CSIC Asset Management Workshop

28 September 2015
Agenda

10:00   Welcome and introduction
10:20   Value-based Asset Management
10:55   Infrastructure futureproofing
11:25   Coffee
11:40   Asset Information Management
12:10   Information Futureproofing
12:40   BIM and Condition Monitoring
12:50   BIM for existing infrastructure
13:00   Lunch
Agenda [looking ahead...]

13:45  Introduction to CSIC-2
14:00  International perspective of AM challenges
14:20  Breakout session – 1 (Identifying & Prioritising opportunities)
14:50  Coffee
15:10  Breakout session – 2 (Defining opportunities)
16:15  Wrap up and Next steps
16:30  Close
CSIC Asset Management Projects

Improve the effectiveness of infrastructure asset management

<table>
<thead>
<tr>
<th>Asset Management (Challenges of today)</th>
<th>Future proofing (Challenges of tomorrow)</th>
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<tbody>
<tr>
<td>Value based decision making</td>
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Value-based Asset Management

Raj Srinivasan, Ajith Parlikad
CSIC Asset Management Projects

Improve the effectiveness of infrastructure asset management

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What does “value” mean for infrastructure?

- The infrastructure provides value if it continues to perform its function
  - at the required quality
  - at an acceptable level of risk
  - incurring an acceptable level of expense

- Note 1: Individual assets seldom provide value by themselves
- Note 2: Assets can affect value through their interaction with other assets in the system
- Note 3: “Value” can mean different things to different people
How does asset management generate value?
## How is a value-based approach different?

<table>
<thead>
<tr>
<th></th>
<th>Cost-based (traditional)</th>
<th>Value-based (recommended)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core focus</td>
<td>Cost</td>
<td>Cost, Risk, Performance</td>
</tr>
<tr>
<td>Unit of analysis</td>
<td>Generally focusses on asset specific issues</td>
<td>Focusses on system level dependencies and business value</td>
</tr>
<tr>
<td>Management philosophy</td>
<td>Minimize expenditure while maintaining satisfying performance requirements</td>
<td>Maximize performance and minimise risk while satisfying budgetary constraints</td>
</tr>
<tr>
<td>Stakeholder focus</td>
<td>Decision maker</td>
<td>All stakeholders of the asset (e.g., owner, operator, user, regulator)</td>
</tr>
<tr>
<td>Impact on service</td>
<td>Maintain minimum service levels</td>
<td>Explore innovative approaches to improve service levels</td>
</tr>
<tr>
<td>Difficulty</td>
<td>Well established body of knowledge</td>
<td>Concepts not well understood in theory and practice</td>
</tr>
</tbody>
</table>
Systematic approach for value based decision making

A. Establish the Context
   A1 Set the scope and objectives
   A2 Define the problem statement
   A3 Determine the time period for evaluation

B. Value Mapping
   B1 Identify all stakeholders
   B2 Identify all stakeholders requirements and objectives
   B3 Identify the value elements that contribute to stakeholders requirements
   B4 Identify value metrics to assess each value elements
   B5 Determine how the asset can directly influence each of the value metrics
   B6 Determine how the asset can indirectly influence each of the value metrics
   B7 Determine the external factors that influences asset and value metrics
   B8 Determine the various intervention and control options
   B9 Identify and map the link between various factors to value generation
   B10 Determine the factors that influence the decisions

C. Value Assessment
   C1 Identify Modelling Requirements
   C2 Determine the potential techniques to encapsulate the modelling requirements
   C3 Develop the model
   C4 Perform sensitivity analysis and choose the best option
A. Establish the Context

• The main objectives of this stage are:
  – To clearly identify the objectives and scope
  – To define the problem
  – To determine the time period for evaluation
B. Value Mapping

- Main stage of the process
- Captures the value generation process
- Produces a value map as an output depicting
  - How the value is created
  - What influences or affects this value
  - How to control this value

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Value Map for Deep Tube Tunnels
C. Value Assessment

• The main objectives of this stage are:
  – Using value map, to identify the key modelling requirements for the identified problem
  – To determine potential techniques to model
  – To develop the model
  – To perform sensitivity analysis
  – To choose the best option
Case Study 1: Cambridgeshire County Council

- **Problem:** The council has to maintain around 1500 bridges. Budget constraints limit the amount of maintenance work that can be performed each year.

- **Approach:** Developed spreadsheet prioritisation tool based on value and criticality of different bridges.

- **Benefits:**
  - Confidence to justify expenditure and maintenance programming of the structures
  - Target limited resources to the benefit of the local communities
1. Establish context

• There are 1500 bridges and there is a budget constraint (£2.5 million/year)

• To allocate the OPEX for the bridge works, only a percentage of jobs can be selected

• Current method of prioritisation fails to differentiate between a low value bridge and a high value bridge

• Key question: How to identify the value of a bridge and how can this be used to prioritise the jobs for different bridges?
## Value assessment output

### Value of bridge

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Impact to Network</th>
<th>Road Classification</th>
<th>Traffic Volume</th>
<th>Integrated Transport</th>
<th>Heritage Status</th>
<th>VALUE SCORE</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huntingdon River Bridge</td>
<td>Minor impact on network</td>
<td>B road</td>
<td>&gt;1000 HGVs &amp; &gt;12500 veh/day</td>
<td>Bus route or strategically important</td>
<td>Listed or heritage structure</td>
<td>80</td>
<td>High</td>
</tr>
<tr>
<td>Alconbury Bridge</td>
<td>Minor impact on network</td>
<td>Unclassified (U)</td>
<td>0-10 HGVs &amp; &lt;200 veh/day</td>
<td>Bus route or strategically important</td>
<td>Listed or heritage structure</td>
<td>50</td>
<td>Medium</td>
</tr>
<tr>
<td>Whittlesford Railway Bridge</td>
<td>Major impact on network</td>
<td>A road/Strategic A road</td>
<td>501-1000 HGVs &amp; 7001-12500 veh/day</td>
<td>Bus route or strategically important</td>
<td>No heritage or local interest</td>
<td>80</td>
<td>High</td>
</tr>
<tr>
<td>Split Drove Junction</td>
<td>No impact on network</td>
<td>Unclassified (U)</td>
<td>0-10 HGVs &amp; &lt;200 veh/day</td>
<td>No bus route and or not strategically important</td>
<td>No heritage or local interest</td>
<td>20</td>
<td>Low</td>
</tr>
<tr>
<td>Milebrook Bridge</td>
<td>No impact on network</td>
<td>Unclassified (U)</td>
<td>0-10 HGVs &amp; &lt;200 veh/day</td>
<td>Bus route or strategically important</td>
<td>No heritage or local interest</td>
<td>30</td>
<td>Low</td>
</tr>
<tr>
<td>New Bedford River Bridge</td>
<td>Minor impact on network</td>
<td>Unclassified (U)</td>
<td>0-10 HGVs &amp; &lt;200 veh/day</td>
<td>No bus route and or not strategically important</td>
<td>No heritage or local interest</td>
<td>30</td>
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### Prioritisation of works

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Faults/Issue</th>
<th>Before (If work is not carried out)</th>
<th>After (If work is carried out)</th>
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<tbody>
<tr>
<td>Huntingdon River Bridge</td>
<td>Minor Safety Problem</td>
<td>Safety 80 (before) Safety 0 (after)</td>
<td>Safety 80 (after) HIGH 100</td>
</tr>
<tr>
<td>Alconbury Bridge</td>
<td>Minor Safety Problem</td>
<td>Safety 80 (before) Safety 20 (after)</td>
<td>Safety 60 (after) MEDIUM 60</td>
</tr>
<tr>
<td>Whittlesford Railway Bridge</td>
<td>Minor Safety Problem</td>
<td>Safety 60 (before)</td>
<td>Safety 30 (after) LOW 60</td>
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<td>Huntingdon River Bridge</td>
<td>Minor Safety Problem</td>
<td>Change in Risk 0</td>
<td>Change in Risk 20</td>
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<td>Change in Risk 20</td>
<td>Change in Risk 60</td>
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<td>Whittlesford Railway Bridge</td>
<td>Minor Safety Problem</td>
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<td>Change in Risk 30</td>
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<td>Classification HIGH 100</td>
<td>Classification MEDIUM 60</td>
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<td>Classification LOW 60</td>
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### Prioritisation of works

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Final Impact</th>
</tr>
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<tbody>
<tr>
<td>Huntingdon River Bridge</td>
<td>150</td>
</tr>
<tr>
<td>Alconbury Bridge</td>
<td>150</td>
</tr>
<tr>
<td>Whittlesford Railway Bridge</td>
<td>140</td>
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**CSIC**
Cambridge Centre for Smart Infrastructure and Construction

**EPSRC**
Engineering and Physical Sciences Research Council

**Innovate UK**
Technology Strategy Board

**UNIVERSITY OF CAMBRIDGE**
Case Study 2: London Underground Tunnels

• Problem: Seepages have occurred in several areas on the London Underground Bakerloo Line. Significant maintenance effort is required to prevent these issues affecting the reliability of the service.

• Approach: Use a value-based approach for choosing the best possible repair solution that provides the best value to stakeholders over 30 years.

• Benefits:
  – improve the ability to make good investment decisions and achieve maximum value benefits from a given level of investment.
  – provides a standardised approach for making decisions throughout LU.
Value Map for Deep Tube Tunnels
Value assessment output

**Benefits:**
- Improve the ability to make good investment decisions and achieve maximum value benefits from a given level of investment.
- Provides a standardised approach for making decisions throughout LU.

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### Business Impact

- **Acrylic Grouting**
- **Lead Caulking**

### Asset location in network

- **Repair Options**
  - Option 1
  - Option 2
  - Option 3
  - Option 4
Case Study 3: Surrey County Council

- Problem: A large number of highway safety barriers have been in use beyond their intended life. Justifying investment in replacing them is challenging due to their perceived low-value.

- Approach: Used the value-map to calculate the value of safety barriers at different locations optimised replacement timing.

- Benefits:
  - Enables a clear business case to be made to the Council for safety barrier replacement.
  - Provides a standardised value-based approach for making decisions throughout the Council.
Value Map for Safety Barriers

Intervention/Control options
- Inspection
- Replacement
  - Weather
  - Age
  - Weather
- Tensioning
- Tree falling
- Collision

External Factors
- Weather
- Age

Asset Related Factors
- Corrosion of metal
- Rotting of wood
- Tree falling
- Breakage of barriers

Value Influencing Factors
- Ability to withstand accidents (functionality)
- Risk contributed to network SPN
- Passenger fatalities and casualties
- Number of accidents and barrier impact
- Maintenance cost
  - Tensioning cost
  - Replacement cost
- CAPEX
- Replacement cost
- Disruption cost
  - Lane closure
  - Traffic management cost
- Journey Time

Value Metrics
- Service
- Reliability
- Costs
- Regulatory compliance
- Sustainability
- Reputation

Value Elements
- Safety
- Costs
- Meeting legal requirements
- Meeting budget requirements
- Meeting the requirements of local users (specification)

Stakeholder requirements
- Safe journey
- Protecting other assets
- Low maintenance
- Less disruptions
- De-cluttered highway

Stakeholders
- Users
- Council Highways
- Executive Management of County Council (Funders)
- Central government
- Adjacent Partners: Network Rail, Highways Agency, Environment Agency

CSIC Cambridge Centre for Smart Infrastructure and Construction
EPSRC Engineering and Physical Sciences Research Council
Innovate UK Technology Strategy Board
University of Cambridge
Value assessment output

<table>
<thead>
<tr>
<th>Damage Impact</th>
<th>Optimal replacement age years</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100 000</td>
</tr>
<tr>
<td>20</td>
<td>200 000</td>
</tr>
<tr>
<td>40</td>
<td>300 000</td>
</tr>
<tr>
<td>60</td>
<td>400 000</td>
</tr>
<tr>
<td>80</td>
<td>500 000</td>
</tr>
</tbody>
</table>

Bridge – Rail/Motorway
Bridge – Road/Canal/Stream
Central Reservation
Verge
Embankment
Private access
Road sign post

High Priority Road
B road
What’s next?

• Guidance document to be published by ICE
• 2 Journal papers in preparation
• Consultancy via IfM ECS
• Further research proposals (e.g. EPSRC, Innovate UK, Industry funded)
Guidance document

1. Introduction
   1. Purpose
   2. Scope
   3. Audience
   4. Structure

2. Value Driven Asset Management
   1. Overview
   2. Why value?
   3. What is value?
   4. Benefits

3. Whole life value process

4. Stage A: Establish Context
   1. Set scope and objectives
   2. Define the problem
   3. Determine time period

5. Stage B: Value Mapping
   1. Identify Stakeholders
   2. Identify Stakeholders requirements
   3. Identify value elements
   4. Identify value metrics
   5. Determine the direct factors that influence value
   6. Determine the indirect factors that influence value
   7. Determine the external factors
   8. Determine the various intervention and control options
   9. Identify and map the links
   10. Determine the decision influencing factors

6. Stage C: Value Assessment
   1. Identify modelling requirements
   2. Determine solutions to represent value
   3. Develop the model
   4. Sensitivity Analysis

7. Case Study
   1. London Underground Tunnels
   2. Surrey County Council Safety Barriers

8. Conclusions and Recommendations
Concluding remarks

- The process
  - ...provides a systematic methodology to make decisions based on WLV
  - ...provides clarity regarding the concept of asset value and how the value needs to be managed

- The value map
  - ...has the potential to become the cornerstone of infrastructure asset management strategy and planning when developed at the portfolio, system and asset levels
  - ...is an effective communication tool across the organisation to highlight the value generation process and value management options
  - ...enables the identification of information required to support AM

- We are only scratching the surface of value-based asset management!