It’s time for a fresh look at bridges
National Local Government Infrastructure & AM Conference – June 19
Tim Heldt, Neal Lake, Joshua Seskis
Agenda

• Australian local government bridge context
• The bridge management roadmap - past and future
• Industry current state - bridge management
• Risk – what is it and how does it help
• Performance – demand, stakeholders - “must have” vs “nice to have”
• Bridge structural assessment – where are we now and where are we going?
• Conclusions & Recommendations – It’s time for a fresh look at bridges
• P.S…. Engineering assessment frameworks
Australian LG bridge context

- ALGA – NSoA Report 2018 – Bridges**
- Capacity noted – condition and function similar
- Replacement value circa $14 B
- Timber still dominant material
- Bridges commonly 50-70 years old
- Approaching/in the higher maintenance period of life
- Heavy vehicle task often greater than envisaged in design
- Limited funds for inspection and maintenance – replacement?
- Decisions...Decisions...

** Australian Local Government Association
National State of the Asset Report November 2018
Roadmap
past & future
Bridge management - The “state” journey from maintenance management to AM

This will take a while…

Now

MAINTENANCE MANAGEMENT

Current State

Then

ASSET MANAGEMENT

Future State

GARAGE

NEED A VEHICLE
Bridge (maintenance) management now…
Framing the current state…focus…data…and the nature of decisions…
Bridge asset management – target framework

Framing the future state... focus... data... and the nature of decisions...

- Organisation journey required
- Improve existing business processes
- Cultural change
- System development
- Time and investment required – continual improvement
The Vehicle
to travel from Current to Future State
Garage
Transforming the vehicle...

Value to all stakeholders
Structured, Innovative management

VALUE
ALIGNMENT
LEADERSHIP
ASSURANCE

Transparent, simplified processes
Organisation’s assets, great culture, motivated staff

Reference: Institute of Asset Management and aligns to AS55001
Industry Current Practice
Bridge Management - the evolving journey…

• Bridge Management state of the art (IABMAS 18, Melbourne)
  • Bridge management systems world wide are generally similar and lack AM rigour – Bridge Maintenance Strategies – A brief comparison among different countries around the world (Scutaru, M. C. et al, 2018)
  • Data driven bridge management is in its infancy - Long Term Bridge Performance Program Status and Preliminary Results (Johnson, B. V., et al, 2018)
  • Bridge risk management needs an overhaul - Bridge Risk Management: Credibility Gaps (McCarten, P., 2018)

• AM principles have impacted other sectors to significant advantage
### Bridge Management - score card 2019 – current state

<table>
<thead>
<tr>
<th>What we do OK…</th>
<th>What we don’t do well…</th>
<th>What does it mean…</th>
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</thead>
<tbody>
<tr>
<td>Increasing use AM principles</td>
<td><strong>Focus on decision inputs</strong></td>
<td>Limited effectiveness and efficiency</td>
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<tr>
<td>Collect historical data…?</td>
<td><strong>Document decisions</strong></td>
<td>Better decisions faster</td>
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<tr>
<td>Collect condition data</td>
<td>Document basis for decisions</td>
<td>Increased liability</td>
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<tr>
<td>Collect capacity data…?</td>
<td>Link decisions (line of site)</td>
<td>Limited continual improvement</td>
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Example agency…Bridges Servicing & Rehabilitation

Typical funding needs vs allocation
– engagement around “Cost”, not “Performance” & “Risk”
Difficult when “Risk” & “Performance” have poor definition.

CAPITAL EXPENDITURE ALLOCATION
(% CALCULATED NEEDED)
• Typically 20% annually

OPERATIONAL EXPENDITURE ALLOCATION
(% CALCULATED NEED)
• Typically 70% annually
Risk - What is it, How does it help?
How to understand Risk - Recent Bridge Failures?

Russian Footbridge New Years 2018

2018 Genoa Morandi Bridge collapse **43 Fatalities** – cause? poor maintenance, non seismic footing design & overload

NZ Waiho bridge collapse March 2019. Rocks and water flow strike bridge during storm Sth Island West Coast
Recent Example…so do we Understand Risk?

- 14 year old bridge with halving joints
- Level 2 inspection program every 5 years
- 2018 L2 picked up some Halving Joints shear cracks in headstocks (not the girders) – Engineer review triggered based on inspector observations
- L3 requested and completed
  - Worst cracks more severe than anticipated
  - Numerous cracks not picked up in 2018 L2
  - Evidence that cracks not picked up in previous L2
  - Remediation plan under development
- Demonstrates the need for robust data collection, review, audit, and follow up
- Demonstrates condition inspection detecting defect that may be indicative of durability (condition) and capacity concerns
- FHWA (2001) – half of condition ratings (US) are likely to be erroneous – process needs to support people
- Broader focus than technical required…
Understanding Risk – a Key to Bridge Management (Quartile One)

Knowledge of risks exist but clear mechanisms to link risk, reputation, value and expenditure are unclear

RISK ASSESSMENT

After Risk Appetite Framework is developed and implemented

- Functional bridge risks defined
- Risks are identified and assessed using a clear risk appetite statement and risk tolerance
- Risks are effectively managed and reported against
- Facilitates both risk control and governance
- Links between risk, performance and cost transparent

- Inspection/Condition identifies defects – risk appetite unknown or undefined
- Mapping of defects to risk obscure
- Defects are only a subset of risks
Bow tie diagram reframes risk and risk control...

- Controls that minimise exposure
- Controls that detect and deflect threats
- Last chance intervention controls
- Protection controls
- Isolation/containment controls
- Recovery/restoration controls

Decreasing intervention time for ARRESTING CONTROLS

Increasing intervention time for MITIGATION CONTROLS
Shift focus to risk control & control effectiveness?

The cage and the gun are both controls in this scenario, which one is more effective?

Risk is determined by the effectiveness of controls.
Performance, demand, stakeholders & assessment
Base level of service required by your community?
Defining the “must have” and the “nice to have”

• Level of Service demand identification
  – Traffic (volume) capacity
  – **Structural capacity**

• What (structural capacity) does your community need (service levels & criticality defined?)
  – Heavy freight (that drives community outcomes)
  – Routine GML traffic
  – Routine sub-GML traffic & emergency use (school bus, fire truck)
  – *Which assets are critical to deliver economic/community performance (Criticality)*

• PBS and other permit vehicles – where do they fit?
  – Depends on the above

• Performance – Risk – Cost conversation?
Structural (capacity) assessment – now and then…

Current questions – answers – assumptions & basis…

• Where is the capacity data?
• Engineering assessment – bespoke and can cost quite a lot?
• Who pays for assessments and/or interventions?
• Baseline assessment underlying assumptions
  – Assumes condition “adequate” with no major defects (due diligence)
  – Assumes construction in accordance with design
  – History of use without known issues
Structural assessment – Austroads & other

Recent developments...and a baseline...

- Austroads - TP1951: Implementation of a Nationally Consistent Framework for the Assessment of Bridges in Australasia
- Austroads – TP1952: Higher Order Bridge Assessment in Australia
- **Tier 1 - Line model comparison against design load/criteria**
  - Move to have this as a web-based platform
- Higher Tiers...
  - Structural assessment including capacity
  - Risk management vs intervention
Structural assessment – Tier 1 concept (TP1952)

Baseline question...Is this vehicle OK to cross that bridge?

• Assumptions
  – Condition “adequate”
  – Constructed to design
  – History of use
  – Design** load/era

** Design & assessment fundamentally different decision processes
Next Steps
Bridge management - Maintenance management to AM – your journey?

This will take a while…
Conclusions & Recommendations

Its time for a fresh look at bridges…

• Progress the journey from maintenance management to AM
• Establish measures of bridge performance and criticality
• Reframe the understanding of risk, controls, and effectiveness
• Engage in P-R-C conversations with
  – Other asset classes
  – Stakeholders – both internal and external

• And on Monday…
  – Stocktake your current state – process, people, technology
  – Progress the “low hanging fruit” – quantify performance and risk
  – Report on status and progress
  – Document asset decisions & basis for same – link to P-R-C
  – Focus bridge assessments on the above – wait if possible
Bridge Assessment Frameworks to incorporate SHM

• Technical Framing – AS5100.7
  - Prediction of loads and capacities
  - Underpinned by conventional engineering processes
  - Requires condition to be understood
  - Accommodates the use of load testing/structural health monitoring

• Management framing – AS/ISO13822
  – Risk informed management of assets
  – Cognisant of business outcomes
  – Significant benefits, but requires more sophisticated management processes

• Framing is organisation specific
AS5100.7 – Process and context

Assists quantification of structural behaviour

**Process**
- Understand condition
- Identify technical factors
- Determine loads
- Determine capacity
- Calculate rating
- Optional refinement
- Report
AS13822 Process and context

Assists quantification of risk and performance

**Process**
- Define **Objectives**
- Scenarios
- Preliminary assessment
- Detailed assessment
- Report
- Iterate

Diagram:
- Business Management
  - Structural Engineering
  - Structural Analysis
  - Asset Management
  - Business Management