



CHALLENGING THE PARADIGM IN BRIDGE ASSET MANAGEMENT MORE PROBLEMS REQUIRE MORE FUNDING

ROYCE GREAVES - CPENG INPE MIPENZ NDIAM

Mackinac Bridge, Michigan, USA

OVERVIEW

- The Current Reality
- Definitions
- Case Studies
 - Auckland Harbor Bridge
 - Bridge Strengthening Program
- Summary
- Acknowledgements
- Questions

Kicking Horse Canyon Park Bridge, Canada

THE CURRENT REALITY: GENERAL PRINCIPLES

AMA116

Panmure Station, Auckland, New Zealand

Life in the 21st Century....

- Asset Resilience
- Asset Redundancy



Budgets Squeezed!

- Asset Demand
- Environmental Outcomes
- Health & Safety Outcomes



Logical solution...

- More problems = more \$\$\$
- But can we challenge that?
 - Yes!

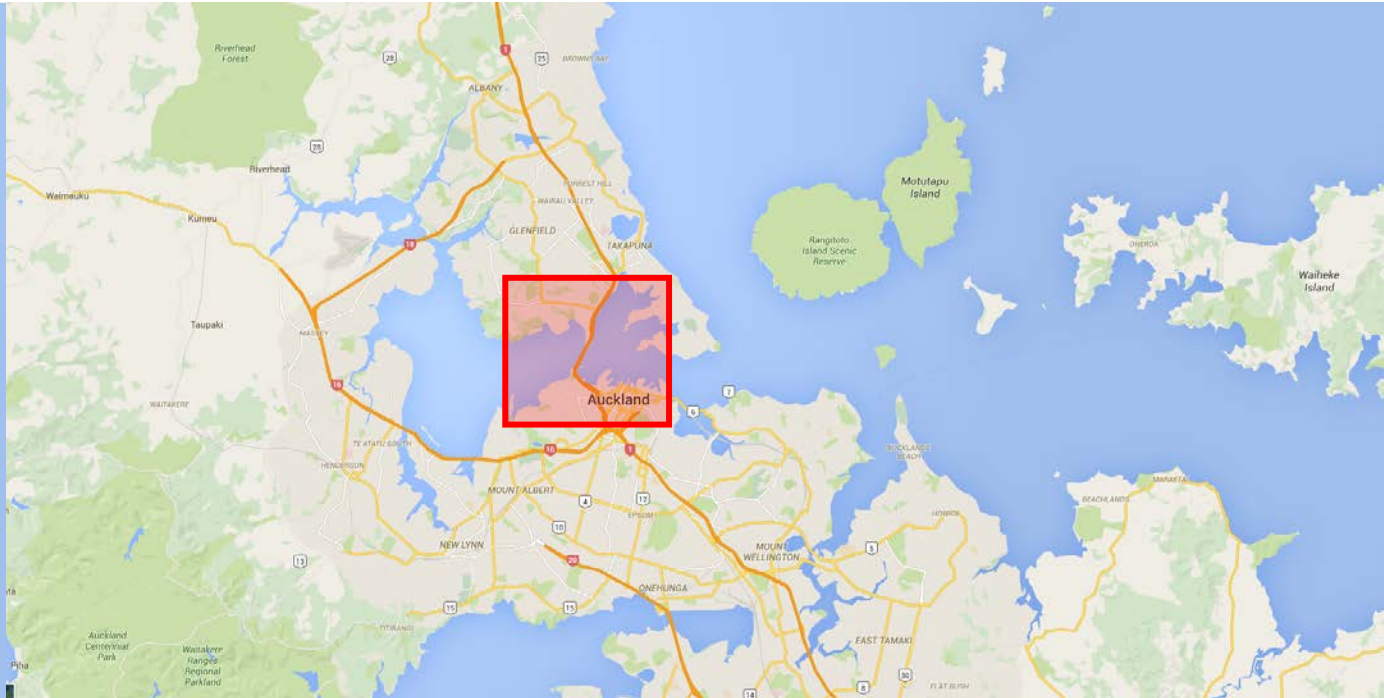
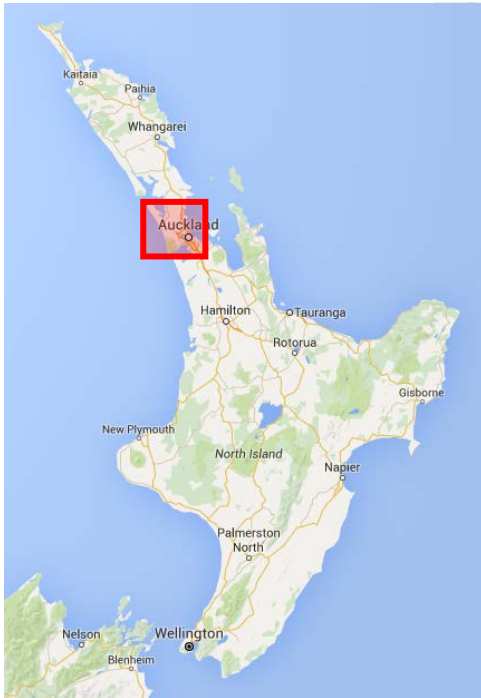
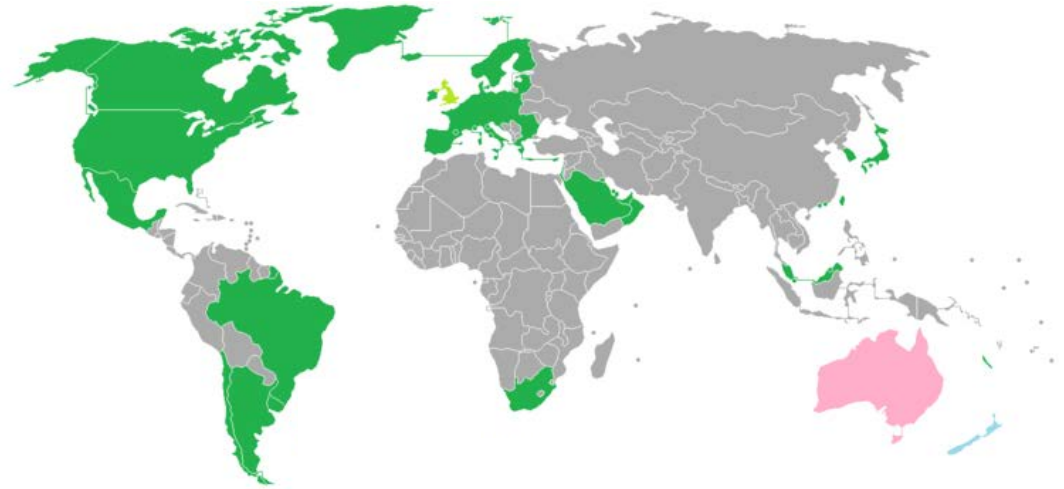


CASE STUDY ONE: AUCKLAND HARBOR BRIDGE

Auckland Highway Alliance, New Zealand



Location



Gallery





Key Statistics

- Lanes : 8 (with tidal flows)
- Length: 0.6 mile 1.1 km
- Type: Box Truss
- Clearance: 142 feet / 43m
- Opened: 1959
- Traffic: 160,000 vpd
- Nickname: “Coathanger”

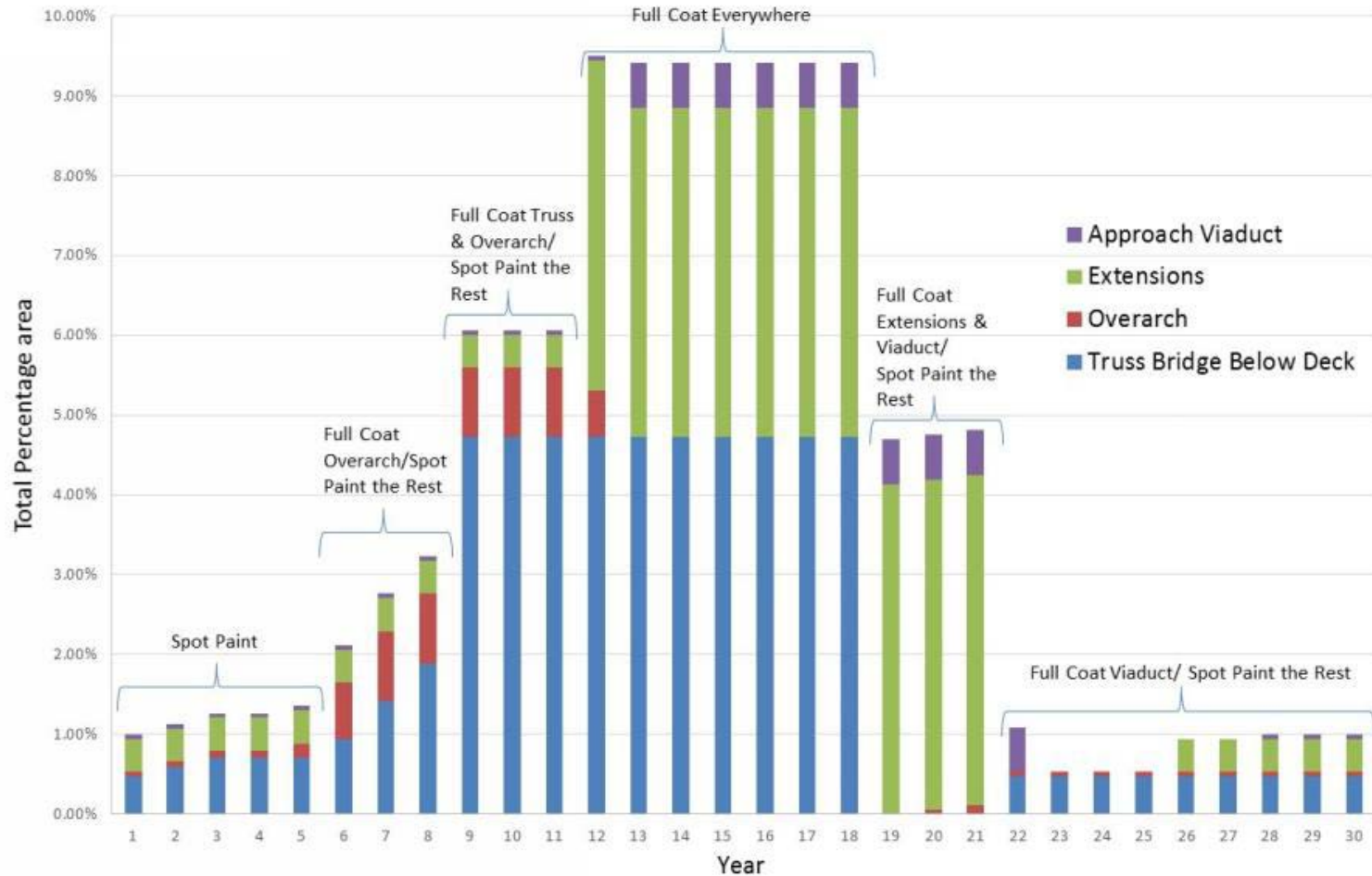


Key Issues

- Sensitive marine environment
- Load restrictions
- Huge surface area
 - 125,000 sq m / 1.35 M sq ft.
 - Requires protection
 - Significant painting program (\$0.5M per annum)



Existing Painting Program



Key Issues

- Increasing load demands
 - Already little redundancy
- Pending environmental restrictions
 - Resource consent related
 - Dust containment
“structure” required
- Current maintenance cost expected to increase....



With issues come opportunities!

- When challenged, we are forced to think differently
- Was there another way to deliver an improved LoS at the same cost, or
- Deliver the same LoS at a lower cost?



Asset
Managers
Dream!

Solution

- Robust maintenance strategy which:
 - Reviewed and challenged existing coatings
 - Type
 - Application intervals
 - Required protection
 - Different scenarios assessed
 - NPV analysis
 - Optimum strategy identified



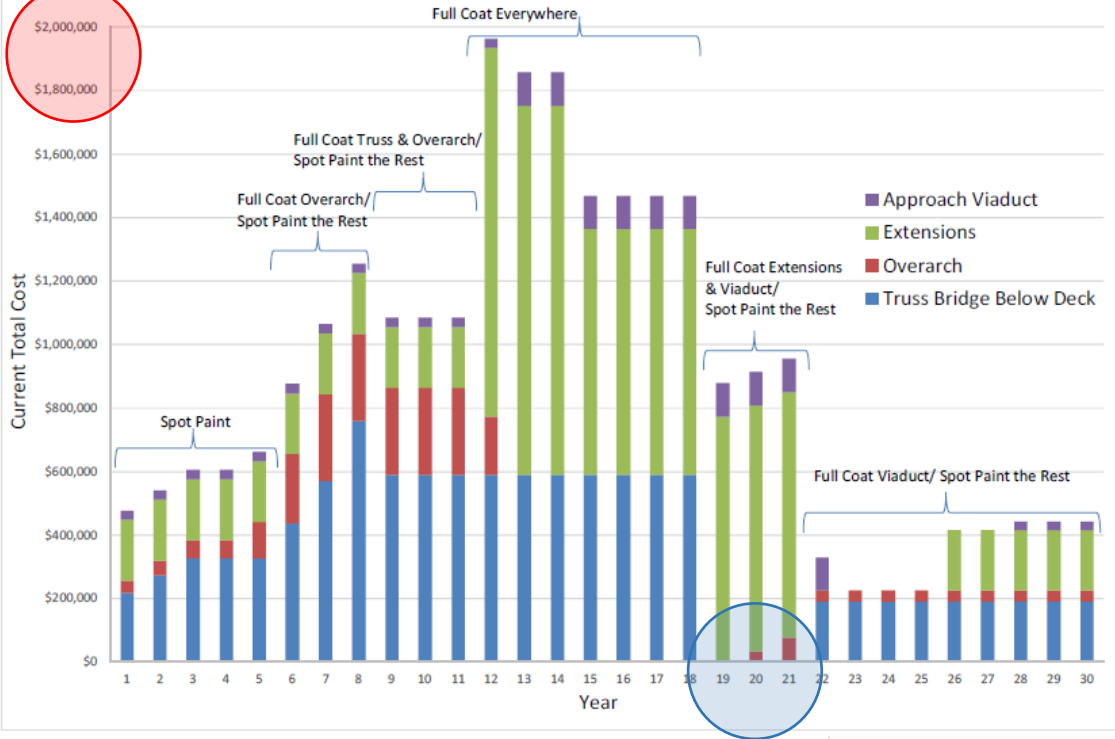
NPV Analysis

Scenario 1

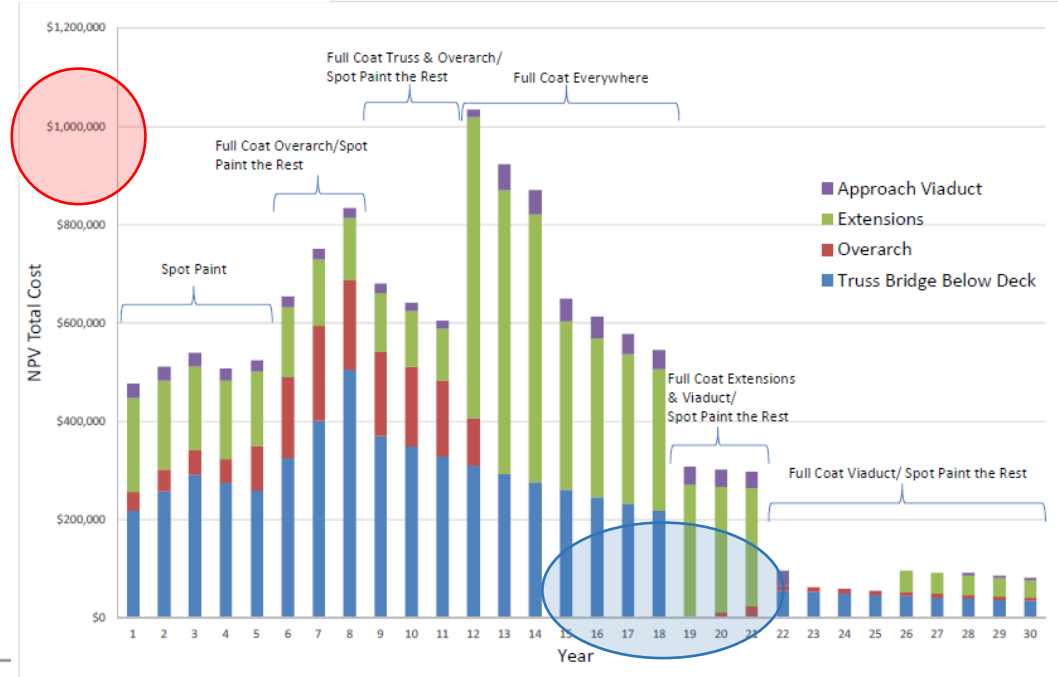
Actual Year	%Area Maintained of Truss Bridge	Paint Option	Area (m ²)	%Area Maintained of Overarch	Paint Option	Area (m ²)	%Area Maintained of Extensions	Paint Option	Area (m ²)	%Area Maintained of Viaduct	Paint Option	Area (m ²)	Total Current Cost ⁽¹⁾ \$/total m ²	NPV ⁽²⁾ for DR ⁽³⁾ 6% \$/total m ²
1	1.00%	Spot MCU	590	1.00%	Spot MCU	73	1.00%	Spot MCU	517	1.00%	Spot MCU	70.00	3.82	3.82
2	1.25%	Spot MCU	738	1.25%	Spot MCU	91	1.00%	Spot MCU	517	1.00%	Spot MCU	70.00	4.33	4.08
3	1.50%	Spot MCU	885	1.50%	Spot MCU	110	1.00%	Spot MCU	517	1.00%	Spot MCU	70.00	4.84	4.31
4	1.50%	Spot MCU	885	1.50%	Spot MCU	110	1.00%	Spot MCU	517	1.00%	Spot MCU	70.00	4.84	4.06
5	1.50%	Spot MCU	885	3.00%	Spot MCU	219	1.00%	Spot MCU	517	1.00%	Spot MCU	70.00	5.30	4.20
6	2.00%	Spot MCU	1180	15.00%	Full Termarust	1095	1.00%	Spot MCU	517	1.00%	Spot MCU	70.00	7.45	5.57
7	3.00%	Spot Termarust	1770	15.00%	Full Termarust	1095	1.00%	Spot MCU	517	1.00%	Spot MCU	70.00	8.52	6.00
8	4.00%	Spot Termarust	2360	15.00%	Full Termarust	1095	1.00%	Spot MCU	517	1.00%	Spot MCU	70.00	10.03	6.67
9	10.00%	Full Termarust	5900	15.00%	Full Termarust	1095	1.00%	Spot MCU	517	1.00%	Spot MCU	70.00	8.68	5.44
10	10.00%	Full Termarust	5900	15.00%	Full Termarust	1095	1.00%	Spot MCU	517	1.00%	Spot MCU	70.00	8.68	5.14
11	10.00%	Full Termarust	5900	15.00%	Full Termarust	1095	1.00%	Spot MCU	517	1.00%	Spot MCU	70.00	8.68	4.84
12	10.00%	Full Termarust	5900	10.00%	Full Termarust	730	10.00%	Full MCU	5170	1.00%	Spot MCU	70.00	15.71	8.28
13	10.00%	Full Termarust	5900	0.00%	No Painting	0	10.00%	Full MCU	5170	10.00%	Full Termarust	700.00	14.85	7.38
14	10.00%	Full Termarust	5900	0.00%	No Painting	0	10.00%	Full MCU	5170	10.00%	Full Termarust	700.00	14.85	6.96
15	10.00%	Full Termarust	5900	0.00%	No Painting	0	10.00%	Full Termarust	5170	10.00%	Full Termarust	700.00	11.75	5.20
16	10.00%	Full Termarust	5900	0.00%	No Painting	0	10.00%	Full Termarust	5170	10.00%	Full Termarust	700.00	11.75	4.90
17	10.00%	Full Termarust	5900	0.00%	No Painting	0	10.00%	Full Termarust	5170	10.00%	Full Termarust	700.00	11.75	4.63
18	10.00%	Full Termarust	5900	0.00%	No Painting	0	10.00%	Full Termarust	5170	10.00%	Full Termarust	700.00	11.75	4.36
19	0.00%	No Painting	0	0.00%	No Painting	0	10.00%	Full Termarust	5170	10.00%	Full Termarust	700.00	7.03	2.46
20	0.00%	No Painting	0	1.00%	Spot Termarust	73	10.00%	Full Termarust	5170	10.00%	Full Termarust	700.00	7.31	2.42
21	0.00%	No Painting	0	2.00%	Spot MCU	146	10.00%	Full Termarust	5170	10.00%	Full Termarust	700.00	7.64	2.38
22	1.00%	Spot Termarust	590	1.00%	Spot Termarust	73	0.00%	No Painting	0	10.00%	Full Termarust	700.00	2.64	0.78
23	1.00%	Spot Termarust	590	1.00%	Spot Termarust	73	0.00%	No Painting	0	0.00%	No Painting	0.00	1.80	0.50
24	1.00%	Spot Termarust	590	1.00%	Spot Termarust	73	0.00%	No Painting	0	0.00%	No Painting	0.00	1.80	0.47
25	1.00%	Spot Termarust	590	1.00%	Spot Termarust	73	0.00%	No Painting	0	0.00%	No Painting	0.00	1.80	0.44
26	1.00%	Spot Termarust	590	1.00%	Spot Termarust	73	1.00%	Spot MCU	517	0.00%	No Painting	0.00	3.33	0.77
27	1.00%	Spot Termarust	590	1.00%	Spot Termarust	73	1.00%	Spot MCU	517	0.00%	No Painting	0.00	3.33	0.73
28	1.00%	Spot Termarust	590	1.00%	Spot Termarust	73	1.00%	Spot MCU	517	1.00%	Spot Termarust	70.00	3.53	0.73
29	1.00%	Spot Termarust	590	1.00%	Spot Termarust	73	1.00%	Spot MCU	517	1.00%	Spot Termarust	70.00	3.53	0.69
30	1.00%	Spot Termarust	590	1.00%	Spot Termarust	73	1.00%	Spot MCU	517	1.00%	Spot Termarust	70.00	3.53	0.65
31														

Total NPV Cost/m ²	\$109
Total NPV for 30 years	\$13,609,672.49

Current Maintenance Strategy NPV > \$30M over 30 years



New Maintenance Strategy NPV \$13.6M over 30 years



The outcomes....

- New maintenance strategy that:
 - Achieved more
 - enviro
 - In
 - Safety
 - Asset Managers Dream!
 - Dis
 - Same risk profile
 - More cost effective than existing



The Paradigm Challenging enablers....

- Asset management thinking:
 - Lifecycle costs
- Change in status quo
 - New environmental policies
- Supplier agnostic consultant
 - What's best for client
 - Not best for supplier
- Materials and deterioration experts
- Asset performance data



CASE STUDY TWO: BRIDGE STRENGTHENING PROGRAM

Sea to Sky Highway, Canada



Background



Problem Statement

- Ageing Bridge Stock
- Increased loadings
 - Volume
 - Mass
- Insufficient \$\$ for Resulting Strengthening / Replacement Program



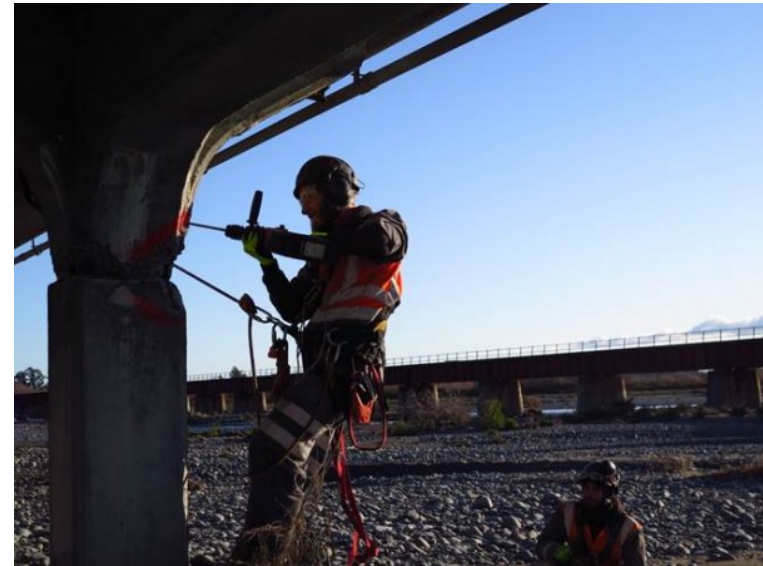
But....

- How well are the bridges understood?
- In bridge design:
 - Material strength reduction factors
 - Workmanship reduction factors
 - Loading multiplication factors
 - Estimates around deterioration rates and design life
- Time to ask the real question:
 - Perhaps there is some redundancy?



Methodology

- Understand in situ bridge performance
 - Stress gauges
 - Displacement gauges
 - Accelerometers
 - Add proof loading
 - Materials testing
- Revisit bridge strength
 - Review design vs actual
 - Identify redundancy
 - Program work accordingly



Result

- **Redundancy identified!**
 - Extend bridge life
 - Extend bridge loading
 - Reduce extent of strengthening work
- **Resulting program**
 - More affordable
 - More practical
 - Proactively managed risk (inspections)



The Paradigm Challenging enablers....

- Asset management thinking:
 - Level of service, deterioration modelling
 - Challenging design assumptions
- Change in status quo
 - New vehicle mass policy
- Materials and deterioration experts



SUMMARIZING

Life in the 21st Century....

- Asset Resilience
- Asset Redundancy



Budgets Squeezed!

- Network Demand
- Environmental Outcomes
- Health & Safety Outcomes



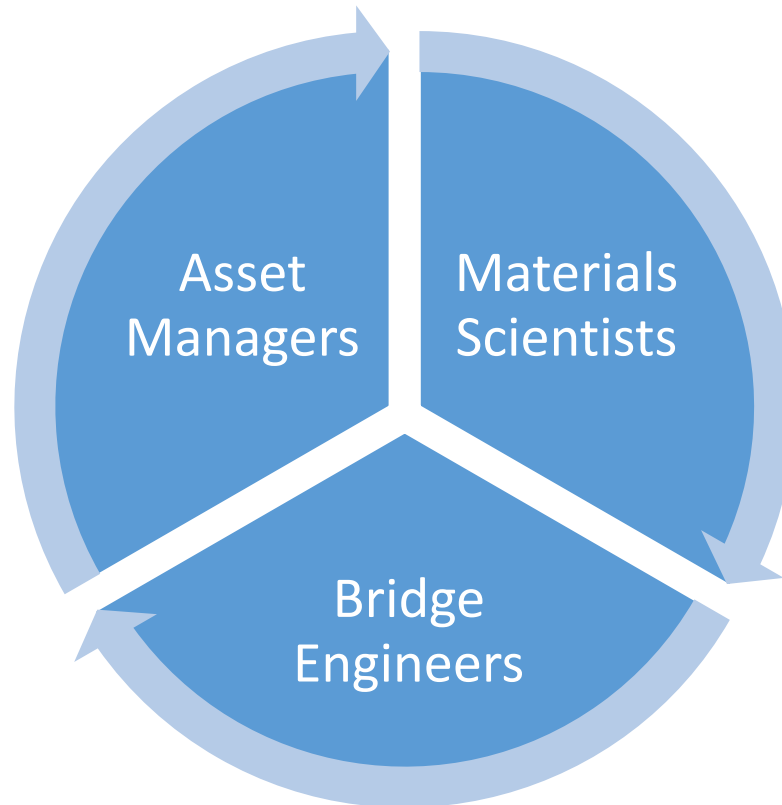
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- More problems = more \$\$\$
- But we can we challenge that!

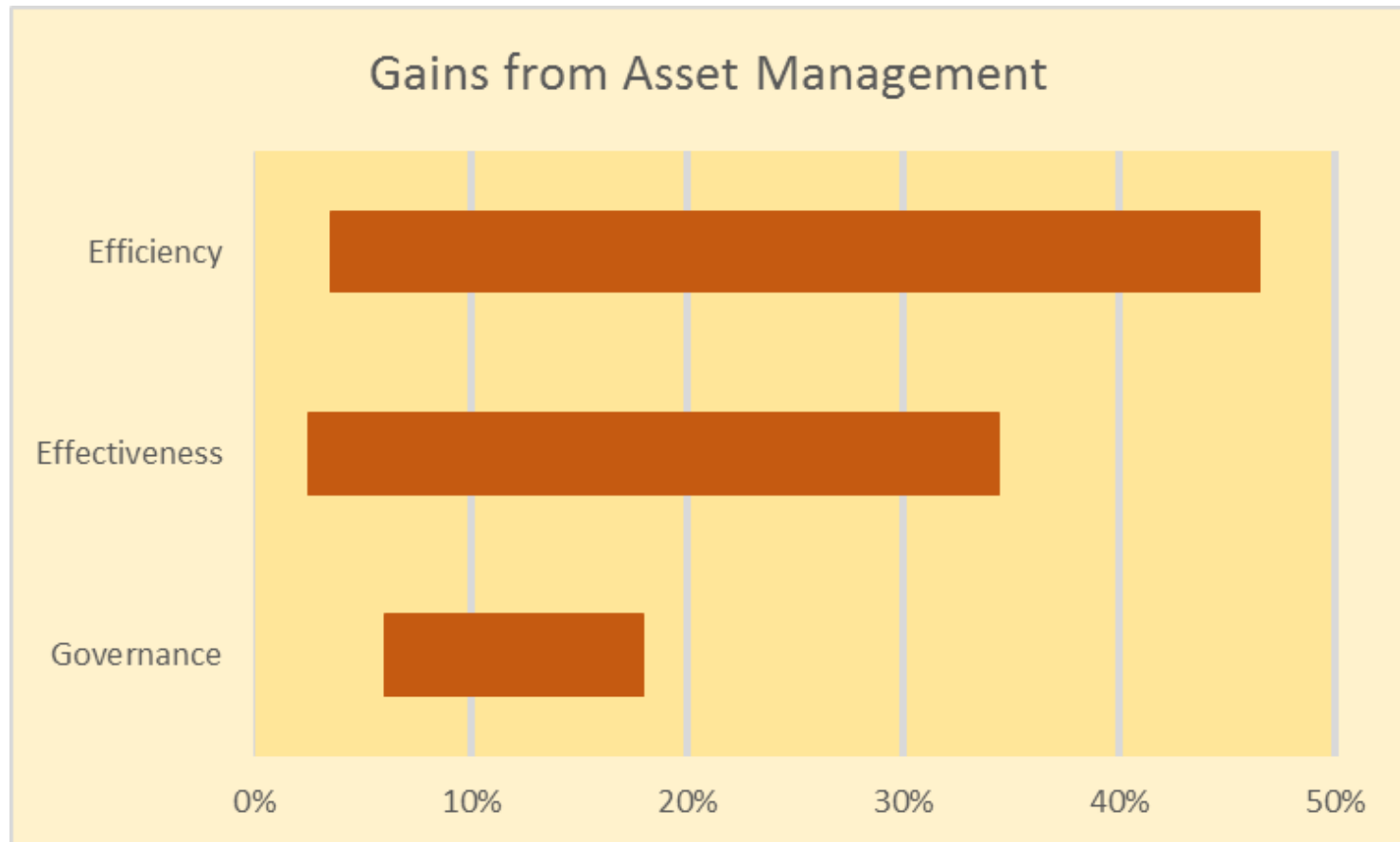


“If everyone is moving forward together,
then success takes care of itself”

Henry Ford – American Industrialist



There are savings to be made



Acknowledgements

- Simon Bush – Opus New Brunswick



- Raed El Sarraf – Opus Auckland



- Willy Mandeno – Opus Wellington



A photograph of the Mackinac Bridge, a large suspension bridge with green steel trusswork and white concrete towers, spanning across a body of water under a clear blue sky. The bridge is the central focus of the image, extending from the foreground towards the horizon.

THANK YOU FOR LISTENING

QUESTIONS?

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Mackinac Bridge, Michigan, USA

