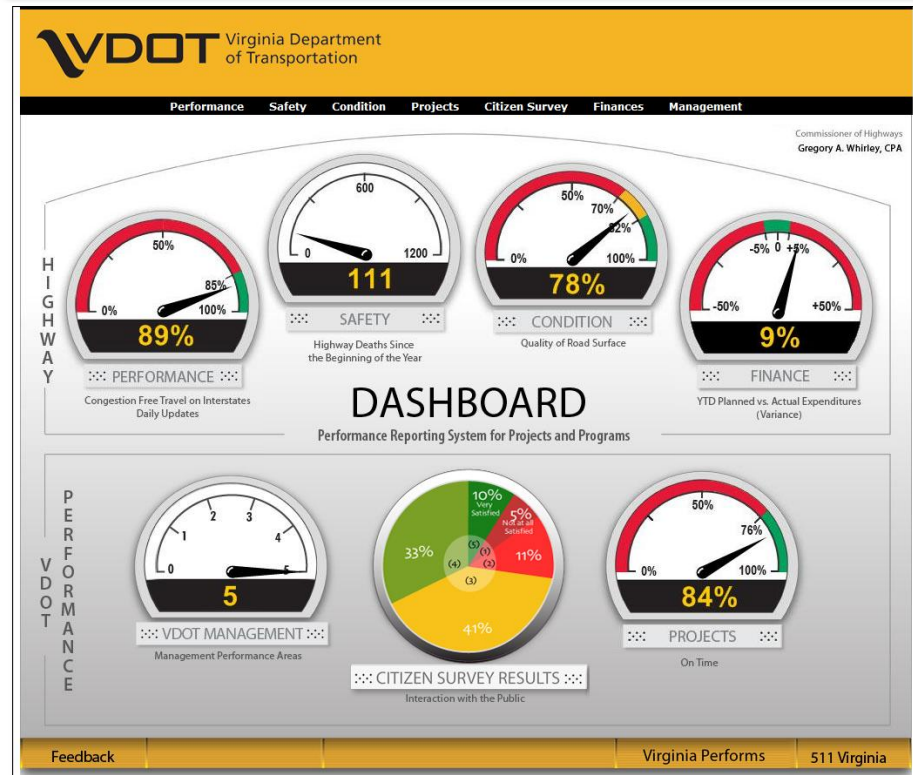
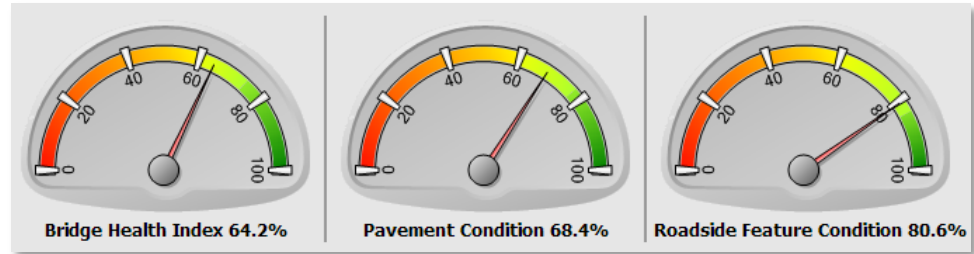
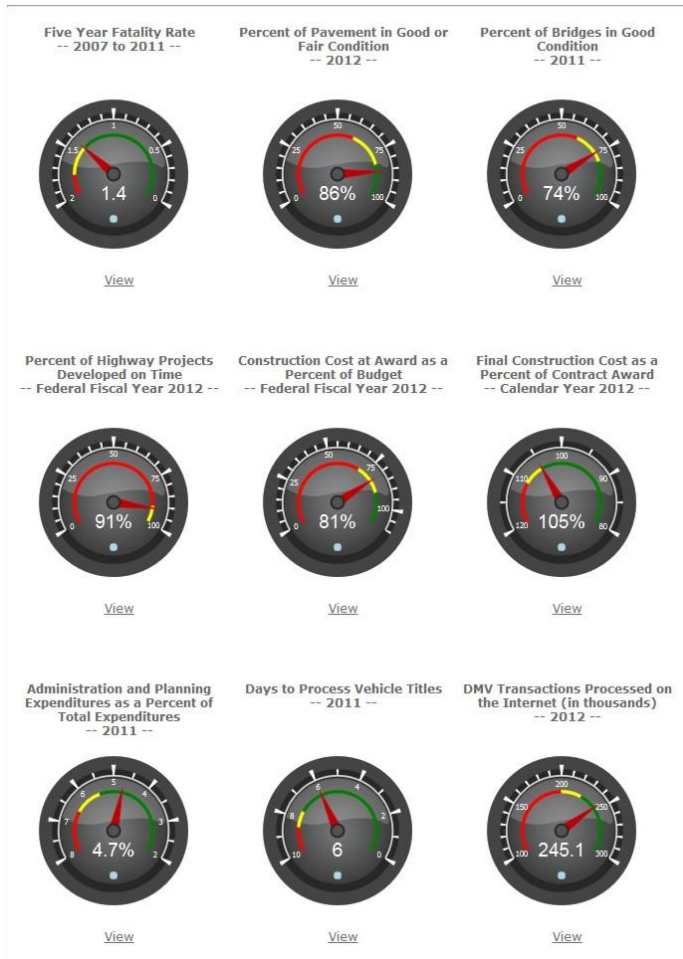


Performance Measures – Use of Data

General Condition	Performance
9	Good, Fair
8	
7	
6	
5	
4	Poor
3	
2	
1	
0	



Performance Measures - Dashboards



Performance Measures - Bridges

	Source			
	MTKN	NCHRP 20-24(37)E	AASHTO Roundtable	BPETG Questionnaire
DOTs Represented, count	36	39	33	17
<i>Performance Measure Input</i>	<i>Performance Measure Use, % of DOTs</i>			
Bridge Condition	56	56	55	64
Bridge Program	33	10	18	7
Functional Obsolescence	14	26	15	29
Weight Restriction	3	10	18	7
Maintenance & Operations	22	3	12	7
Structural Deficiency	39	56	52	50
Sufficiency Rating	-	10	9	7

Performance Measures - Preservation

***P1* Preservation candidates**

Bridges to preserve.

***P2* Preservation need**

Work needed to preserve the *P1* candidates.

***P3* Preservation plan**

Resources required to deliver the *P2* annual need.

***P4* Preservation impact**

Outcomes of preservation programs



Performance Measures - Preservation

***P1* Preservation Candidates**

$$P1, count = \sum_{\geq GCR 5} \text{Structures}$$

$$P1, SY = \sum_{\geq GCR 5} \text{Bridge Deck Area}$$

***P2* Preservation need**

$$P2 = \frac{P1}{\text{Service Interval}}$$

$$P2 = \frac{P1}{S_{[9,5]}}$$

***P3* Preservation plan**

$$P3 = P2 \times \text{Average Cost}$$

***P4* Preservation impact**

$$P4_R = \bar{R}_P - \bar{R}_R$$

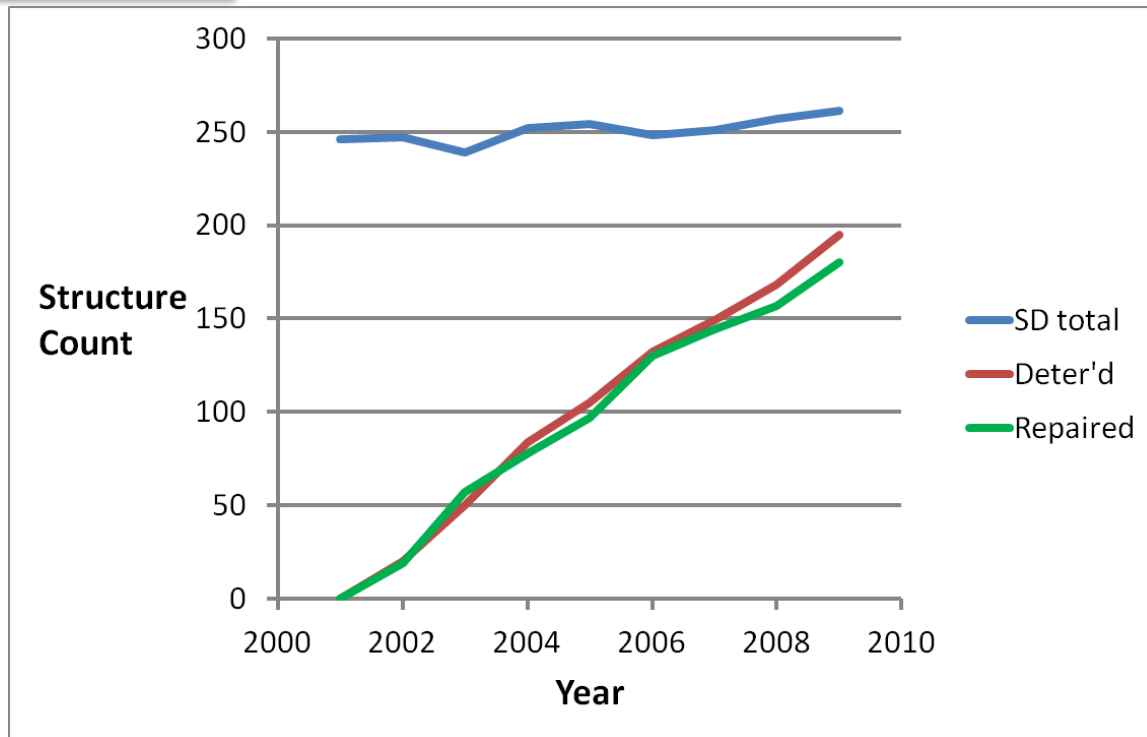
$$P4_W = P2 - W_{\text{replace}}$$

$$P4_C = P3 - C_{\text{replace}}$$

Performance Measures - Examples

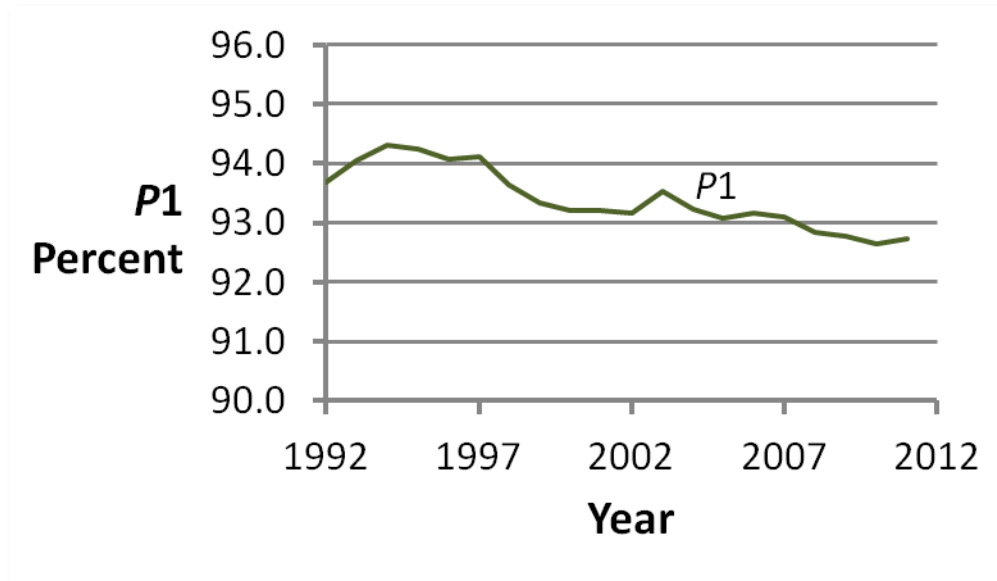


Bridges & Culverts, State-Owned, Span > 20 ft	3,450
Bridge Deck Area, Sq Yards	3,510,000
Median Age, years	42
Median General Condition Ratings	7



Performance Measures – Colorado P1

Candidates



<i>P1</i>	count	3200
	percent	93%
	Deck, Sq Yd	3,140,000

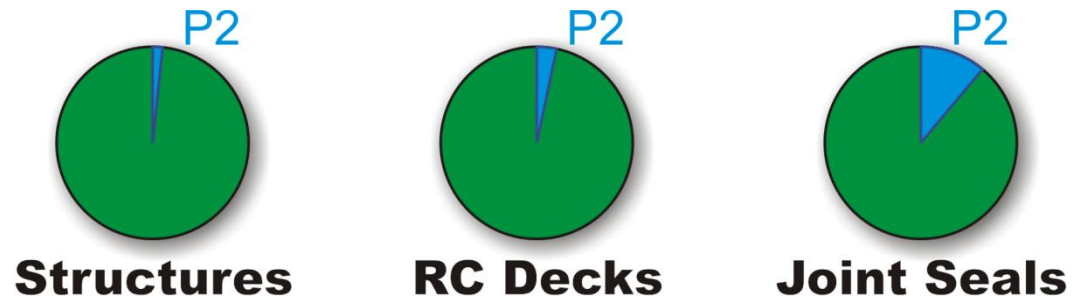
Replacements 1992 to 2011, count	425
Annual replacements, average count	21
Annual deterioration, average count	23

Performance Measures – Colorado P2

Need

$$P2 = \frac{P1}{S_{[9,5]}}$$

	P1	S _[9,5]	P2
<i>Structure-Level</i>			
Structures, Count	3200	64 years	50 / year
Structures, Deck area, SY	3,140,000		49,100 SY / year
<i>Element-Level</i>			
RC Deck, Epoxy bars, SY	316,000	31 years	10,200 SY / year
Seals, Compression Joints, Ft	55,000	9.1 years	6,040 Ft / year



Performance Measures – Colorado P3

Plan

$$P3 = P2 \times \text{Average Cost}$$

Project Type	Cost, \$ / SY
Bridge repair	180
Bridge major repair or rehabilitation	446
Bridge replacement	658

	<i>P2</i>		Average Cost	<i>P3</i>
Structure-Level				
Structures, Deck area, SY	49,100	SY / year	\$446 / SY	\$21,900,000
Element-Level				
RC Deck, Epoxy bars, SY	10,200	SY / year	\$43 / SY	\$439,000
Seals, Compression Joints, Ft	6,040	Ft / year	\$345 / Ft	\$2,083,800

Performance Measures – Colorado *P4*

Impact on General Condition Ratings

GCR	S_i years
9	1.6
8	8.7
7	22.3
6	22.6
5	17.4
4	28.8

<i>P4</i> Condition	Preservation Program	Replacement Program	$P4_R$
Average Condition Rating	6.6	6.0	+0.6
Bridges \geq GCR 6	86%	63%	+13%
Bridges \geq GCR 5	100%	83%	+17%

Performance Measures – Colorado P4

Impact on Work Need

Program	<i>S</i> , years	basis	<i>W</i> / year	<i>P4_W</i>
Preservation	64	structures	50	+ 12 / year
		deck area	49,100 SY	+12,000 SY / year
Replacement	84	structures	38	
		deck area	36,900 SY	

Impact on Plan

Program	basis	<i>W</i> / year	Cost	<i>P4_C</i>
Preservation	deck area	49,100 SY	\$446 / SY	(\$2,400,000)
Replacement	deck area	36,900 SY	\$658 / SY	

Performance Measures – Colorado Example

Summary

P1 Preservation Candidates	
Bridges, count	3200
Deck area, SY	3,140,000
% of State-owned structures	93%

P3 Preservation Plan – Network Level	
All P1 structures	\$21.9 millions
P3 Preservation Plan – Element Level	
RC deck, Epoxy bars, SY	\$439,000
Compression joints, Ft	\$2,083,800

P2 Preservation Need – Network Level	
Bridges, count	50
Deck area, SY	49,100
P2 Preservation Need – Element Level	
RC deck, Epoxy bars, SY	10,200
Compression joints, Ft	6,040

P4 Preservation Impact		
	Average GCR	+ 0.6
$P4_R$	Bridges \geq GCR 6	+ 23%
	Bridges \geq GCR 5	+ 17%
$P4_W$	Projects per year	+ 12
	Deck Area per year	+ 12,000
$P4_C$	Annual Plan	\$(2.4 millions)

Performance Measures for Bridge Preservation

Performance Measures	<i>P1</i>	Candidates	
	<i>P2</i>	Need	
	<i>P3</i>	Plan	
	<i>P4</i>	Impact	
Existing Data	NBI record, Element-Level Info, Average Costs		
Guidance	Monitor, plan and evaluate programs for bridge preservation		
Application	Trial with Colorado State-owned bridges and culverts		

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