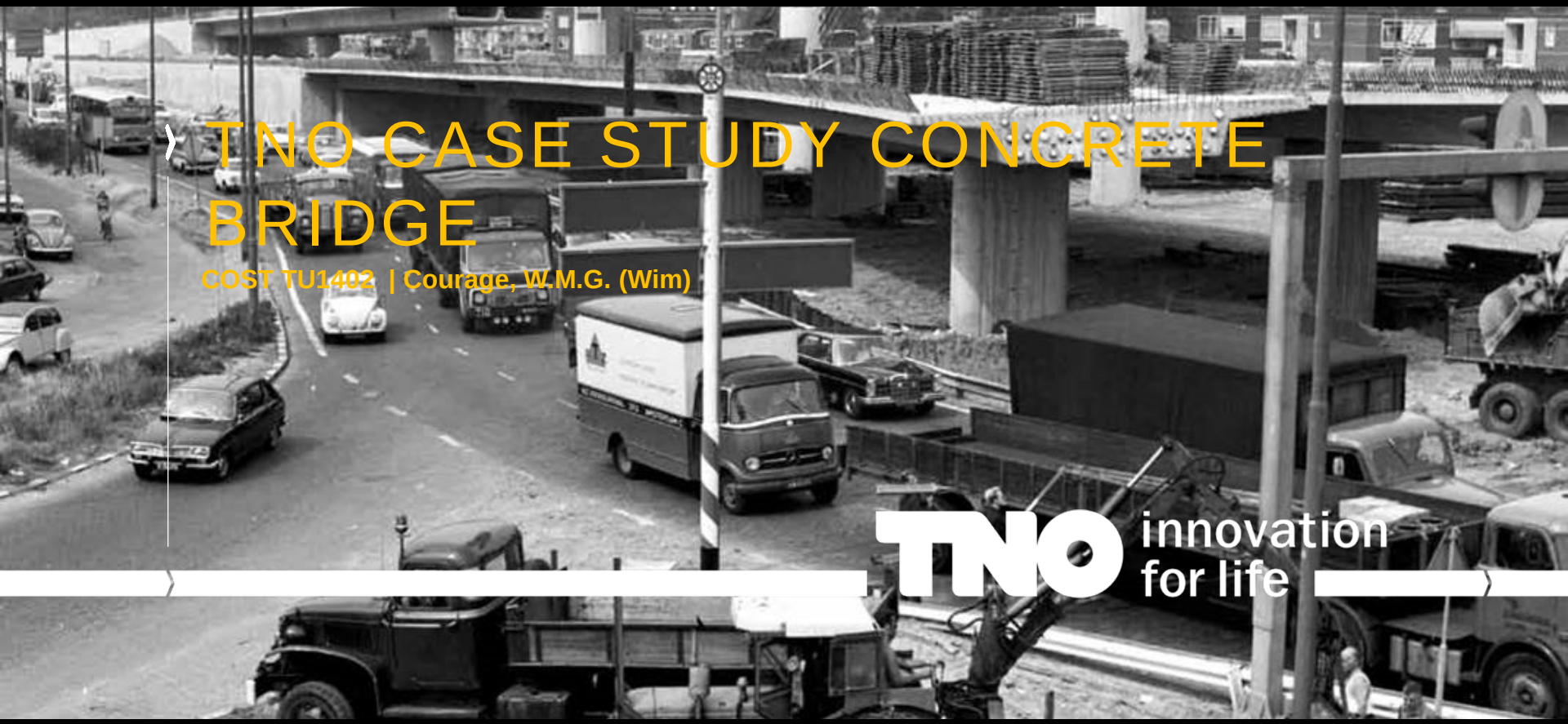


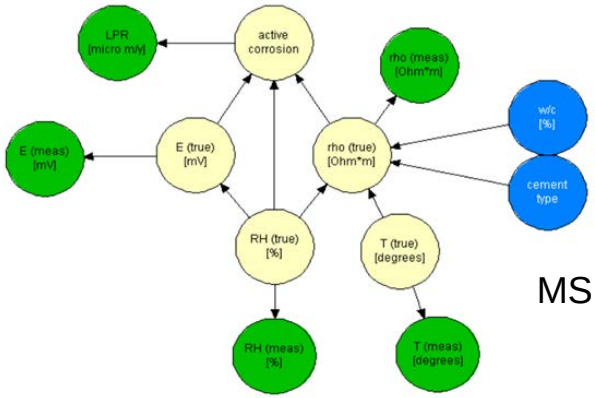
TNO CASE STUDY CONCRETE BRIDGE

COST TU1402 | Courage, W.M.G. (Wim)

TNO innovation for life

Early Research Program ERP_SI_BRIDGE : Scope & focus

- **Advanced assessment of existing RC structures**
- **Accounting for multiple sources of uncertainty, i.e.:**
  - randomness in intrinsic material properties,
  - randomness in defects due to load history,
  - (FEM) modelling uncertainty,
  - randomness in defects due to deterioration mechanisms : **CORROSION**



MSDF sensor

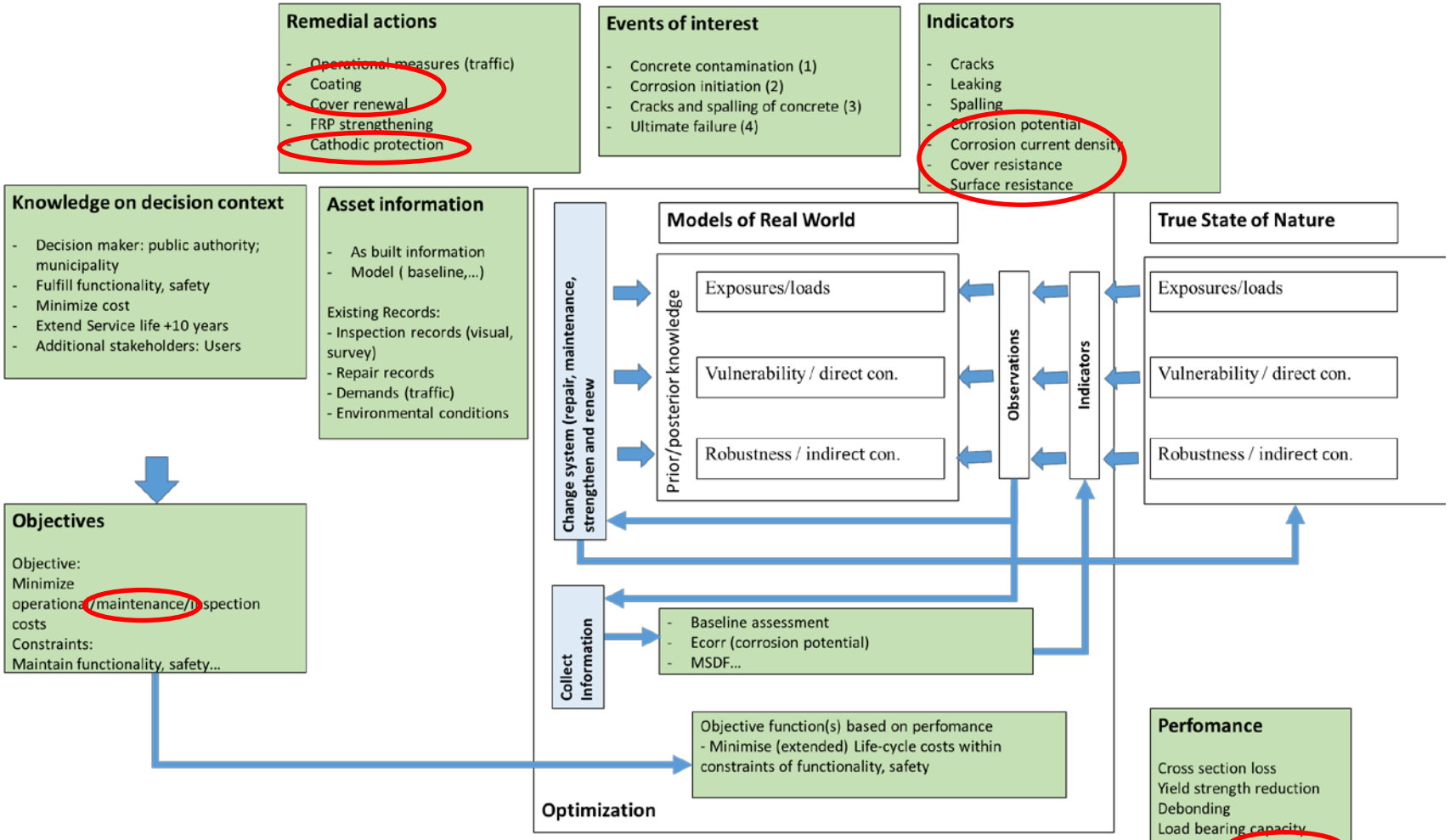
QUESTION

Which SHM technique should the owner apply which results in the minimization of the remaining service life cost?

Answer depends on:

- the **cost** related to each of the measuring techniques;
- the **accuracies** of each of the measuring techniques;
- the possible **actions** resulting from the outcomes of the measuring techniques;
- the **actual state** of the structure;
- the **cost and benefits** related to the failure or existence of the structure.

SHM (MSDF) : VoI Categorization & Flowchart



SHM TECHNIQUES (1)

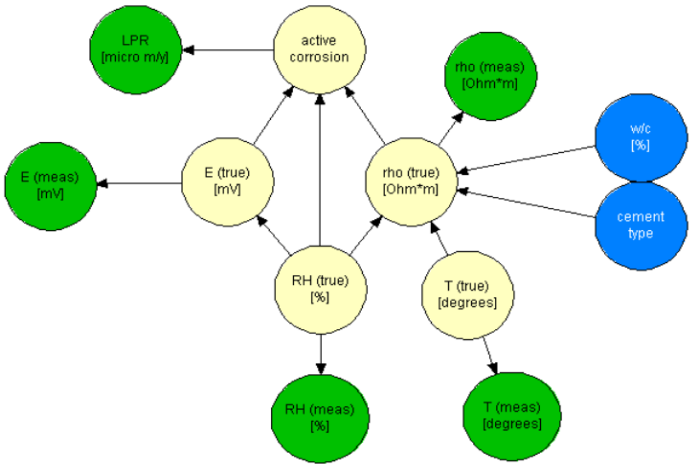
Half-cell potential measurements

- Probability of active corrosion.
- Sensitive to environmental influences.
- Interpretation by means of American Standard ASTM C876.

SHM TECHNIQUES (2)

MSDF

- Probability of active corrosion.
- Embedded sensors
  - Environmental data
  - Multiple Electrochemical data
- Knowledge based (expert) system for data interpretation.
- Autonomous interpretation.



CASE STUDY

- Fictitious, reinforced concrete slab bridge located in Rotterdam.
- Focus on crack width near middle support (w_{lim} = 2mm).
- Two SHM techniques:
  - MSDF
  - Potential measurements
- Two possible actions:
  - No action
  - Cathodic protection (limit corrosion rate)

CASE STUDY

Results from file-survey (nominal / characteristic values)

- The design lifetime: 50 years
- Concrete cover: 30 mm
- Curing time: 28 days
- Water cement ratio: 0.5 [-]
- Cement type: CEMI
- Rebar diameter: 12 mm
- Tensile splitting str. : 2.2 MPa

CASE STUDY

- Environmental class: XS3
- Average relative humidity: 80%
- Average temperature: 20^{o} Celcius

ASSUMPTIONS

Assumptions

- Both measuring techniques equally expensive while compiling first models.
- MSDF more accurate than half-cell potential measurements.

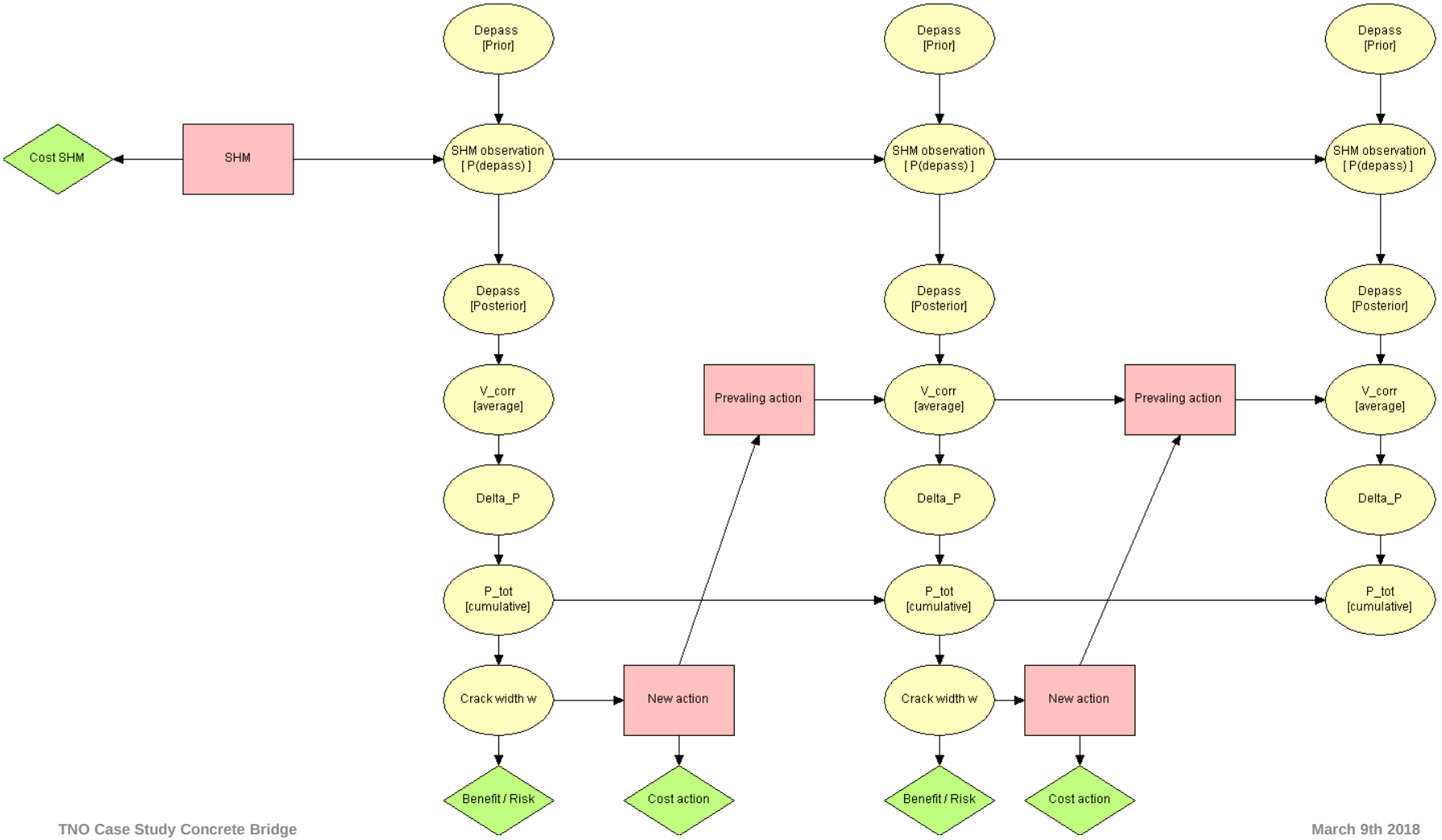
MSDF

P(depass)	depass	no depass
0-10 %	0.05	0.9
10-90%	0.05	0.05
90-100%	0.9	0.05

Epot + ASTM C876

P(depass)	depass	no depass
0-10 %	0.2	0.6
10-90%	0.2	0.2
90-100%	0.6	0.2

LIMID


Cost SHM
SHM
Depass [Prior]
SHM observation [P(depass)]
Depass [Posterior]
V_corr [average]
Delta_P
P_tot [cumulative]
Crack width w
Benefit / Risk
New action
Cost action
Prevaling action
Depass [Prior]
SHM observation [P(depass)]
Depass [Posterior]
V_corr [average]
Delta_P
P_tot [cumulative]
Crack width w
Benefit / Risk
New action
Cost action
Prevaling action
Depass [Prior]
SHM observation [P(depass)]
Depass [Posterior]
V_corr [average]
Delta_P
P_tot [cumulative]

NEEDS/DEVELOPMENTS

- Hierarchical prior model for depassivation to be added
- Developments w.r.t. MSDF sensor to be taken into account
- Costs to be quantified
- Time as parameter in model to be included
- Other actions to be included
- ….

GUIDELINES

- Terminology
- Steps/flowcharts
- Objectivity/Reporting
- ….


THANK YOU FOR YOUR ATTENTION
Take a look:
TIME.TNO.NL
TNO
innovation
for life