MAIN LINE

Final Workshop

Paris

30 September 2014

SEVENTH FRAMEWORK PROGRAMME

This project is co-funded by the European Commission with the FP7

What is asset management?

- Asset Management is:

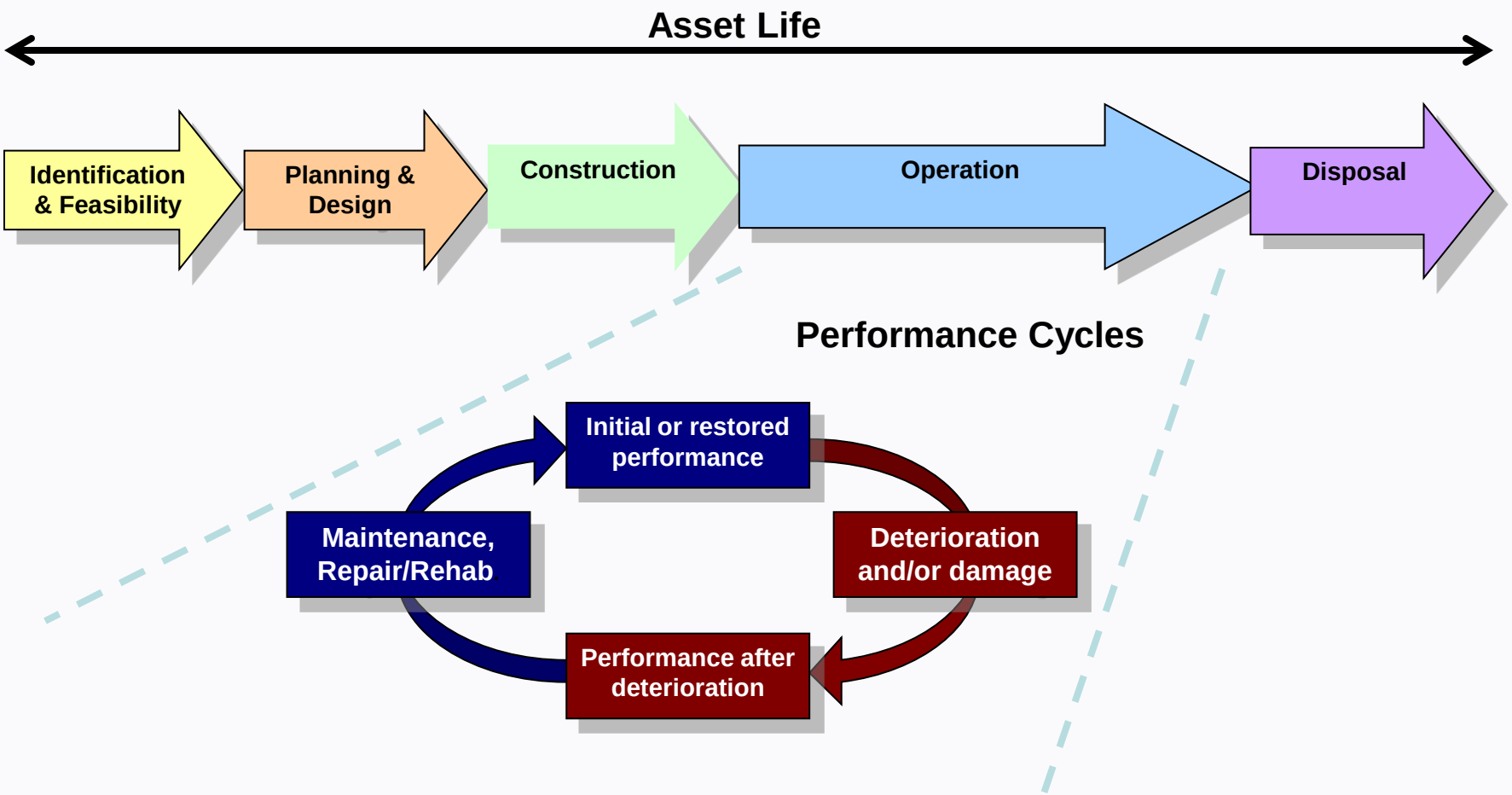
« *The coordinated activities of an organisation to realise value from physical assets* »

Definition from International Standard ISO 55000.

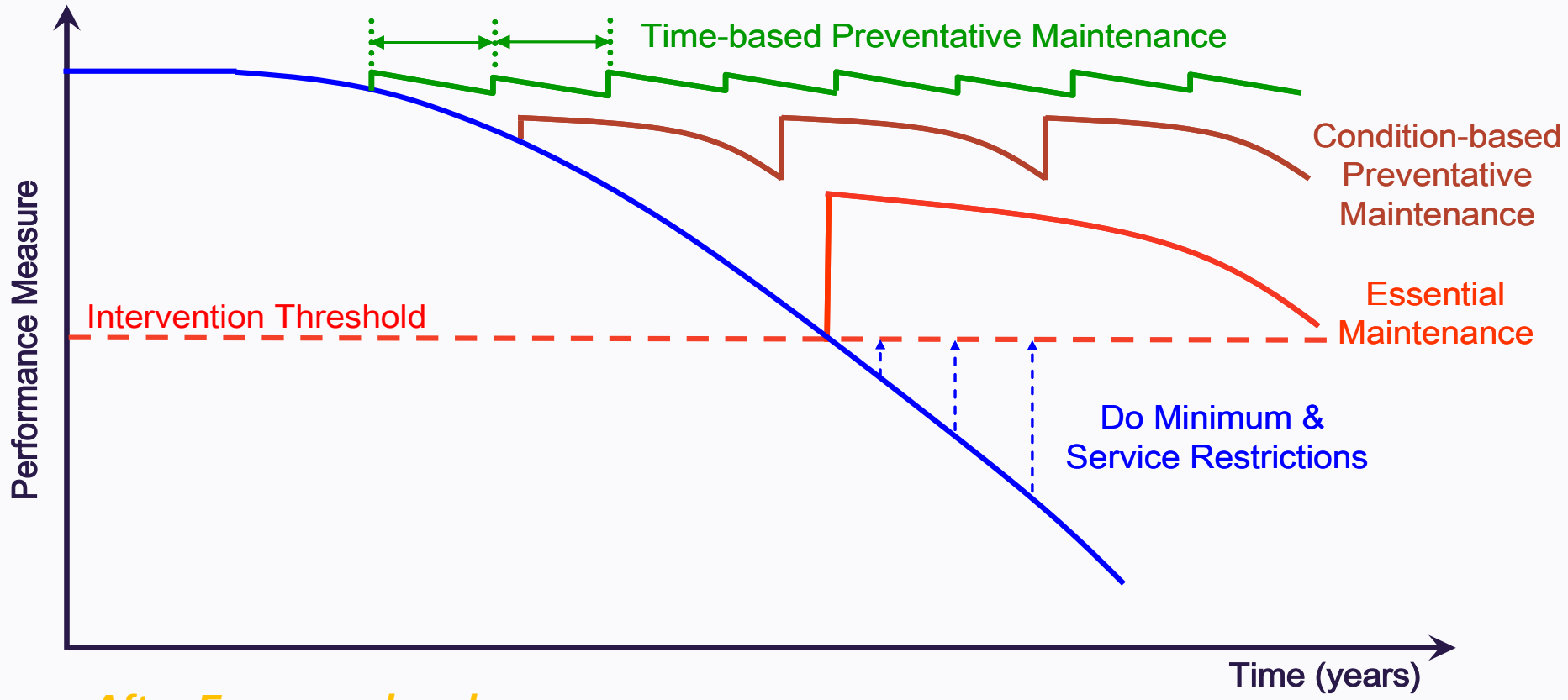
Why is asset management important?

- Asset Management helps Infrastructure Managers to:
  - Prioritise and justify works
  - Spend efficiently
  - Coordinate access/possessions
  - Define levels of safety and service

Degradation - Context



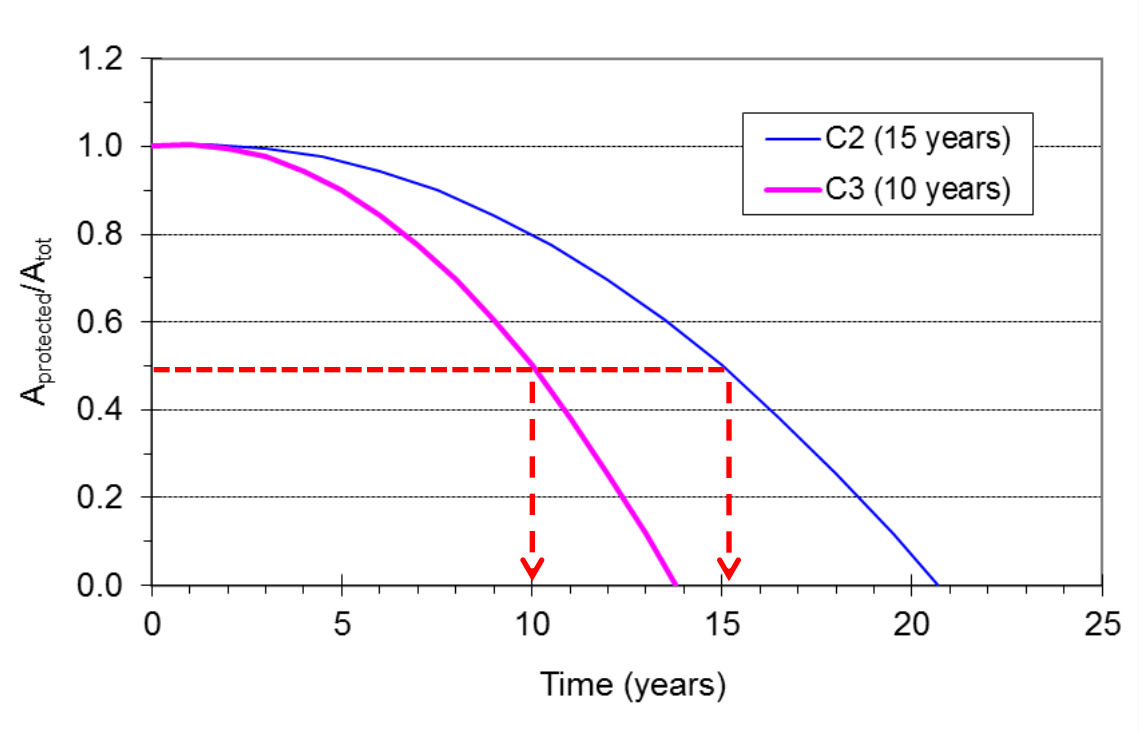
Degradation - Context



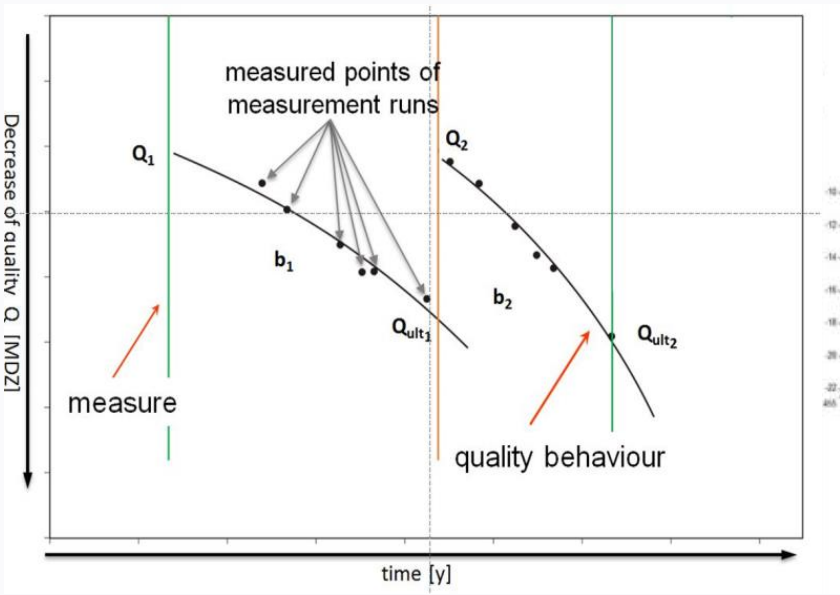
After Frangopol and co-workers, ca. 2000 -

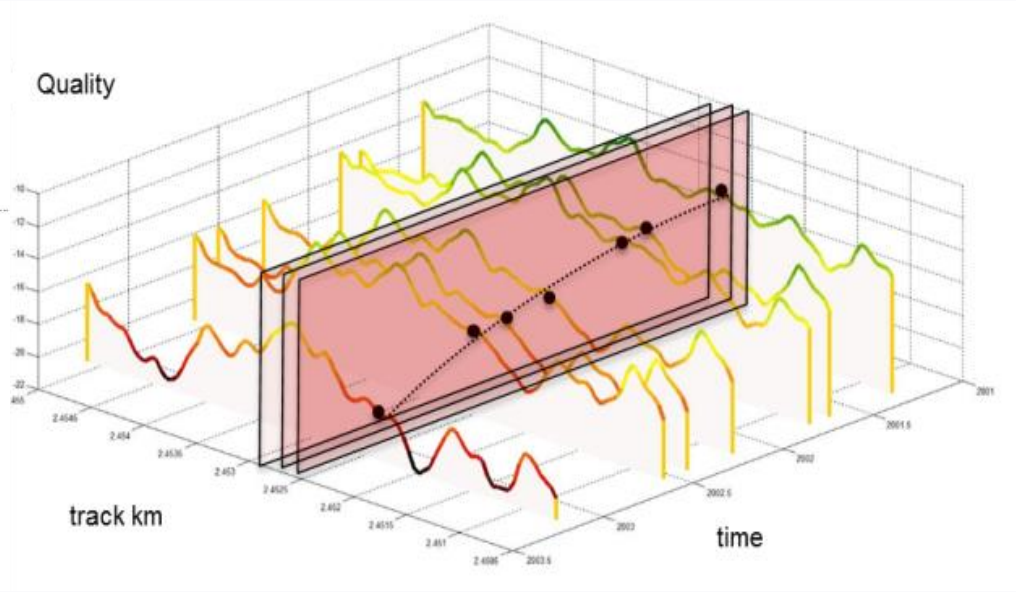
Example: Loss of coating

$$\frac{A_{pr}(t)}{A_{pr0}} = 1 - \left(\frac{0.6t^2}{T_L^2} - \frac{0.1t}{T_L} \right)$$



Example: Track Condition





$$Q_t = Q_n \times e^{b \times t}$$

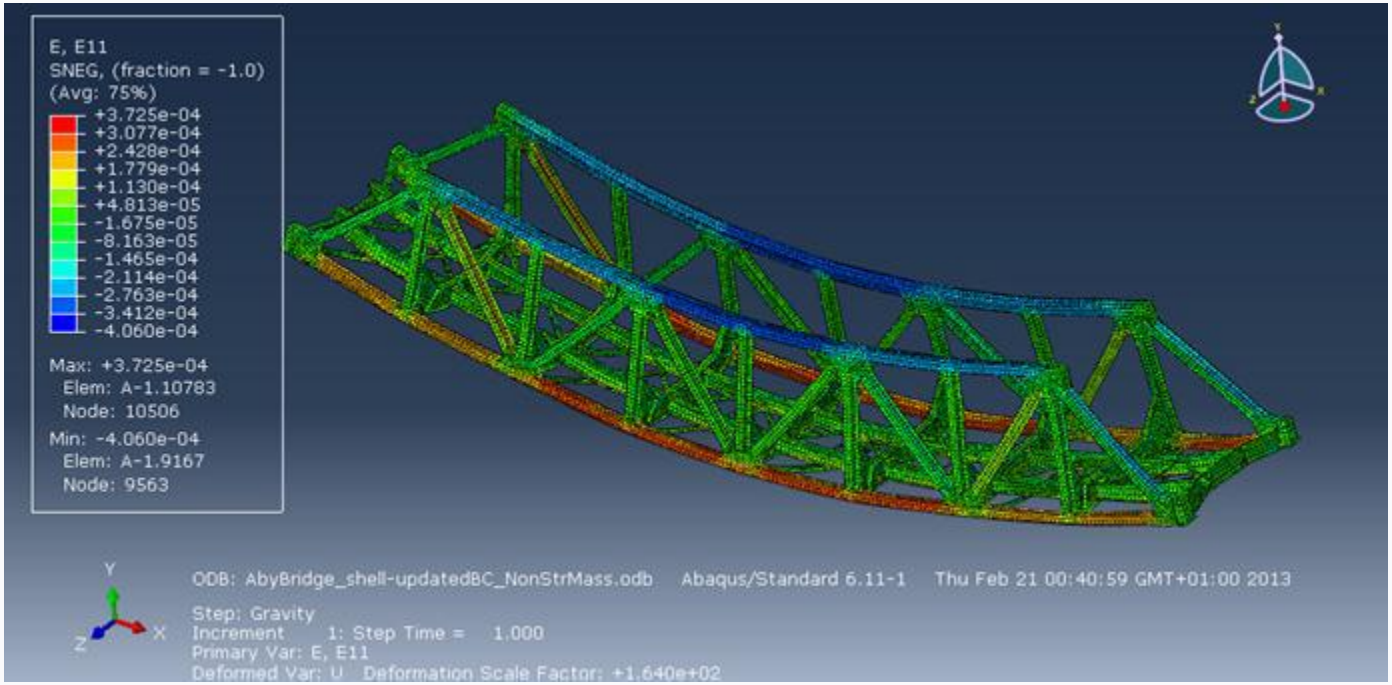
Deterioration rate, b, influenced by:

- Track alignment
- Subsoil condition
- Ballast quality
- Transport load
- …..

Degradation - Main Outcomes

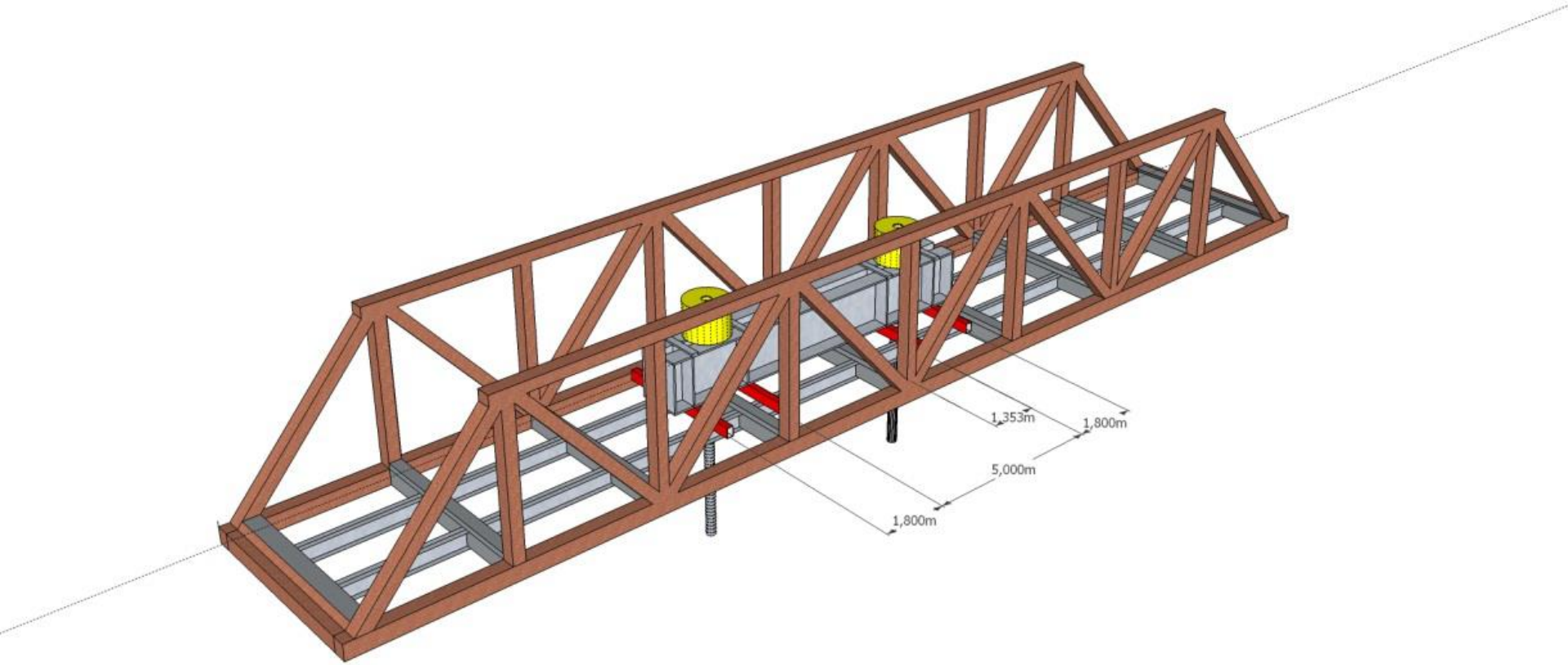
- Substantial progress on deterioration and performance modelling
  - Both physical and empirical models
  - Wide range of input conditions
  - Profiles suitable for LCA/LCC analysis
- Developed both condition and capacity based criteria for:
  - Soil cuttings
  - Track
  - Metallic bridges
  - Concrete lined tunnels
- Wide range of profiles developed for LCAT modelling
  - Representative condition-based profiles
  - Some capacity-based profiles (they need to be case specific)
  - Selection of intervention strategies
- Model validation has been carried out and could be extended as more field data become available

Advanced Assessment

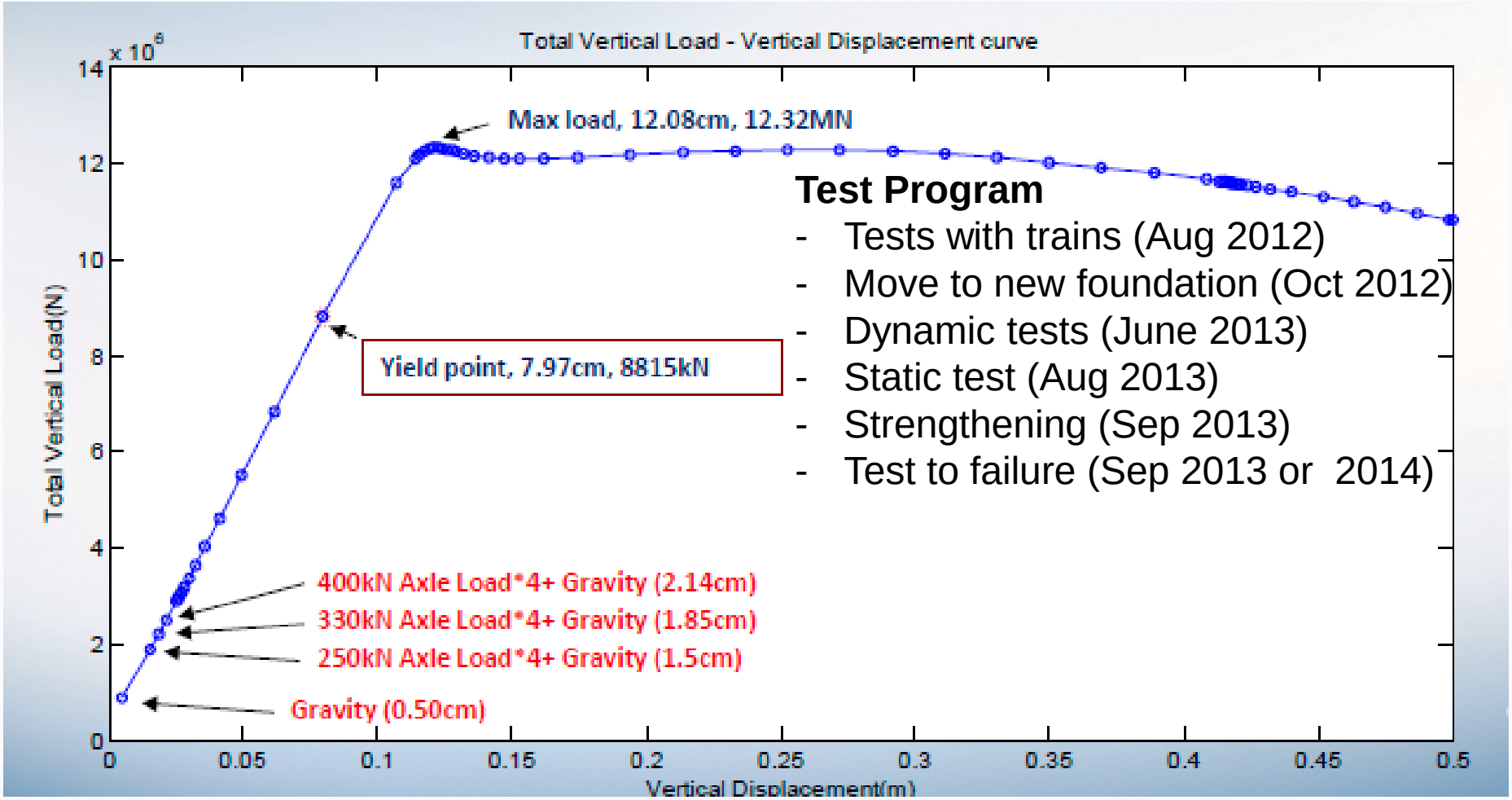


Global view of the E11 strain of deformed Åby Bridge under 250 kN axle load (including self-weight)

Loading to failure



Loading to failure – Abacus model



Test Program

- Tests with trains (Aug 2012)
- Move to new foundation (Oct 2012)
- Dynamic tests (June 2013)
- Static test (Aug 2013)
- Strengthening (Sep 2013)
- Test to failure (Sep 2013 or 2014)

Bridge Replacement

a) Preparation of ground works before launching new bridge.

b) Ground works completed and launching beams installed.

c) Hydraulic jacks instal
the bridge is lifted 5 cm an
position.

Table with main parameters for decision taking

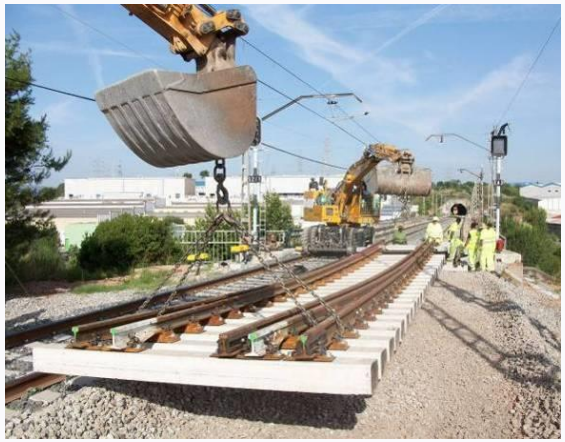
Track possession	☒ 10 days ☐ 1 month roadway below the track has to be closed for ~2 to 3 month
Replacement Design life/durability	☒ full Replacement ☐ partial Replacement ☒ 100 years ☐ 50 years ☐ 10 years
Risk	☒ negligible risk (well-known technology, standard) ☐ minor risk ☐ major risk

Bridge Replacement – Comparison Table

++ = yes + = may work — = no	Mobile Cranes	Rail Mounted Crane	Rail Mounted Bridge Carrier	Longitudinal Launching	Horizontal Launching	Deck Replacement
1. Bridge length						
1.1 Less than 5 m	++	++	++	++	++	++
1.2 5-20 m	++	++	++	++	++	++
1.3 More than 20 m	+	+	+	+	++	++
2. Bridge type to be exchanged						
2.1 Reinforced concrete beam bridge	+	+	++	++	++	++
2.2 Steel truss	++	++	+	++	++	++
2.3 Steel beam	++	++	++	++	++	++
2.4 Arch	+	+	+	+	+	+
2.5 Other	+	+	+	+	+	+
3. Track possession time						
3.1 Between 6-12 h	+	+	+	-	+	+
3.2 Between 12-24 h	++	++	++	+	++	+
3.3 Between 24-60 h	++	++	++	++	++	++
3.4 More than 60 h	++	++	++	++	++	++

S&C Replacement Methods

Excavators



Road cranes

Railway cranes

Crane-beam systems

Portal cranes (UWG/Geismar-Fasseta)

Modular switch

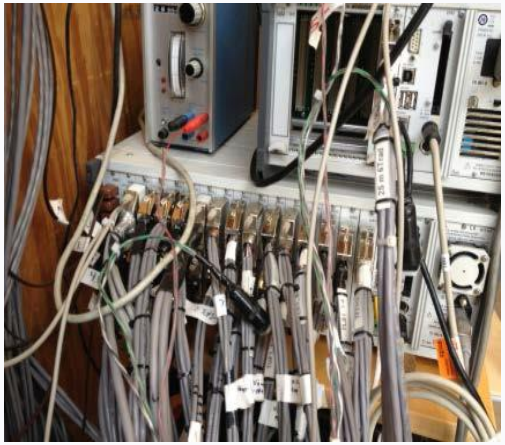
S&C Replacement : Comparison Table

	Output (duration of track possession; total S&C duration)	**Need of lineside space** (for S&C pre-assembly)	**Availability of the system** (is the machinery required widely available? Is its use extended?)	**Labour** (number of workers required for installation)	**Machinery Cost** (cost related to the use of machinery)	**Quality of installation** (is the switch carefully handled during transport and installation?)
Excavators	++	+	+++	+	+++	+
Road Cranes	++	+	+++	+	+++	+
Railway cranes (Kirow, etc.)	++	+	++	++	++	+++
Crane-beam systems (Desec TL1200, VAIACAR, etc.)	++	+	+	++	++	+++
Portal Cranes (UWG, Fasseta, etc.)	++	+	+	+ (UWG) +++ (Fasseta)	++	+++
Modular switch	+++	+++	+	+++	+	+++

+++ Excellent performance
++ Average performance
+ Poor performance

Monitoring Ǎby Bridge

(a)



(b)

(c)

Figures:

- (a)The setup for photometric measurements
- (b) Cables from sensors for measurements
- (c) Optical measurements of strains in the critical riveted connection between transverse and longitudinal beam (Blanksvard et al, 2014)

Data compatibility gaps and potential solutions

Identified Gap	Potential Solutions
Lack of consistent and reliable inspection data across Europe	Standardisation of the inspection assessment through a commonly accepted framework
Lack of established models	Use of field inspection data to develop empirical models; hybrid models
High cost of continuous monitoring and limitations of periodic inspection.	Monitor specific input parameters and avoid excess amount of data
Combining monitoring data (quantitative) with examination information (qualitative)	Develop appropriate decision support tools to combine all available information in an effective way

What is the LCAT?

The Life Cycle Assessment Tool (LCAT) can compare different maintenance/replacement strategies for railway infrastructure based on a life cycle evaluation, which quantifies:

- Direct economic costs
- Availability (delay costs / user cost)
- Environmental impact costs

The LCAT is a series of prototype models that:

- Are written using Microsoft Excel.
- Are flexible to suit different users across Europe.
- Can be adapted by users.

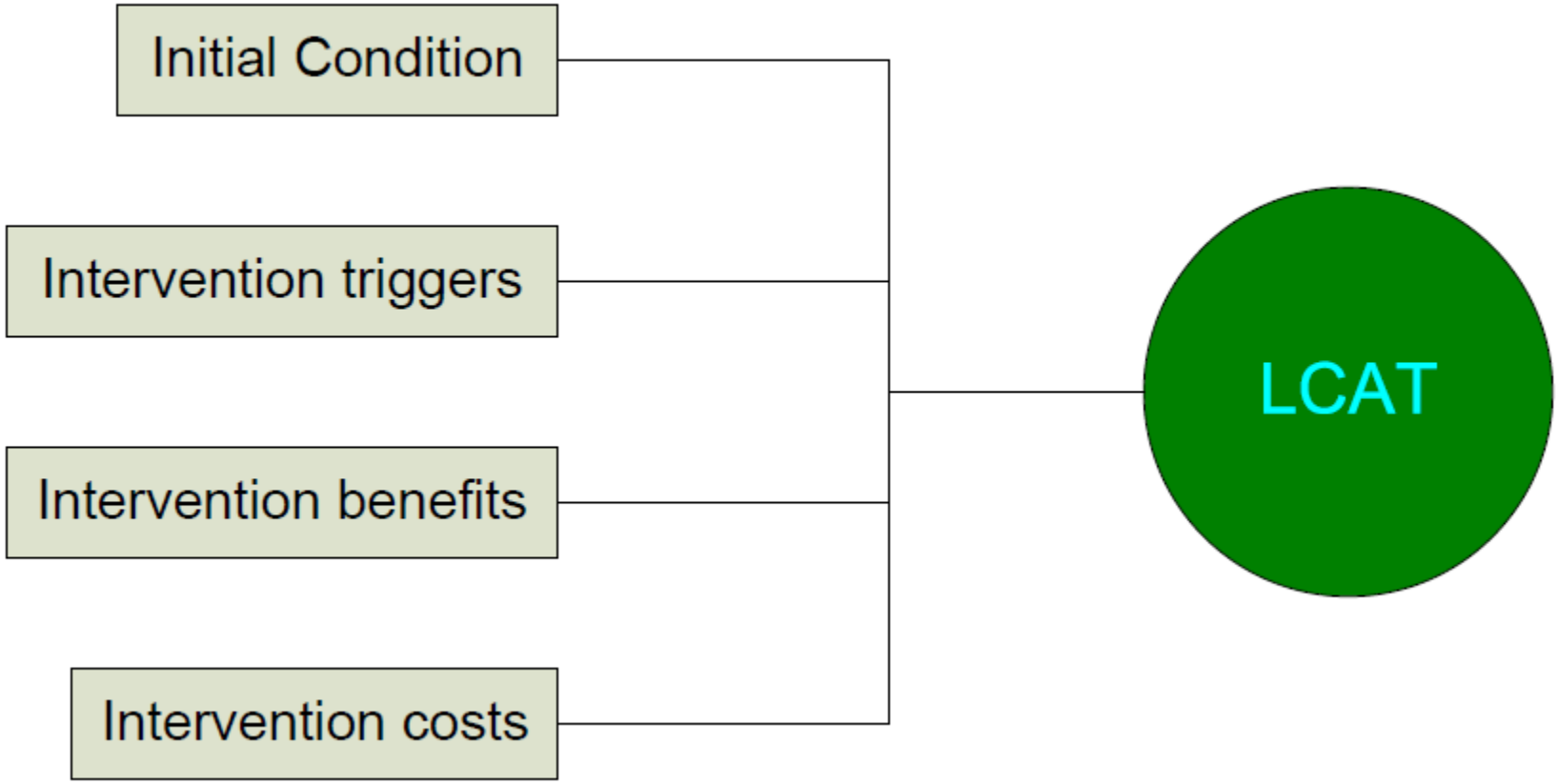
What is the LCAT?

Soil Cuttings

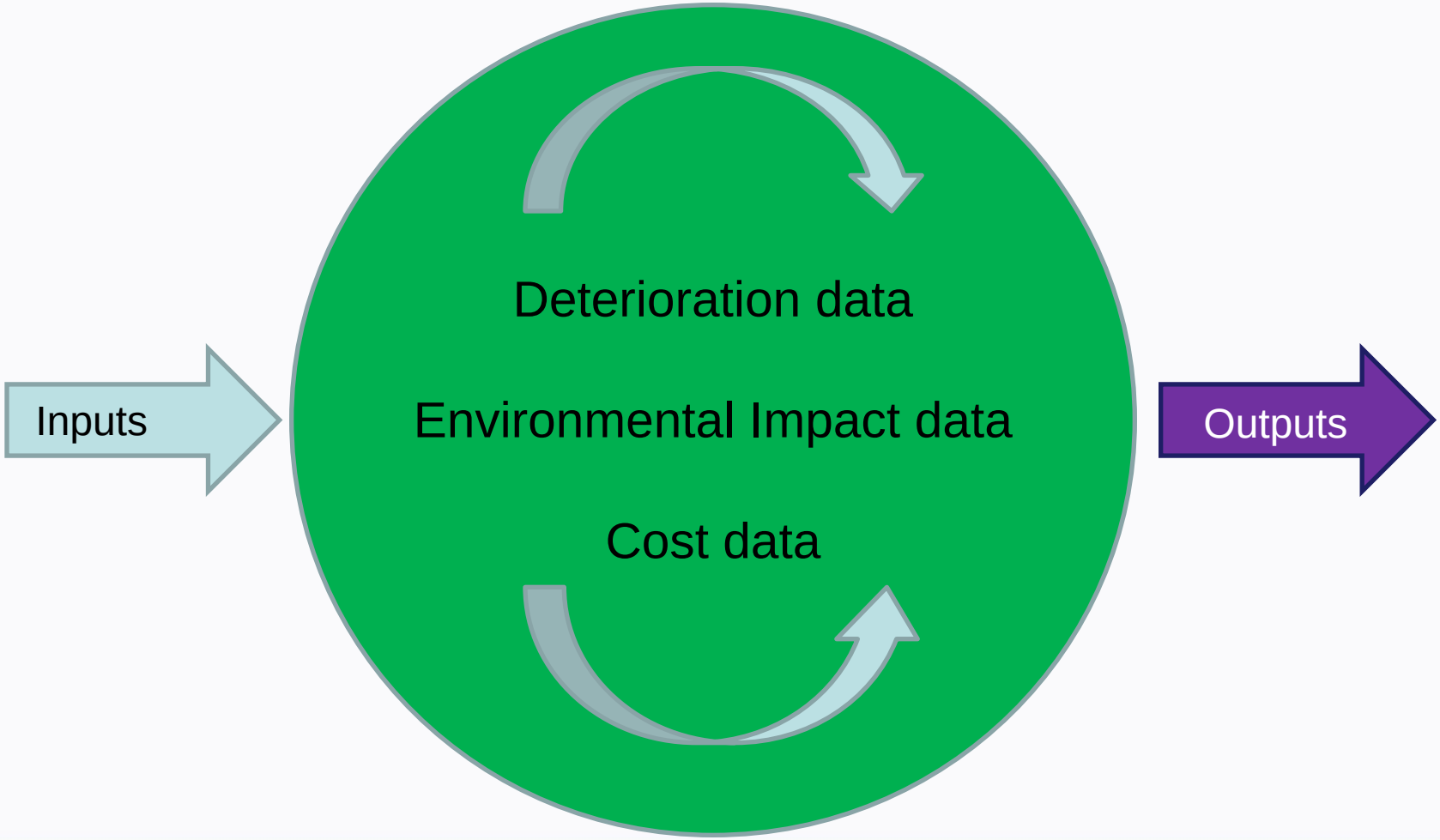
Track

Metal Bridges

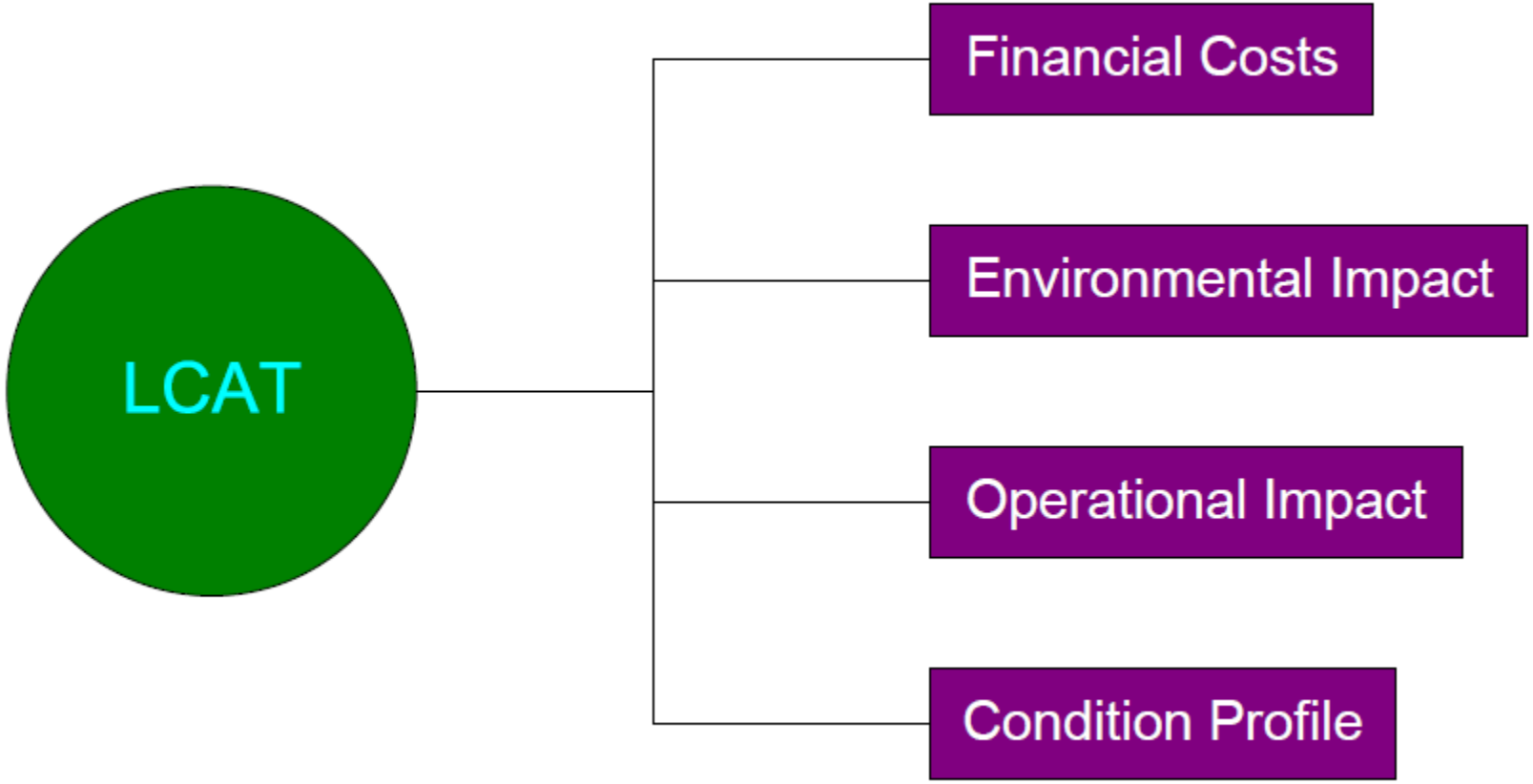
LCAT – Inputs


Initial Condition
Intervention triggers
Intervention benefits
Intervention costs
LCAT

LCAT – Processing



LCAT – Outputs



LCAT – Example Output

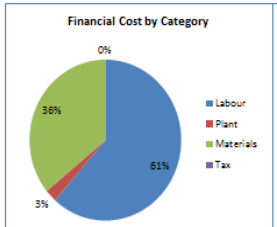
MAINLINE **Metallic Bridges Model**

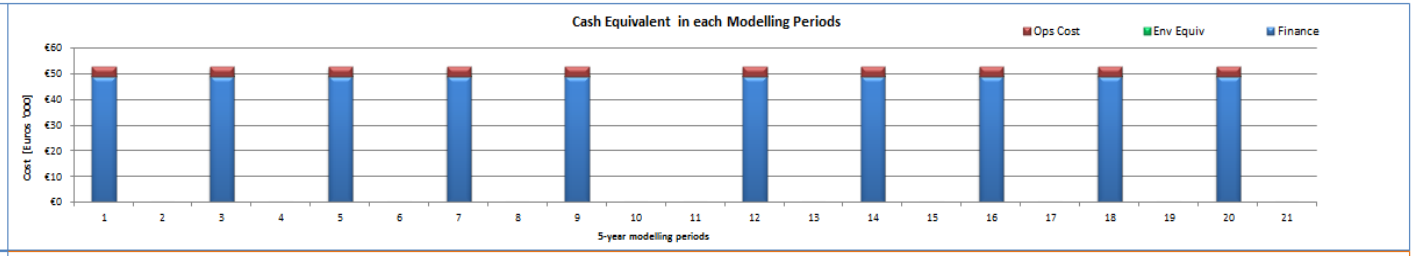
Summary of Costs & Condition

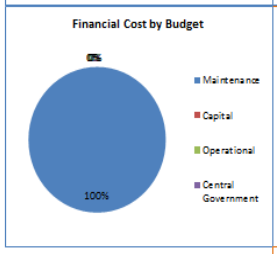
back to: Flowchart

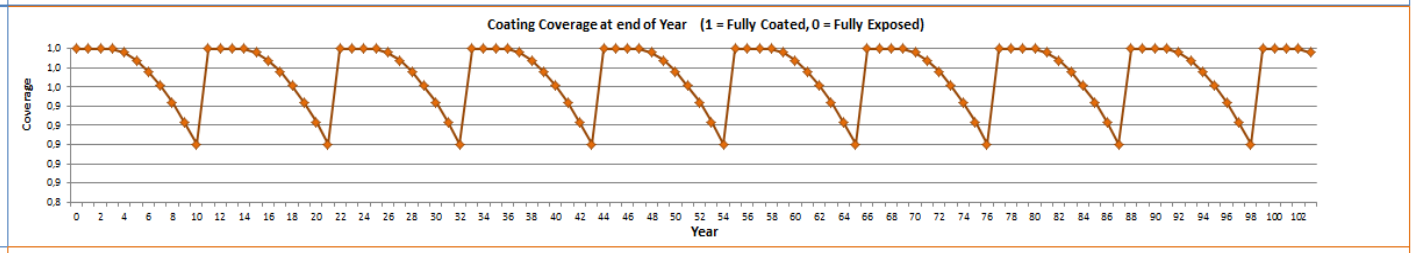
Years:	01-05	06-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	101-05
Period:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

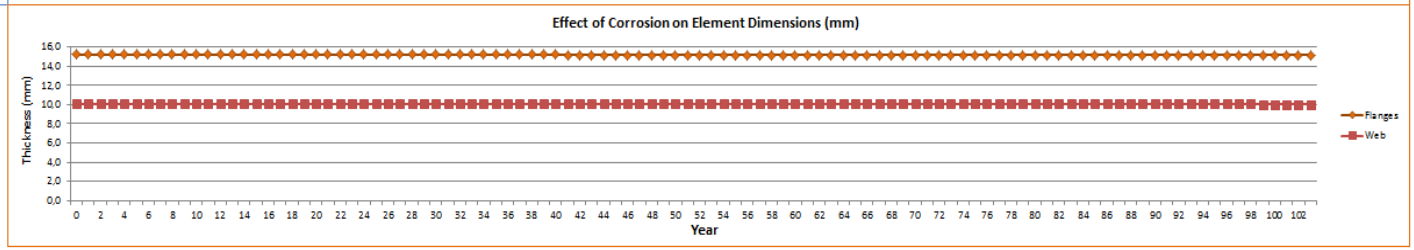
Interventions																							Financial Impacts
No	Name	Number	Intervention schedule																				Cash
1	Plating of Element (Strengthening)	0																					0
2	Re-coating of Element (Painting)	10	1		1		1		1		1			1		1		1		1		1		1.487.500
	All interventions	10	1	0	1	0	1	0	1	0	1	0	0	1	0	1	0	1	0	1	0	1	0	1.487.500
		Cash:	48.750	0	48.750	0	48.750	0	48.750	0	48.750	0	0	48.750	0	48.750	0	48.750	0	48.750	0	48.750	0	











Dissemination

- Transport Research Arena conference, Athens, 2012.
- CIRIA degradation modelling conference, London, 2012.
- FEHRL conference, Brussels, 2013.
- Railway Engineering conference, Cambridge, 2013.
- Transport Research Arena conference, Paris, 2014.
- MAINLINE Eastern European workshop, Budapest, 2014.
- IABMAS conference, Shanghai, 2014.
- MAINLINE LCAT training workshop 1, London, 2014.
- MAINLINE LCAT training workshop 2, Paris, 2014.
- MAINLINE book of final outputs.
- MAINLINE USB with LCATs.
- MAINLINE website.

Conclusions (1)

- The basis of future degradation profiles have been created for track, metallic bridges and soil cuttings.
- Methods for extending the life of assets have been identified, including advanced assessment and physical strengthening.
- Comparsion tables aid the selection of appropriate replacement techniques for bridges and swiches & crossings.
- Monitoring and examination provides evidence for extending asset life.

Conclusions (2)

- The LCAT is flexible to ensure relevance to all users.
- The LCAT is ‘open-source’, so there is no hidden code.
- Environmental and operational costs allow detailed evaluation between similar schemes.
- Outputs from individual schemes can be rolled-up to provide a network view of applying a particular strategy.

Opportunities

- MAINLINE has highlighted opportunities for possible work in the areas below:
  - Data gathering from different asset types
  - Fusion of data with modelling
  - Creation of a consistent data hierarchy for assets in Europe
  - Creation of formal degradation curves for materials/elements
  - Further refinement of LCAT models
  - Creation of LCAT models for different assets
  - Promotion of Lowest Life-Cycle Costing principles

Thank you !