The Söderström Bridge

COST Action TU1402 – Case study

John Leander, KTH Royal Institute of Technology
Dániel Honfi, RISE Research Institutes of Sweden
Ìvar Björnsson, Lund University
Oskar Larsson Ivanov, Lund University

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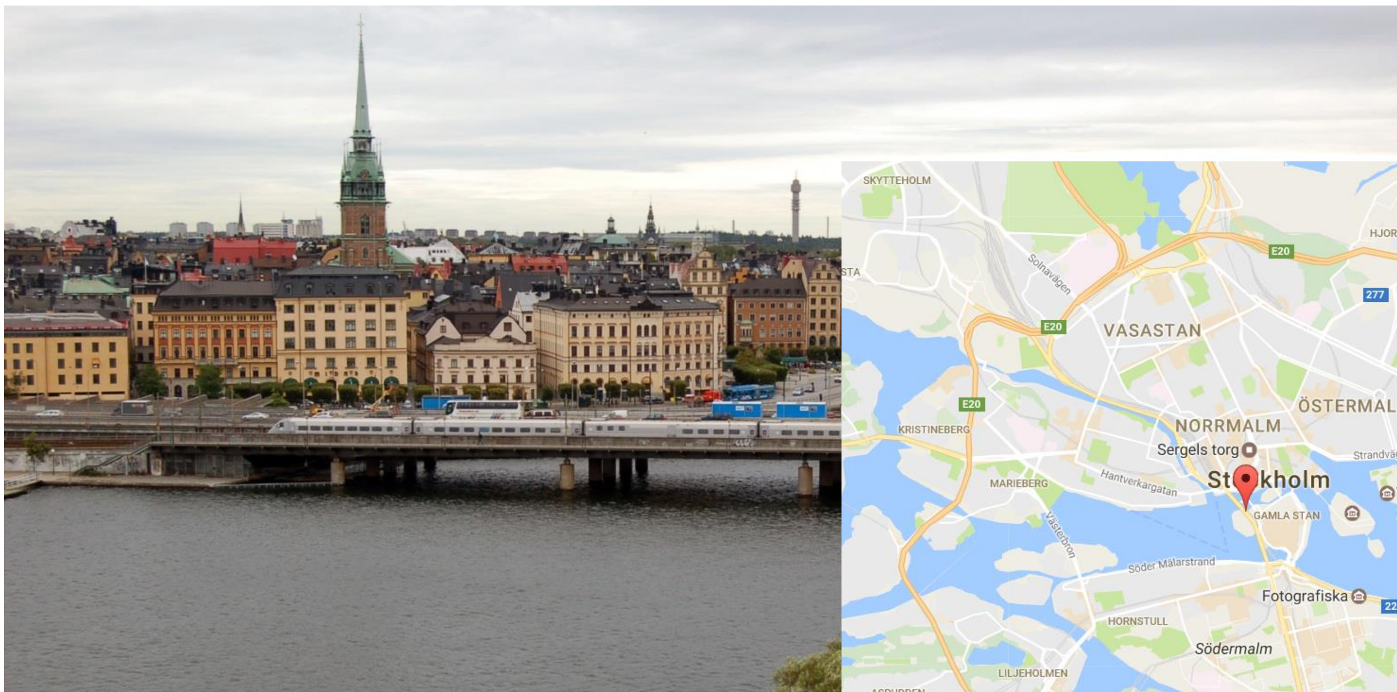
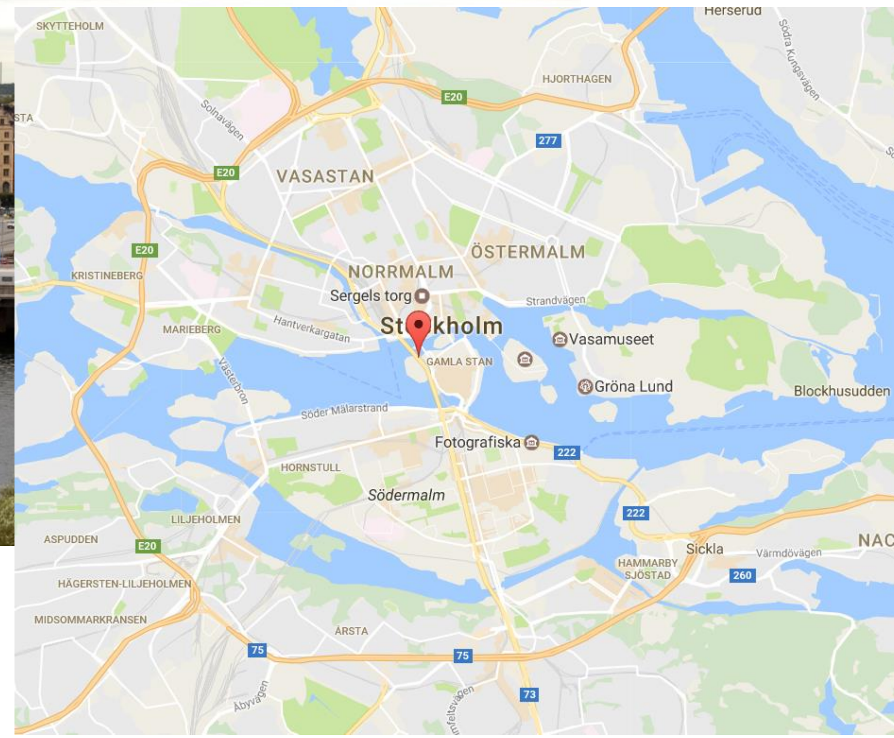
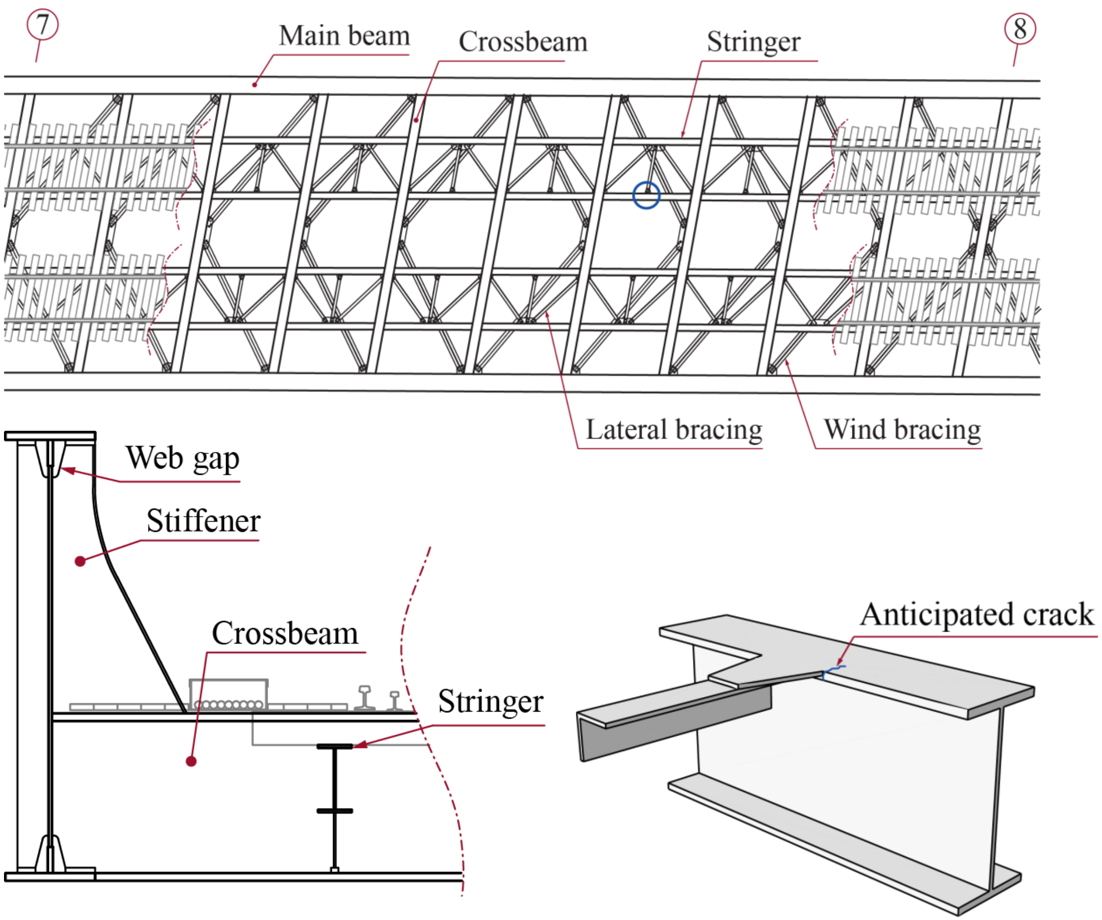
The Söderström Bridge





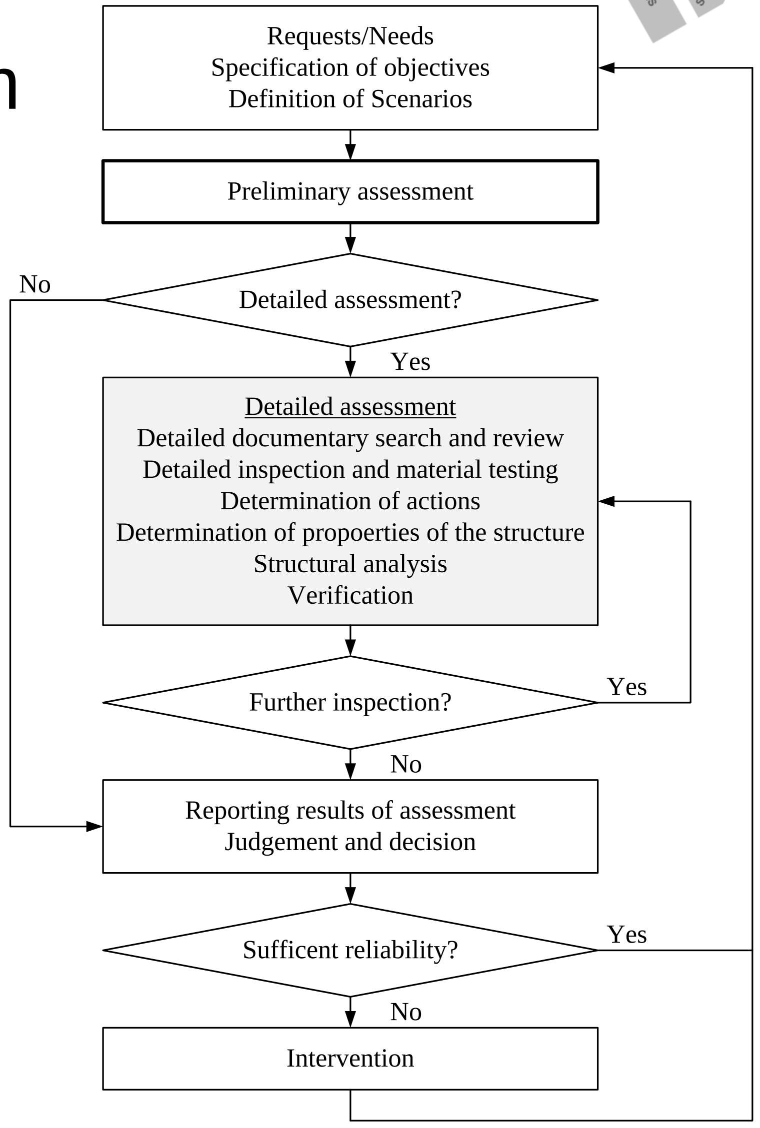
The Söderström Bridge



- This case study is focused on the connection between the lateral bracing and the stringer beams.
- Previous assessments have shown an exhausted fatigue life.
- However, no signs of cracks have been found during inspections.
- So what?

Condition assessment problem

- What methods should be used to assess the condition of the detail?
- Worth to do further assessment?
- How?
    - Inspect more/better?
    - Improve structural analysis?
    - Improve consideration of uncertainties?
    - All?



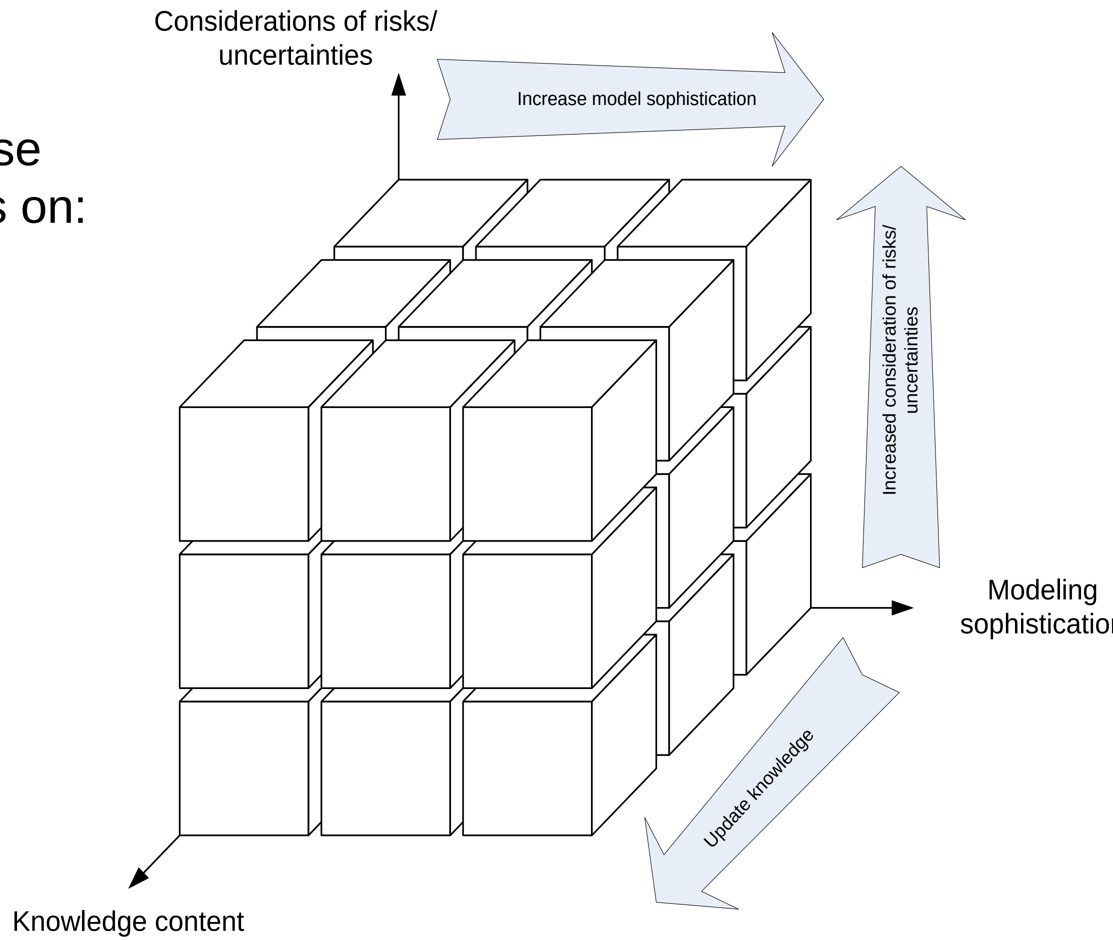
ISO 13822

Levels of condition assessment

Typical approaches to increase level of the assessment focus on:

- Modeling sophistication
- Considerations of risk/uncertainty
- Knowledge/information content

Improved assessment entails moving away from origin.



Levels of condition assessment

Model sophistication

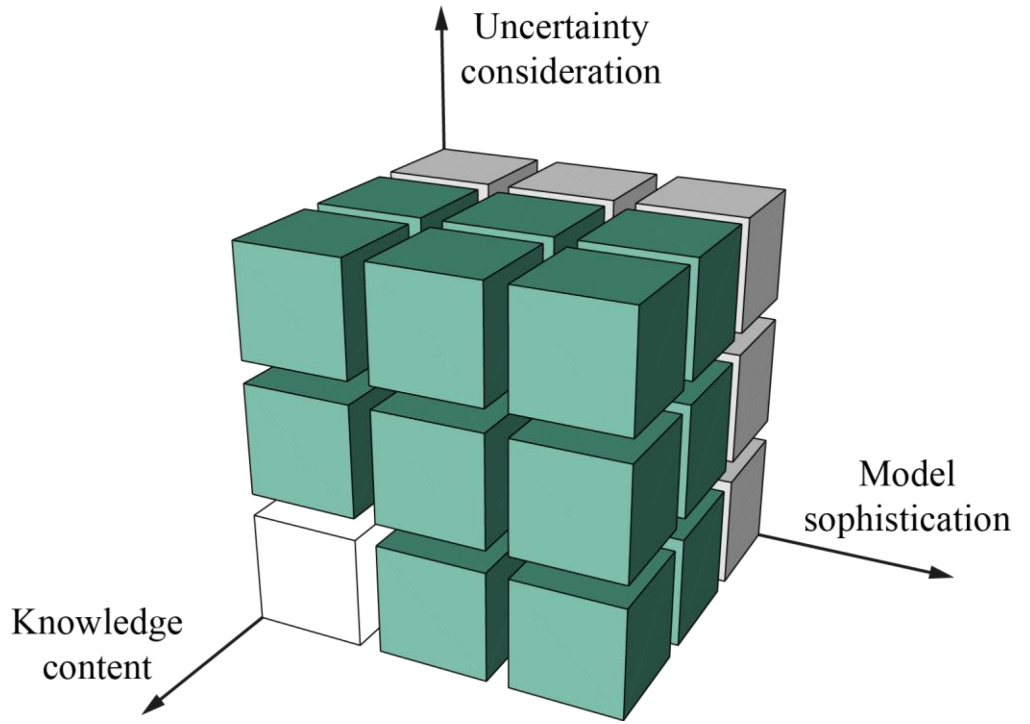
- Simple checks
- Linear damage accumulation
- Linear elastic fracture mechanics

Uncertainty consideration

- Deterministic
- Reliability-based
- Risk-based

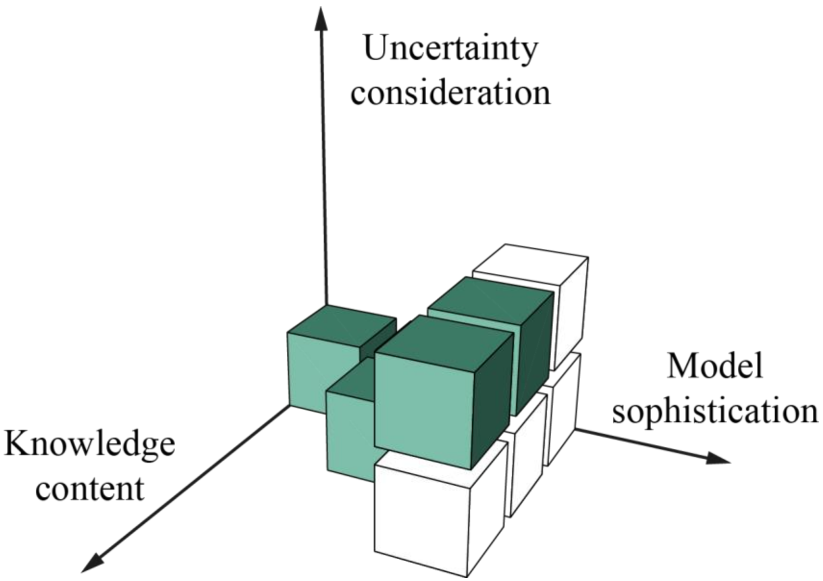
Knowledge content

- Desktop assessment
- Inspections and testing
- Monitoring



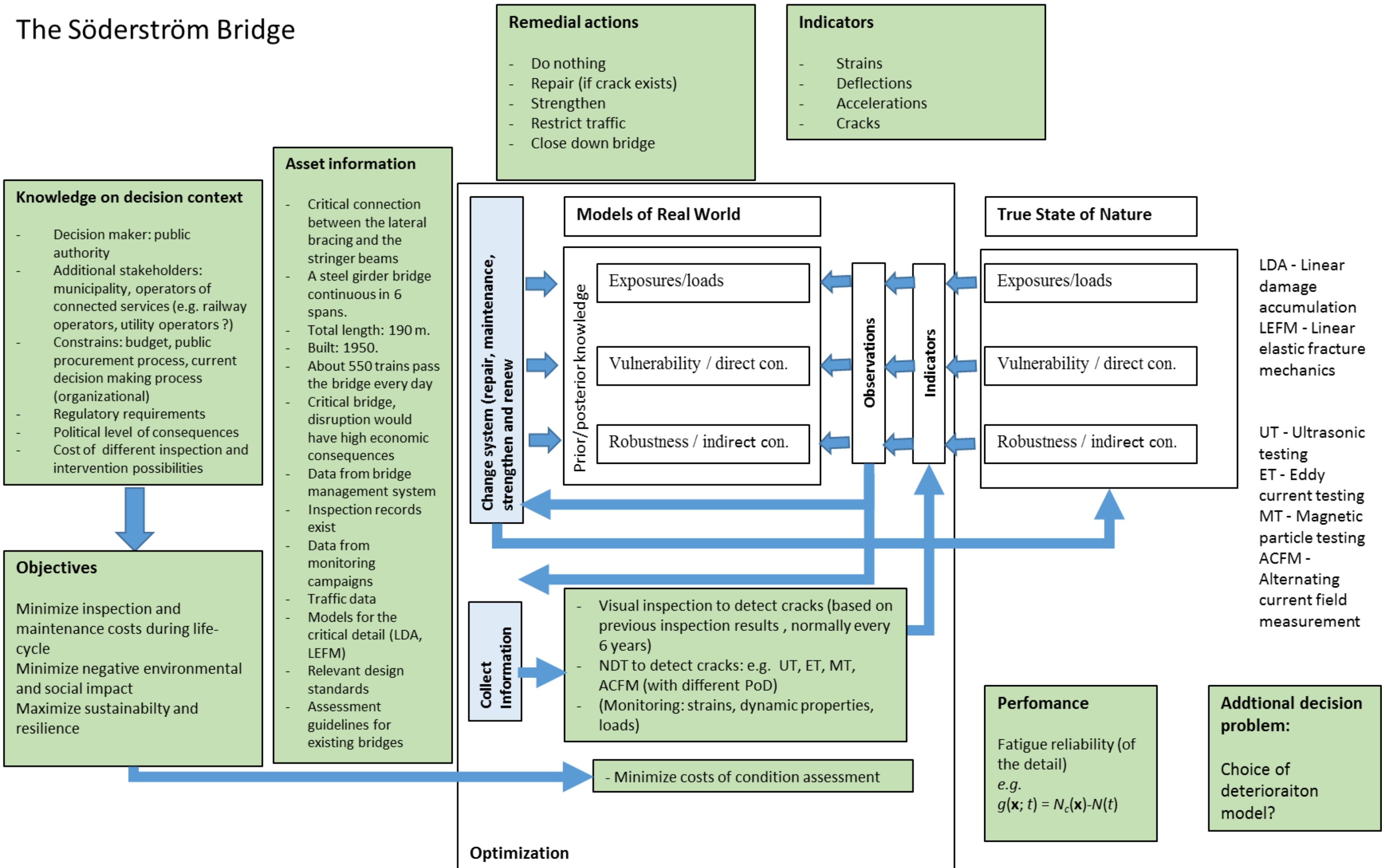
Levels of condition assessment

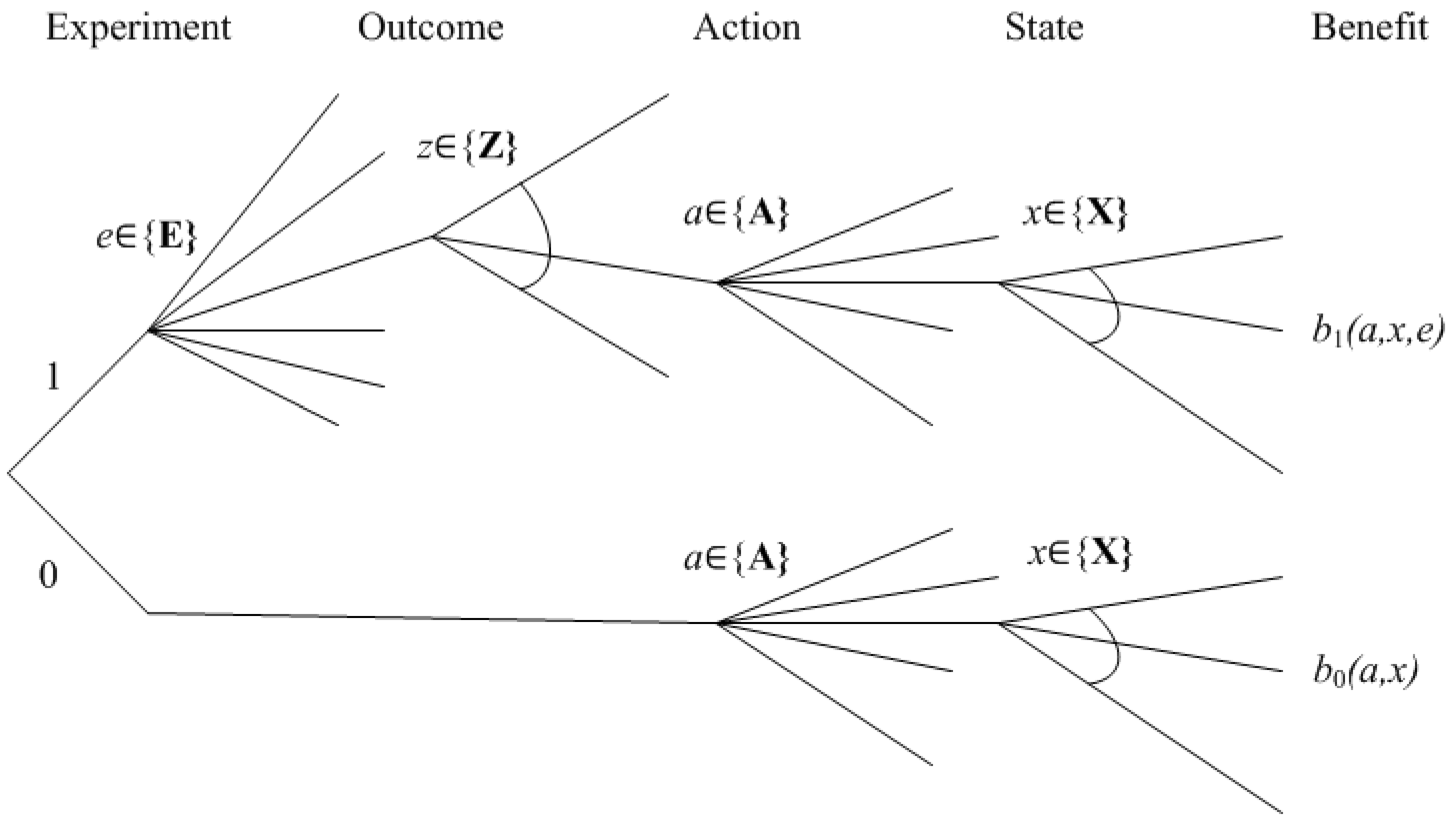
Assessment level	Fatigue life/number of cycles
Initial assessment	Insufficient
Linear damage accumulation Reliability-based Measured response	8.6×10^{6}
Linear elastic fracture mechanics Reliability-based Measured response	20×10^{6}
Linear elastic fracture mechanics Reliability based Measured response NDT results (magnetic particle testing)	42×10^{6}



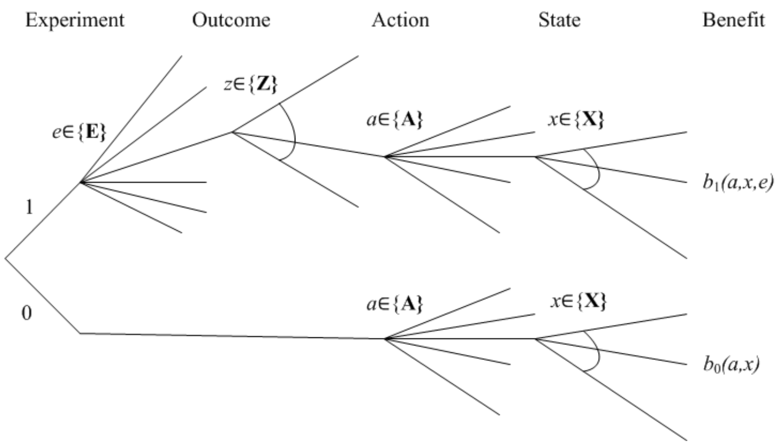
COST TU1402: Quantifying the Value of Structural Health Monitoring

The Söderström Bridge



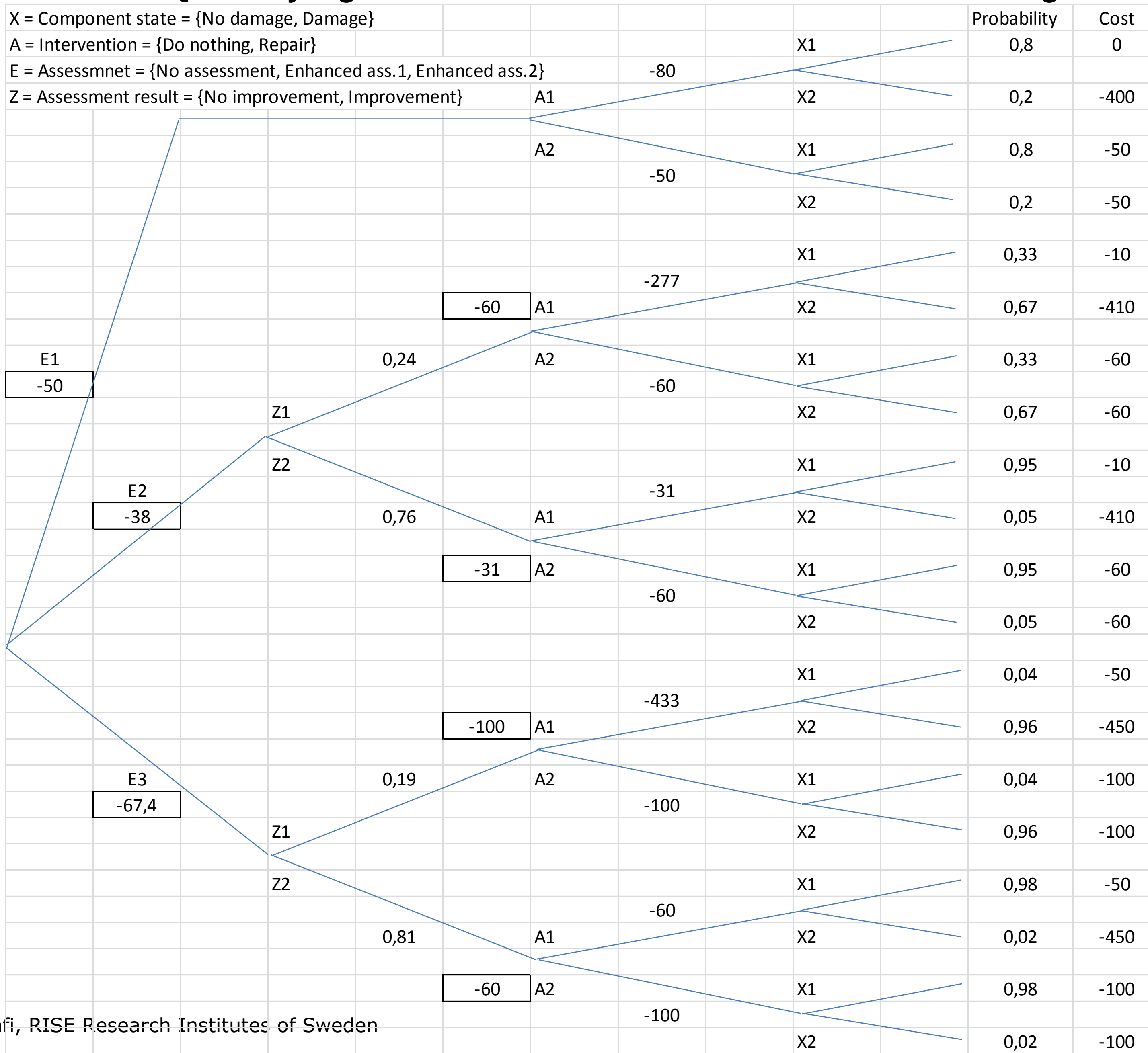

Experiment
Outcome
Action
State
Benefit
$z \in \{\mathbf{Z}\}$
$e \in \{\mathbf{E}\}$
$a \in \{\mathbf{A}\}$
$x \in \{\mathbf{X}\}$
1
$b_1(a,x,e)$
0
$a \in \{\mathbf{A}\}$
$x \in \{\mathbf{X}\}$
$b_0(a,x)$

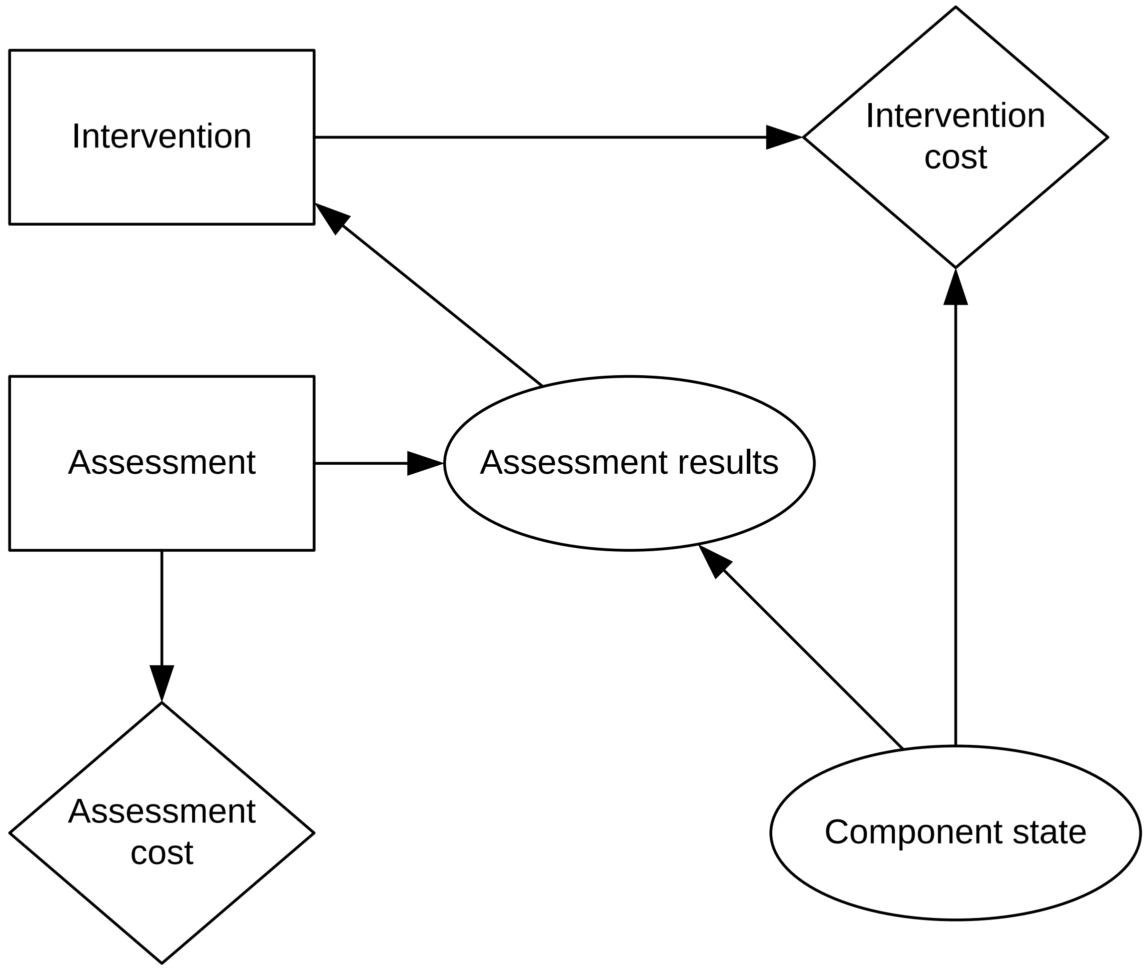
COST TU1402: Quantifying the Value of Structural Health Monitoring

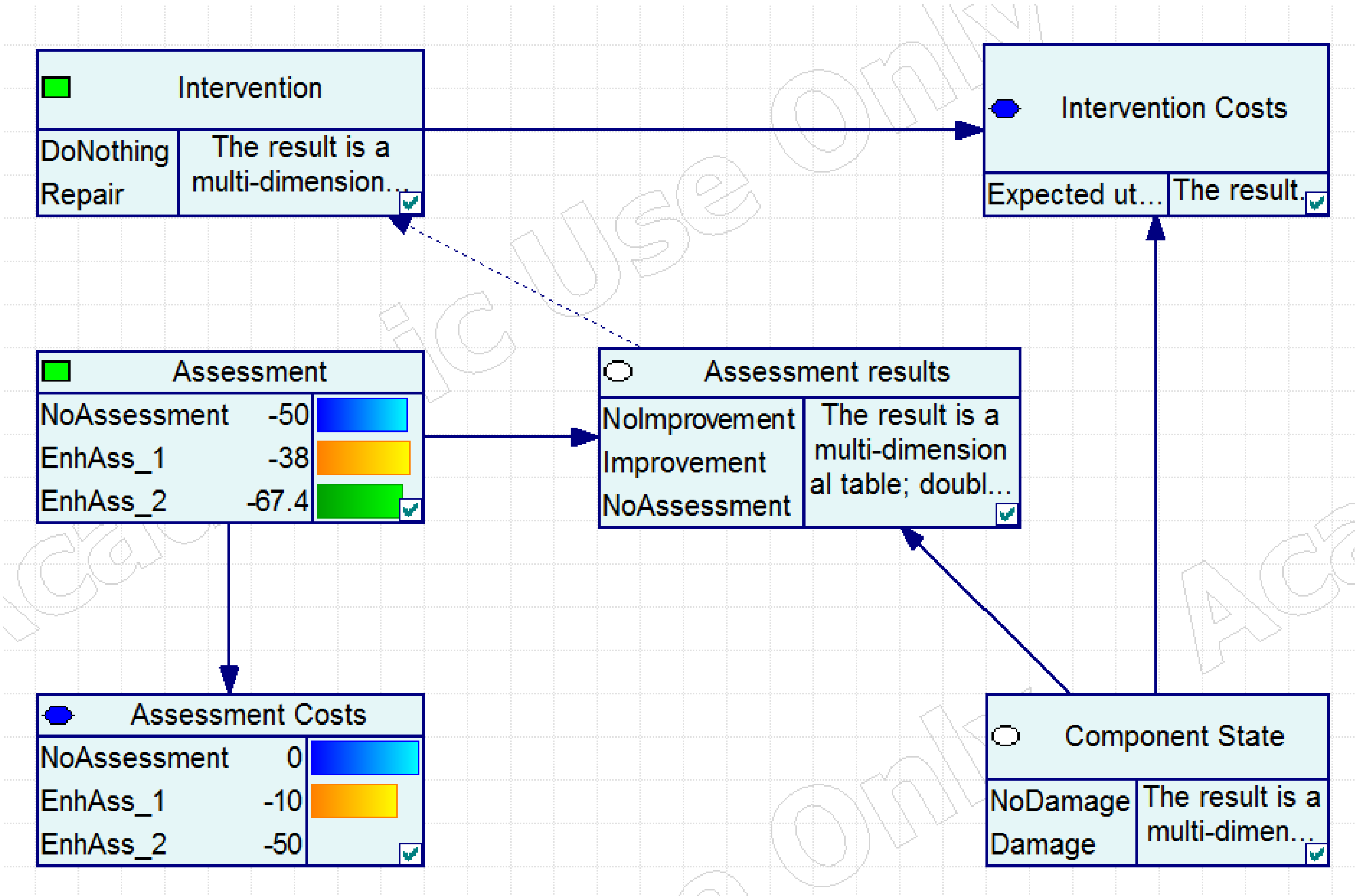


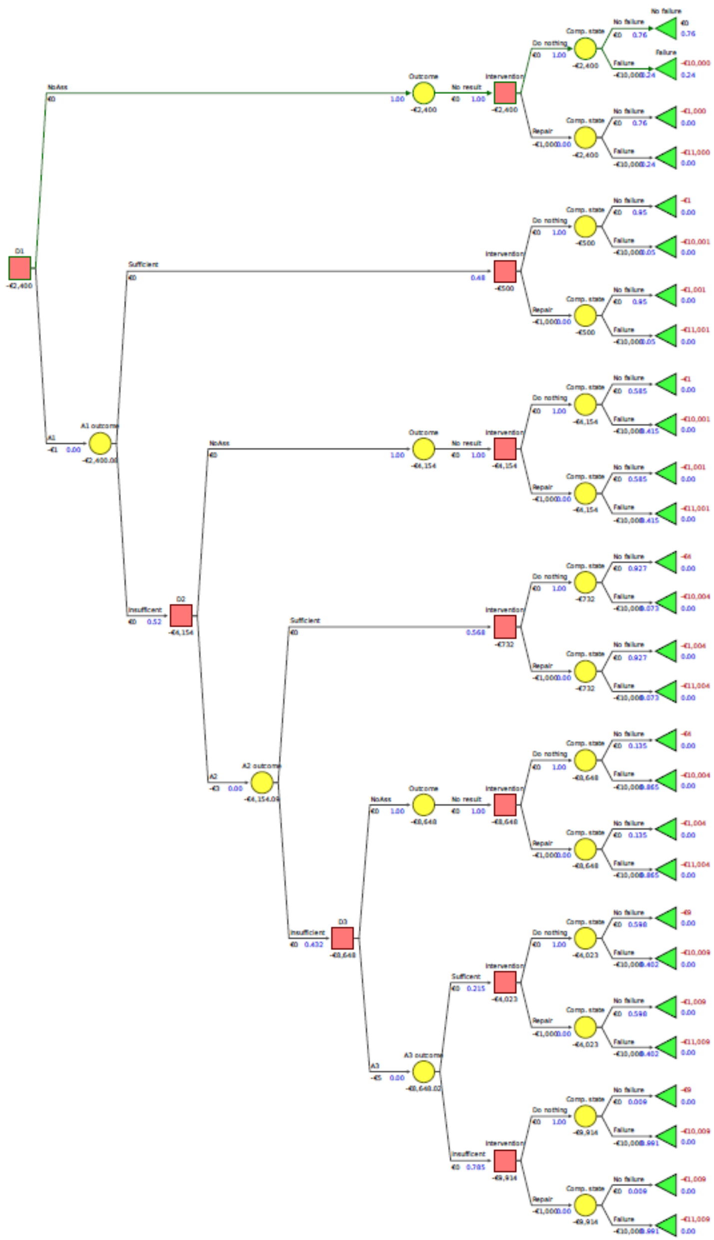
Component state (prior)						
X1	0,8	No damage				
X2	0,2	Damage				
Intervention						
A1	NoRepair					
A2	Repair					
Intervention costs (including conseqences of damage)						
	X1	X2				
A1	0	-400				
A2	-50	-50				
Assessment results			Cost			
E1	NoAssessment		0			
E2	EnhAss_1		-10			
E3	EnhAss_2		-50			
Likelihoods: $P(Z_i \mid E,X_k)$						
	E2		E3			
	X1	X2	X1	X2		
Z1	0,1	0,8	0,01	0,9	No improvement	
Z2	0,9	0,2	0,99	0,1	Improvement	

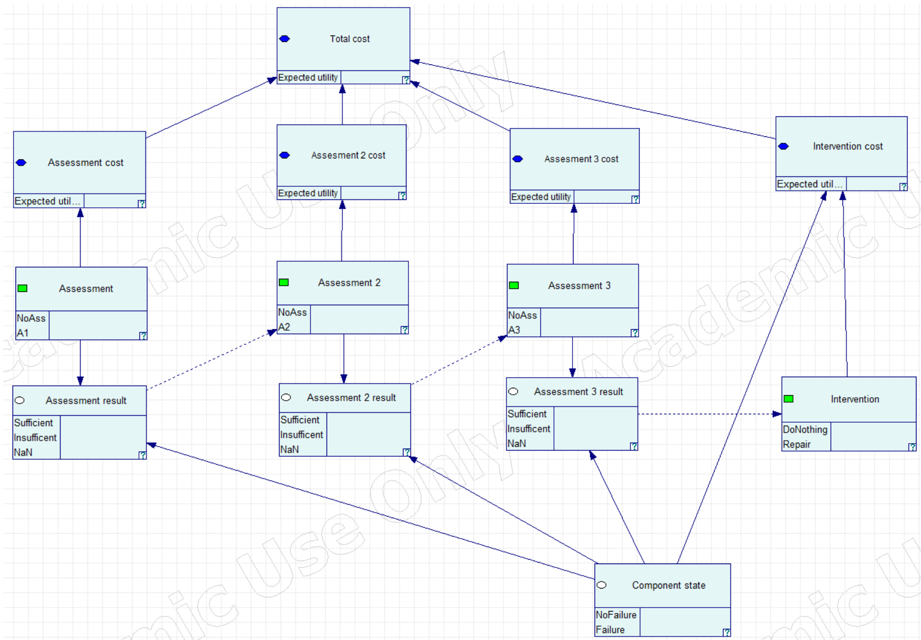
COST TU1402: Quantifying the Value of Structural Health Monitoring

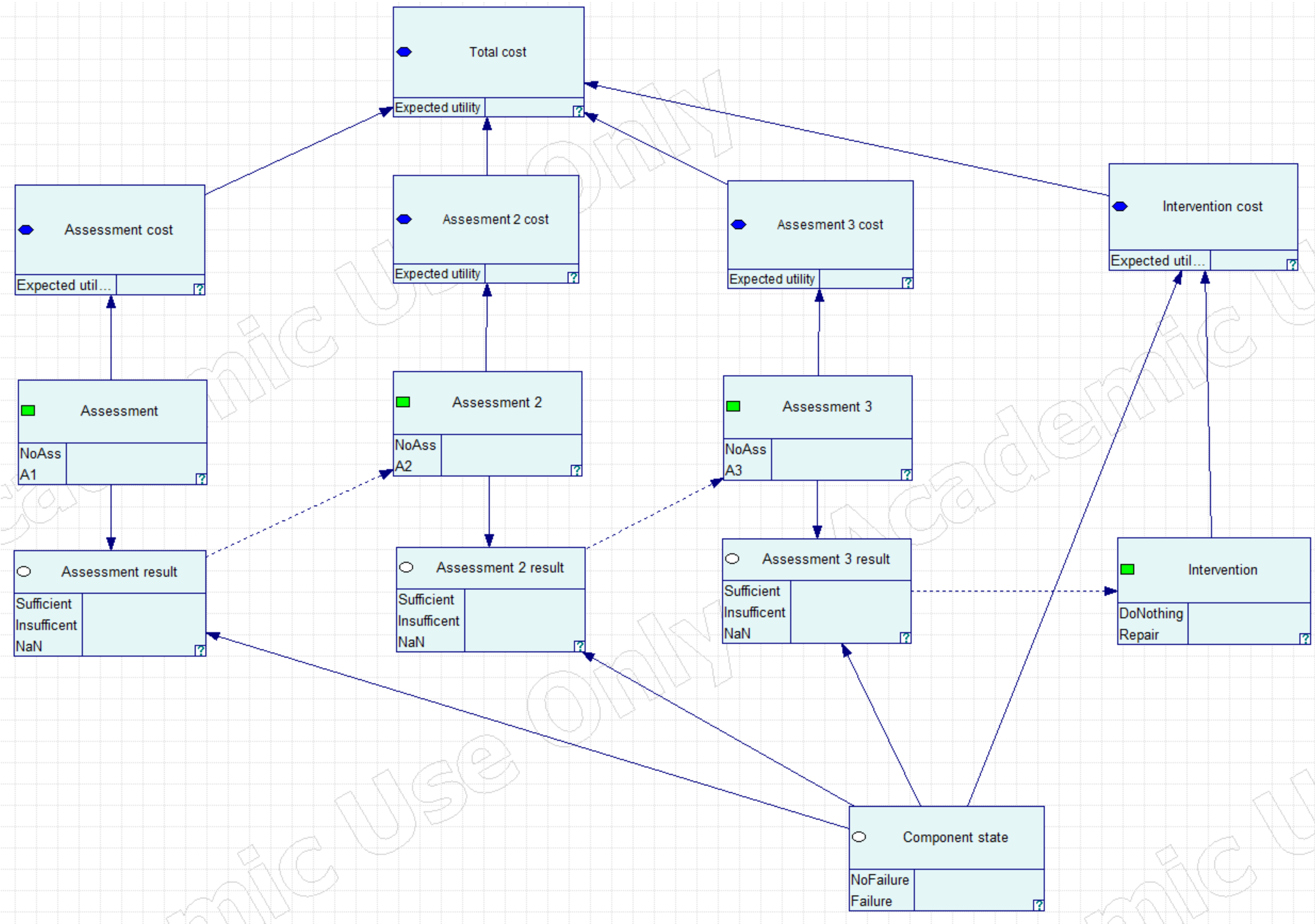



Intervention
Intervention cost
Assessment
Assessment results
Assessment cost
Component state


Intervention
DoNothing
Repair
The result is a multi-dimension...
Intervention Costs
Expected ut...
The result...
Assessment
NoAssessment -50
EnhAss_1 -38
EnhAss_2 -67.4
Assessment results
NoImprovement
Improvement
NoAssessment
The result is a multi-dimensional table; doubl...
Assessment Costs
NoAssessment 0
EnhAss_1 -10
EnhAss_2 -50
Component State
NoDamage
Damage
The result is a multi-dimen...




Total cost
Expected utility
Assessment cost
Expected util...
Assesment 2 cost
Expected utility
Assesment 3 cost
Expected utility
Intervention cost
Expected util...
Assessment
NoAss
A1
Assessment 2
NoAss
A2
Assessment 3
NoAss
A3
Assessment result
Sufficient
Insufficent
NaN
Assessment 2 result
Sufficient
Insufficent
NaN
Assessment 3 result
Sufficient
Insufficent
NaN
Intervention
DoNothing
Repair
Component state
NoFailure
Failure


Total cost
Expected utility
Assessment cost
Expected util...
Assesment 2 cost
Expected utility
Assesment 3 cost
Expected utility
Intervention cost
Expected util...
Assessment
NoAss
A1
Assessment 2
NoAss
A2
Assessment 3
NoAss
A3
Assessment result
Sufficient
Insufficent
NaN
Assessment 2 result
Sufficient
Insufficent
NaN
Assessment 3 result
Sufficient
Insufficent
NaN
Intervention
DoNothing
Repair
Component state
NoFailure
Failure

Related publications

Leander J, Andersson A, Karoumi R, 2010. Monitoring and enhanced fatigue evaluation of a steel railway bridge. *Engineering Structures*, Vol 32(3), pp. 854-863.

Leander J, Karoumi, R, 2012. Quality assurance of measured response intended for fatigue life prediction. *Journal of Bridge Engineering*, Vol. 17(4), pp. 711-719.

Leander J, Norlin B, Karoumi R, 2015. Reliability-based calibration of fatigue safety factors for existing steel bridges. *Journal of Bridge Engineering*, Vol. 20(10).

Leander J. and Selén E. (2017) The applicability of reliability-based inspection planning for steel bridges based on fatigue crack detection, Proc. ICOSSAR 2017, Vienna, Austria.

Honfi D., Leander J. & Björnsson Í. (2017) Decision support for bridge condition assessment. 4th International Conference on Smart Monitoring, Assessment and Rehabilitation of Civil Structures (SMAR 2017), Zürich, Switzerland, 13-15 September, 2017.

Leander J., Honfi D., & Björnsson Í. (2017) Risk-based planning of assessment actions for fatigue life prediction. Procedia Structural Integrity, Vol. 5, pp. 1221-1228.

Honfi D., Leander J., Björnsson Í., Larsson Ivanov O., Plos M., Zandi K., Magnusson J., Lechner T. & Gabrielsson H. (2017) Decision support for maintenance and upgrading of existing bridges, 39th IABSE Symposium – Engineering the Future, Vancouver, Canada, 21-23 September 2017, pp. 336-345.

Thank you for your attention!