TU1402 WG5: Standardisation

Value of Structural Health Information for Decision Support

1. Guide for Operators: What should the infrastructure operators and owners ask for?

- Optimisation of the structural information and integrity management before implementation
- Why: You can save money, reduce risks and facilitate industry 4.0!

2. Guide for Practicing Engineers: How can an engineer perform and support the quantification of the Value of SHI?

- Engineering and application information
- Real case study for implementation

3. Guide for Scientists: How to enter research on value of SHI? How to apply decision analyses to my research field?

- Description and ready to use formulation of a framework and approaches for various structural health information
- Starting set of literature

Quantifying the Value of Structural Health Information for Decision Support Guideline for practicing engineers

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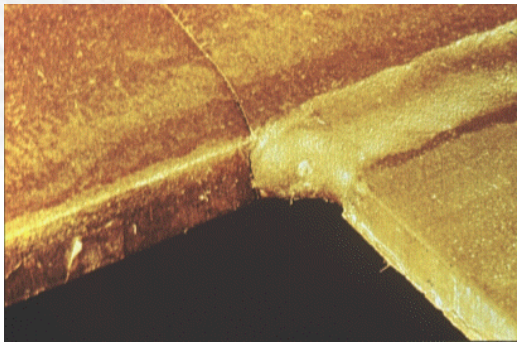
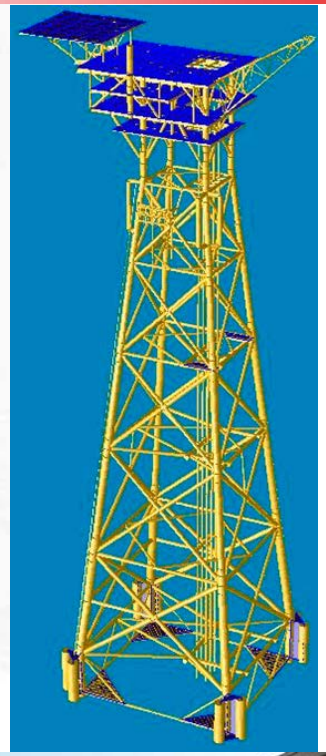
1. Scope (framework)

- Include SHI and SHM in a broad term (SHM, DT, NDT)
- Description of the decision process
- Support for selection of SHM strategy
- Verification of Value of Information
- Integration into state-of-practice
- Impact on Standardization



1. Scope (application fields and types)



Applications

- New structures (innovative designs)
- Existing structures (lifetime extension)
- Type specific population of structures (jacket structures in the same field)

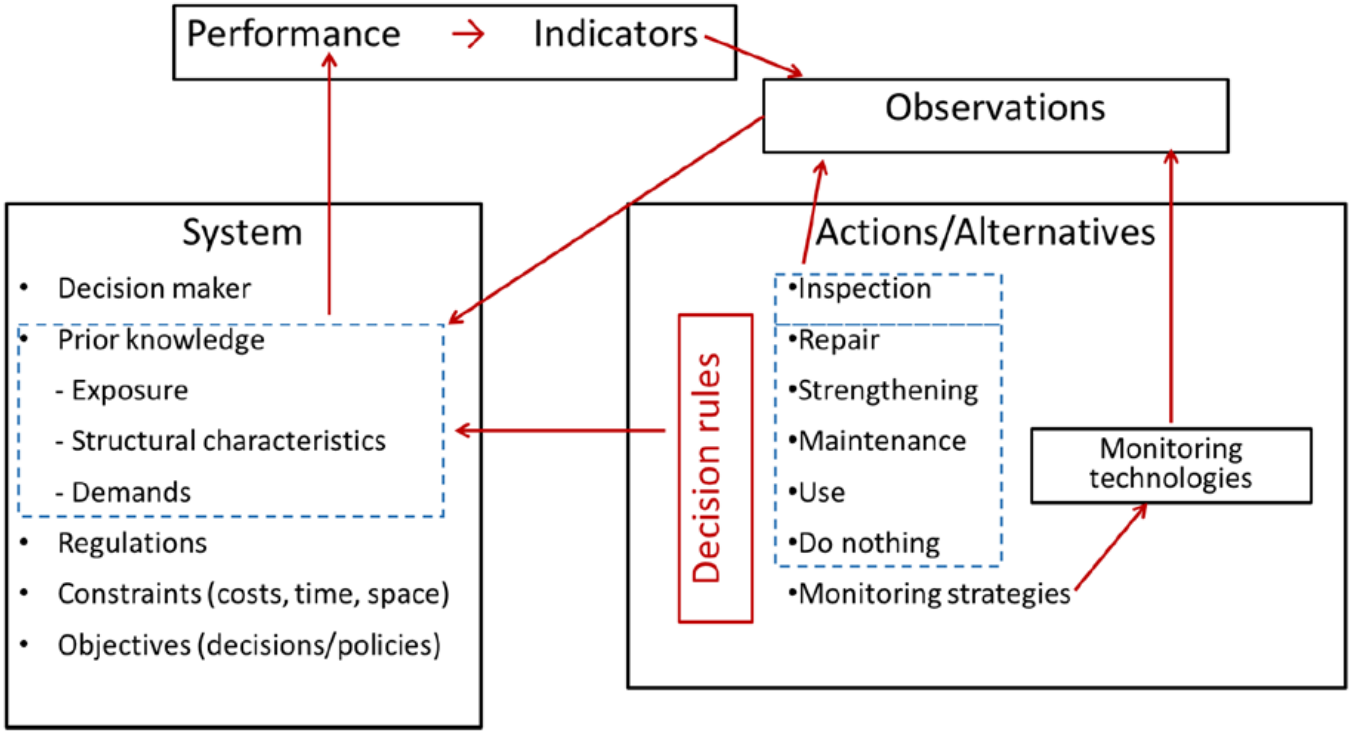
Types

- Spot monitoring (including NDT, DT)
- Periodic monitoring (frequent, triggered)
- Permanent monitoring

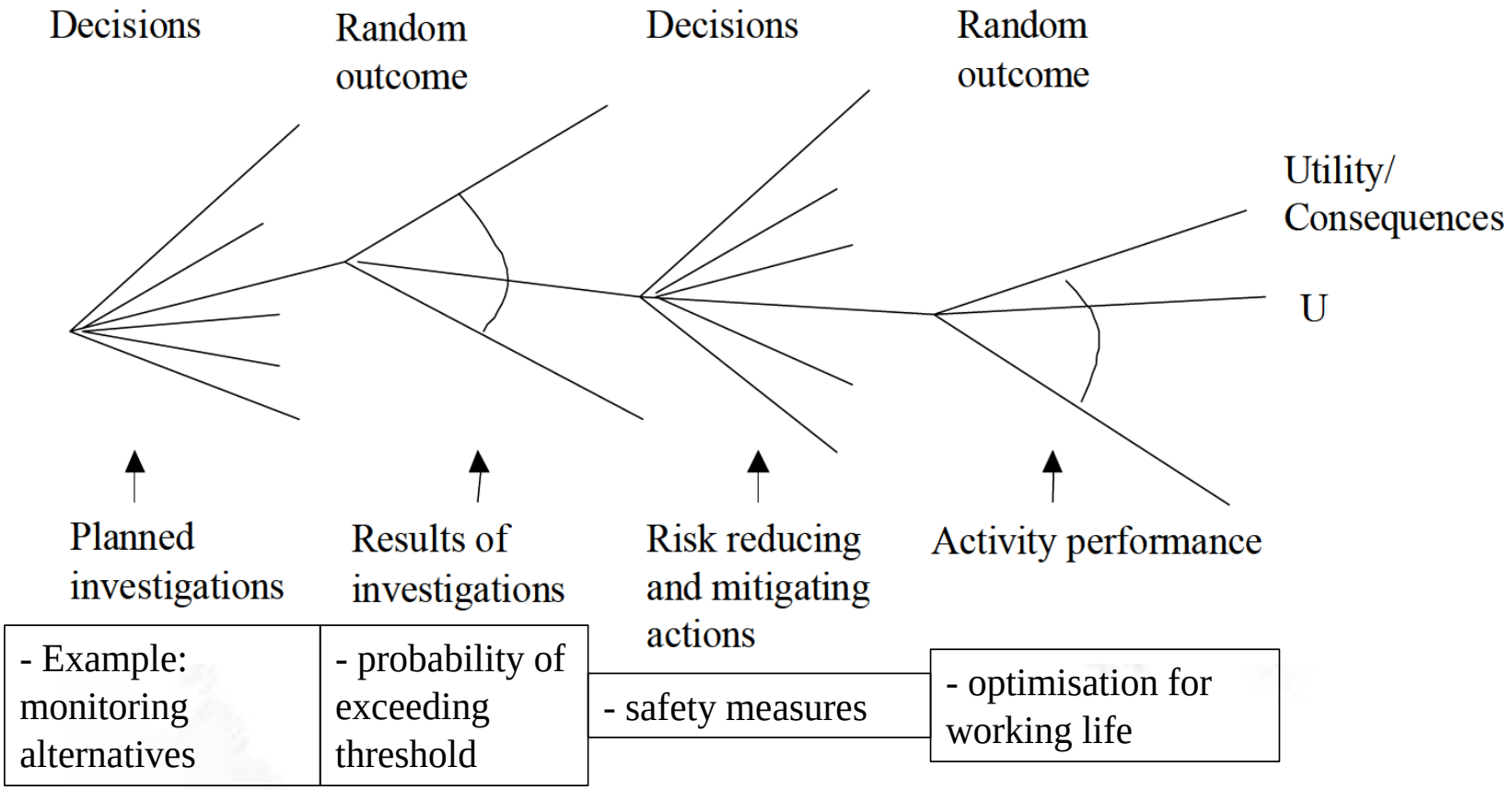
2. Contents

- Nomenclature
- Glossary
- Scope
- Decision process
- Asset and portfolio information
- SHM strategies
- Structural performance modelling
- Intervention actions safety measures
- Lifecycle cost modelling
- Decision and Value of the SHI Analysis analysis
- Implementation – Case study

3. Selected topics (Value of Information Analysis)



3. Selected topics (decision tree)



3. Selected topics (Asset and portfolio information)

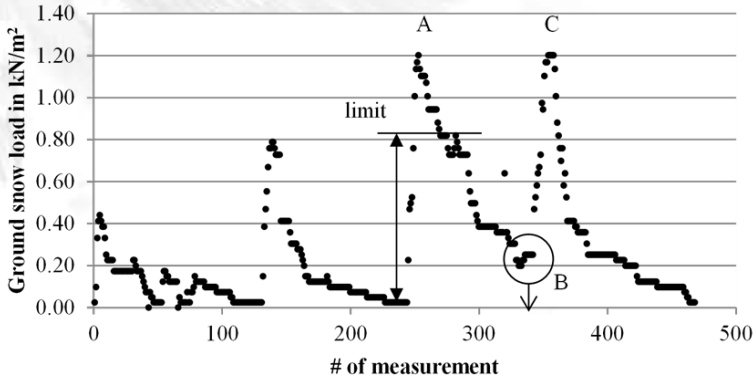
- Codes, standards used at design phase
- Structural typologies(y) and organization
- Environmental data
- Geotechnical data
- Description of design and construction of the structure
- Other existing documentation
- Operation data if available
- Description of possible known damage
- Material characteristics
- Key components
- Cost data such as unit costs of elements, operation costs
- Failure consequences including system resilience

3. Selected topics (Structural performance)

Performance indicators (diagnostic, prognostic)

- performance indicator of the network (system of structures)
- performance of structure (system of components)
- performance indicator of a structural member (component)

Example: stadium roof
limit of snow load
(directly related to reliability and risk)



TRL(Technology Readiness Level) = 9
System proven through successful operations

3. Selected topics (SHM strategies)

- parameter to be measured
- sensitivity/reliability of monitoring system
- cost of monitoring

Example: stadium roof - limit of snow

Alternative	Cost	Uncertainty
M1: meteorological station snow depth on ground	negligible	very high
M2: snow depth on the roof	C_I= 7000 Euro C_O = 800 Euro /year	high (snow density)
M3: snow load on the roof	C_I= 14000 Euro C_O = 800 Euro /year	reduced (direct measurement)

3. Selected topics (intervention actions)

- do nothing
- operational measures:
  - provide optimal inspection and maintenance plan
  - decrease exposure (limit number of persons at risk)
  - reduce the loads (e.g. by limiting the traffic on the bridge, re-routing the traffic or by limiting the loads in storage rooms or archives)
  - use the structure under constraints (restrict the traffic on the bridge or access of visitors of the observation tower in periods of strong wind);
  - provide additional safety measures (protection measures such as protective barriers or mitigation measures such as appropriate escape ways)
  - reduce the remaining working life and re-assess afterwards;
- structural interventions:
  - repair to avoid further degradation;
  - upgrade to increase structural reliability

4. Discussion (costs)

Costs:

- Costs of SHM system (total life-cycle)
- Costs of Actions triggered by SHM
- Costs of consequences due to failure (human, economic, environmental)

Costs should be expressed in monetary terms and discounted

4. Discussion (VoI)

Benefit:

Expected Value of Information V based on expected value of total life cycle costs C_T :

0: no implementation of SHM

M: implementation of SHM

$$V = E[C_{T,0}] - E[C_{T,M}]$$

Impact:

- standards: EN 1990: A2, WG2 existing structures, EN 1997, ISO 13822 and ISO 13823, fib Model Code 2020
- high failure consequences structures: stadiums, congress halls, important bridges, structures in the energy power industry
- under-designed structures (using old codes)
- novel structures (materials, systems)
- heritage structures

5. Conclusions

- Preparation of guideline documents with terminology and compatible flowcharts
- Development through interaction with the other working groups
- Discussion and presentations at various selected occasions
- Focus on quantification of information and decision strategies
- Cost vs benefit and decision on intervention actions are highlighted
- Presentation to practicing engineers – reporting - feedback

Publications

Diamantidis, D., Sykora, M., 2018, "Optimizing monitoring – implementation of draft guideline and case study of roof exposed to snow loads" **IABSE Symposium**, September 19-21, 2018, Nantes, France. Zürich: IABSE, p. S27-27-S27-34, 2018, ISBN: 978-3-85748-153-6; ISBN: 978-3-85748-161-1.

Diamantidis, D. and M. Sykora, 2019, "Implementing Information Gained through Structural Health Monitoring - Proposal for Standards**", 13th ICASP** International Conference on Applications of Statistics and Probability in Civil Engineering, May 2019, Seoul, Korea.

Outreach

results to be further used and included in:

a) consultancy services,
b) committee work (Eurocodes, fib, JCSS),
c) education of students and young engineers.