

JCSS

Joint Committee
on Structural Safety

Workshop on Assessment of Existing Structures

28th and 29th January 2021

Monitoring and Updating of Signature Structures

Helmut Wenzel

Introduction

- **Signature Structures do not fit into standard approaches**
- **Investment Costs are high**
- **Risk informed Management is demanded by Investors**
- **Custom made Asset Management becomes necessary**
- **There is a major difference in managing new or old structures**
- **The focus of this presentation is on new signature structures**



Rare Events: Collapse of Cat Walk in extreme Wind Regime

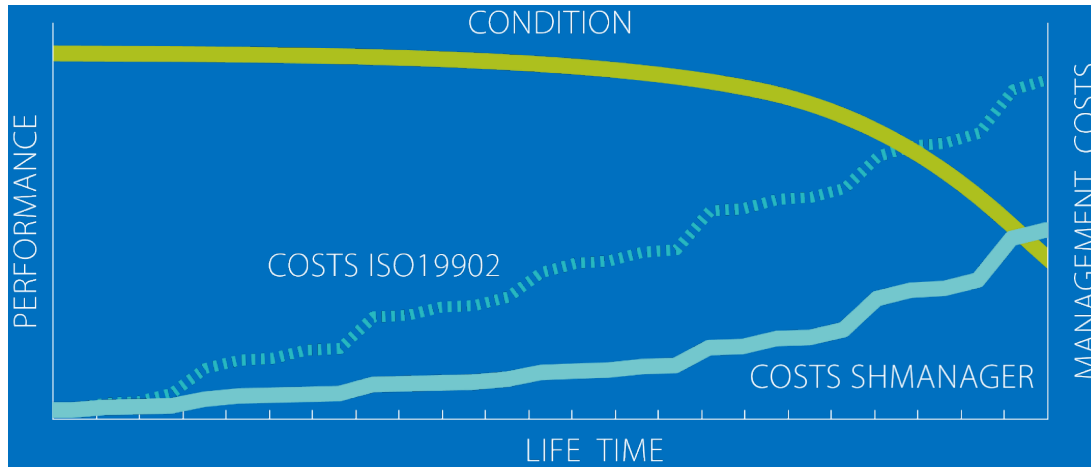
Complex Offshore Assets





Budget Optimization; Targeted Management

► Optimised Risk based Asset Management Costs ◀



Example

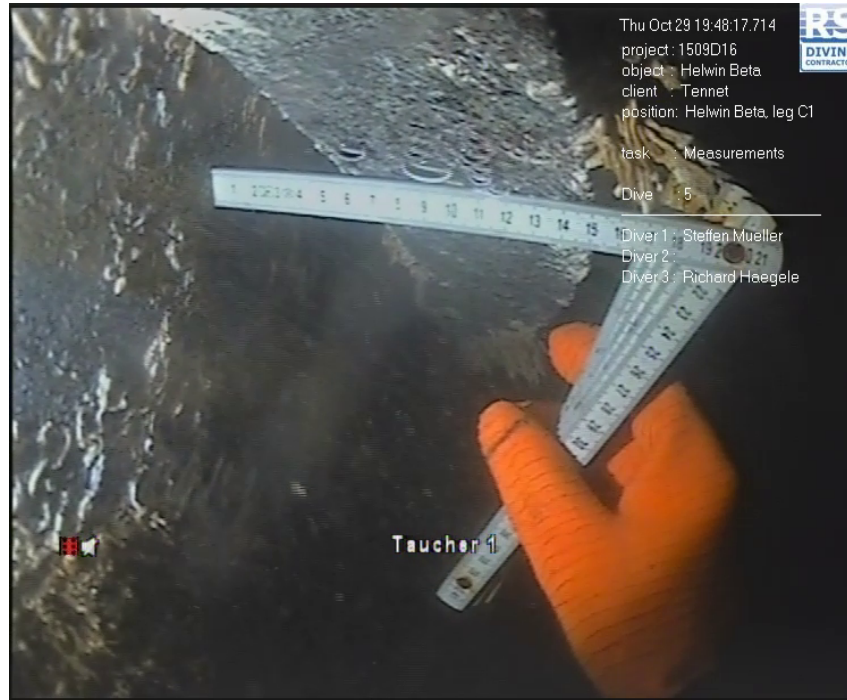
Offshore Platform with Performance Deficit

Example: Erection Issue in a North Sea Application



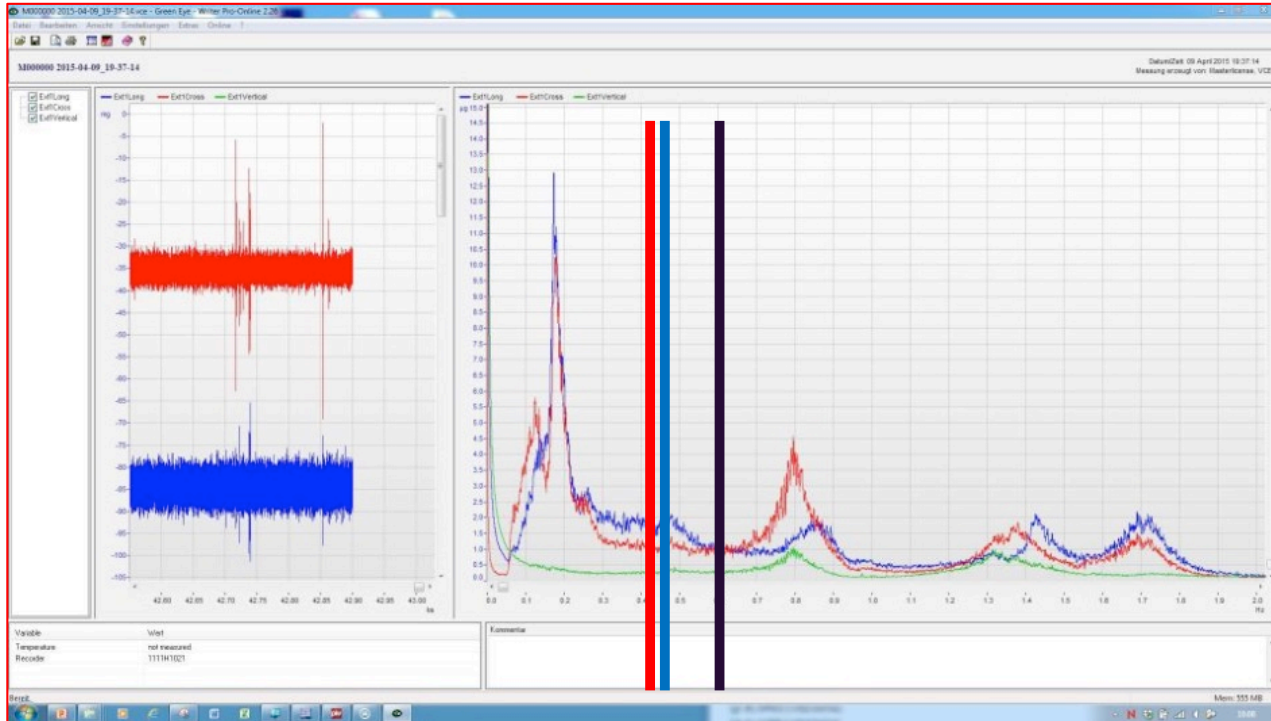
North Sea Application

Sea Bed Survey Information



North Sea Application Fundamental Frequencies

Model vs Measurements



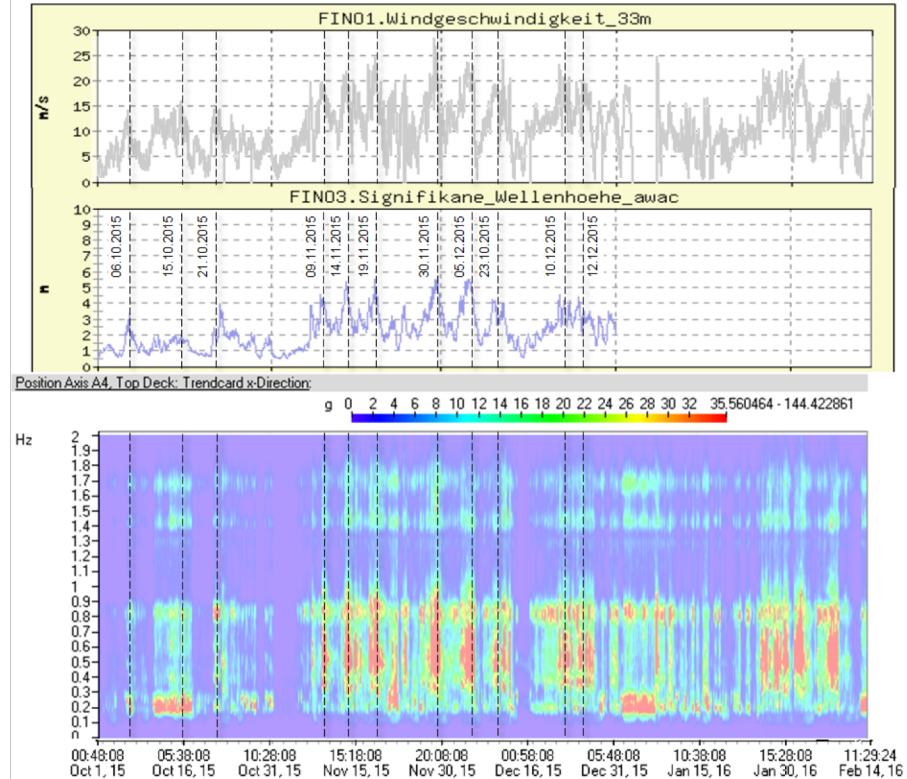
North Sea Application

Correlation: Weather vs Response

Wind [m/s]

Waves [m]

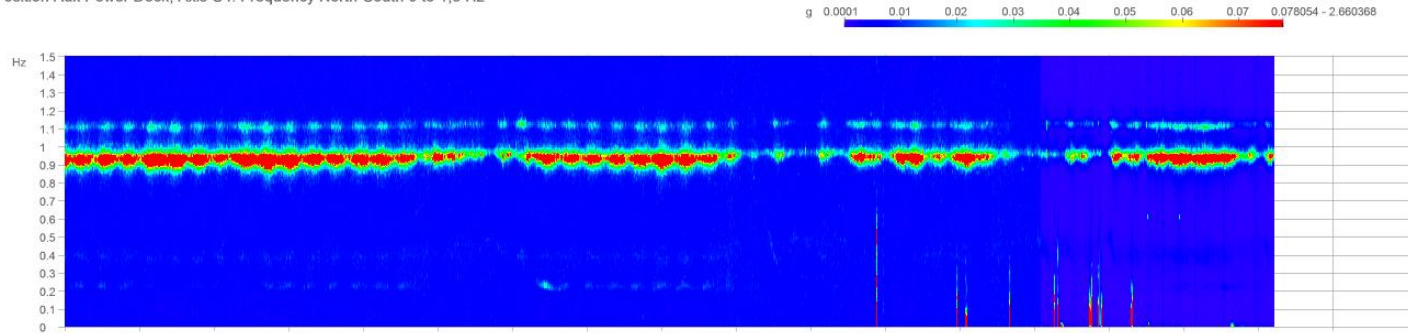
System Response [Hz]



Performance Indicator: Dynamic Signature

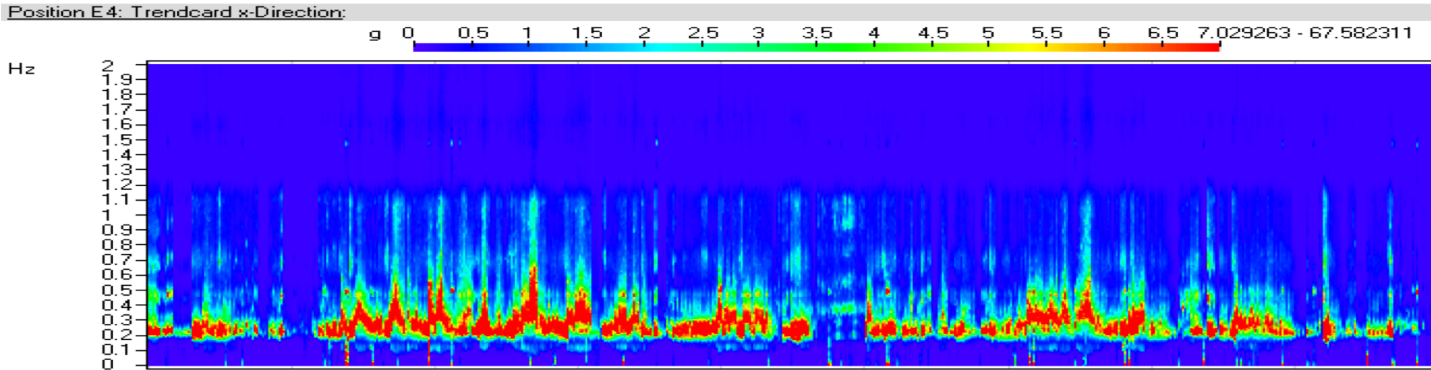
Desired Performance

Position Aux Power Deck, Axis C4: Frequency North-South 0 to 1,5 Hz



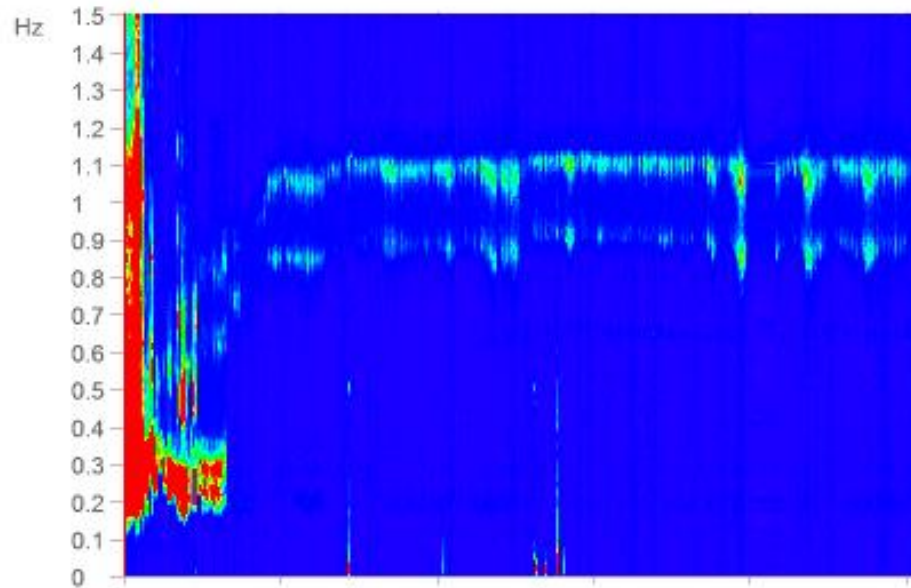
Monitoring Results (Trend Cards)

Monitored Performance



Performance Indicator: Dynamic Signature

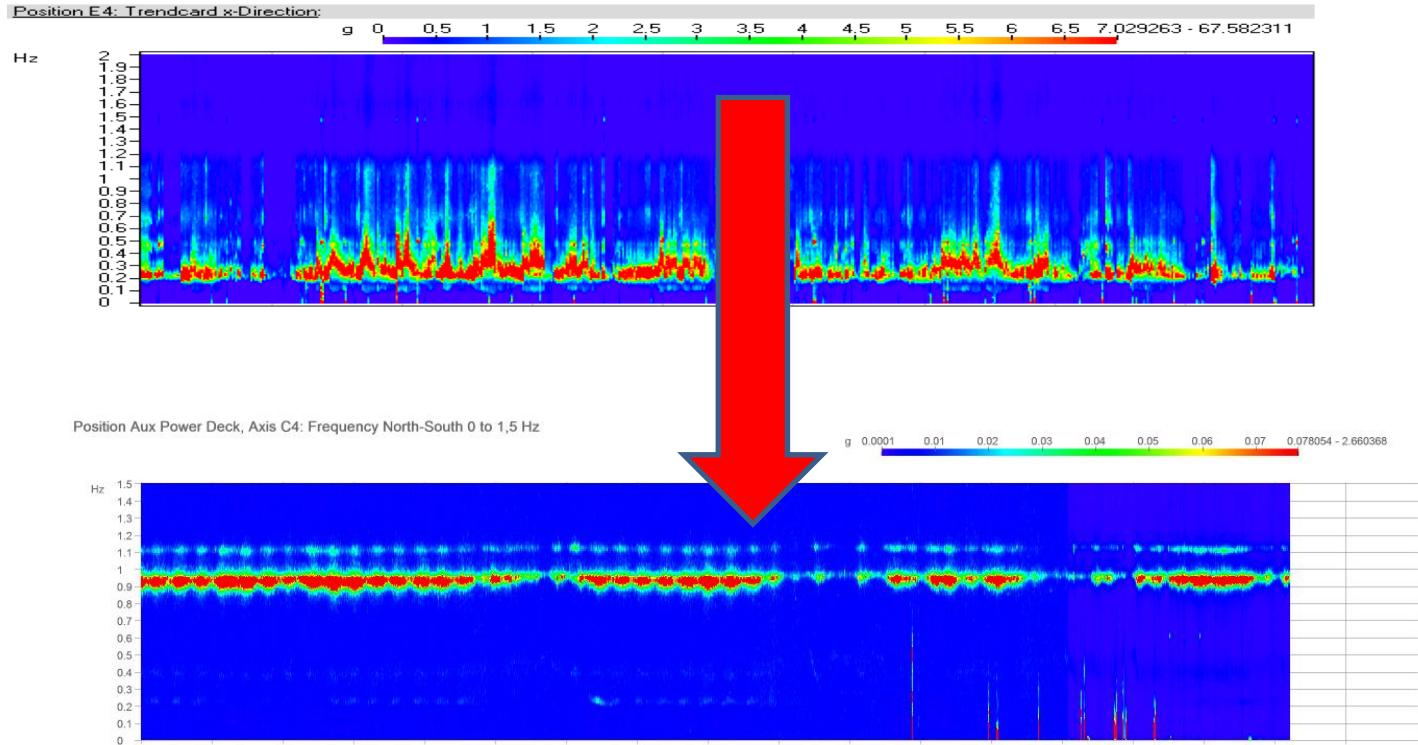
Position Top Deck, Axis D1: Frequency East-West 0 to 1,5 Hz



Performance during Repair Works

Performance after Mitigation

Relevant frequencies shifted from 0,23Hz to 0,92Hz



Example

Signature Bridges in Turkey

Monitoring of Signature Bridges in Turkey



Osmangazi Bridge, (Main Span 1550 meters), complex SHMS, 420 channels



Halic Metro Bridge, Istanbul, Stay Cable Monitoring, 107 channels



3. Bosphorus Bridge in Turkey (1344m hybrid span)

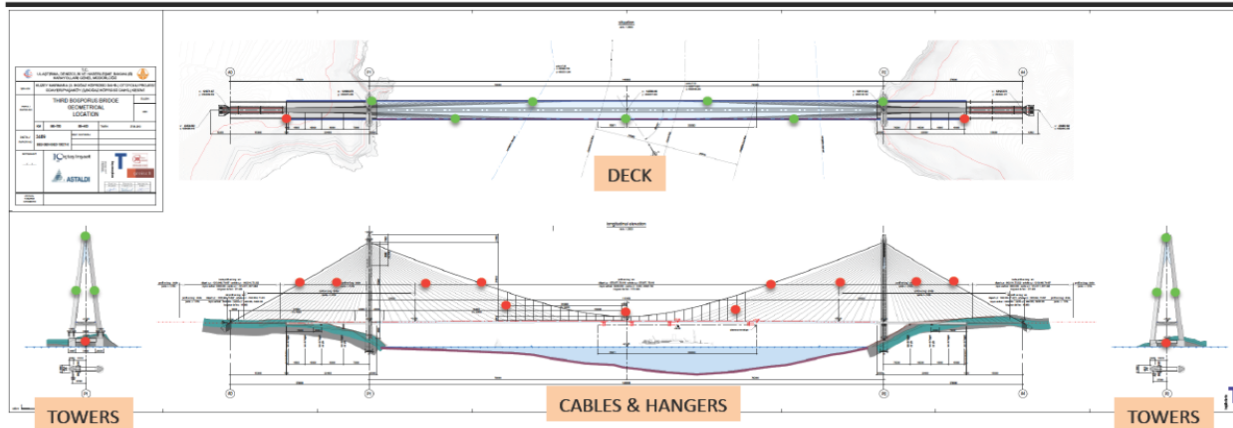


Table of Sensors

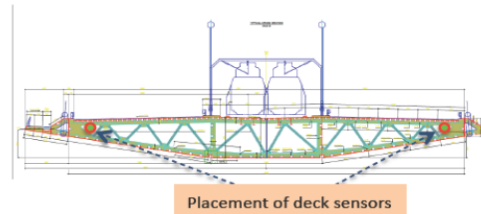
Sensor	Logo	Number of Sensors	Number of channels
Accelerometer:			
Tri-axial cable accelerometer	A3C	11	33
Tri-axial structural accelerometer	A3S	4	12
Bi-axial structural accelerometer	A2S	13	26
GPS:			
GPS-sensors at bridge	GPS	4	12
GPS reference station	GPS-R	1	3
Wind Sensor:			
Ultrasonic Wind 3d	W	3	9
Strain Sensor:			
Strain Gauge	S	12	12
Tilt:			
Tilt sensor Bi-axial	I	5	10
Weather Station:			
		1	
Ultrasonic wind 3d	W		3
Air humidity	H		1
Air temperature	AT		1
Barometric pressure	B		1
Rainfall	R		1
Sum		54	124
Other Equipment		Amount	
Master Station (Central data server)		1	
AD converters		as required	
Cables		as required	
System Software		1	
Lightning Protection		as required	
User Interface + Web user interface		1+1	

Accelerometer Layout 3. Bosphorus Bridge

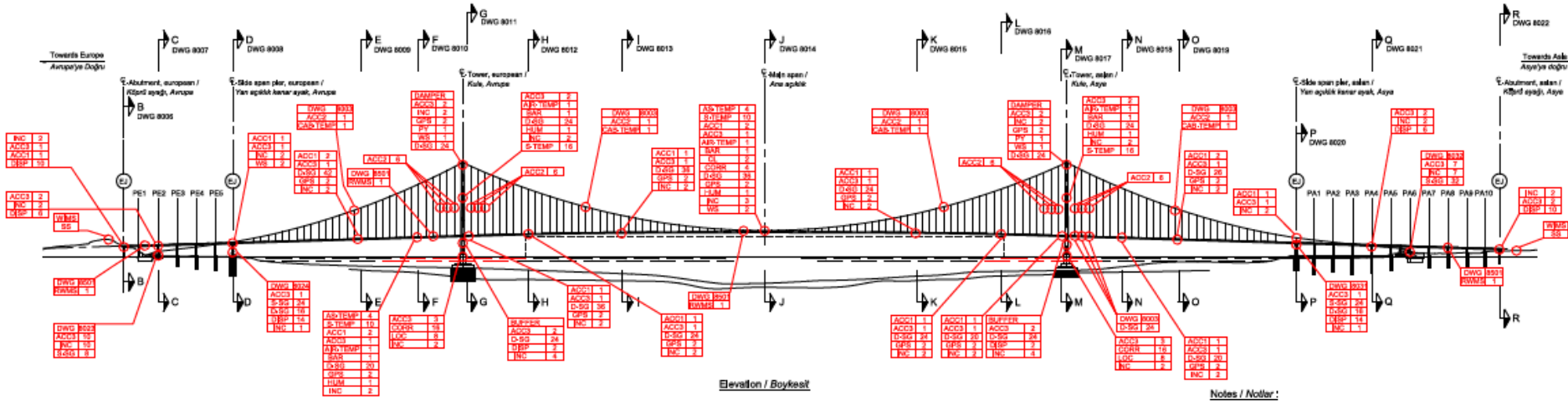
ACCELEROMETER LAYOUT



- Tri-axial accelerometers (15; $15 \times 3 = 45$ channels)
- Bi-axial accelerometers (13; $13 \times 2 = 26$ channels)
- Total number of acceleration channels = 71



Monitoring Layout 1915 Canakkale Bridge (main span 2023m)



> 1000 Sensors

Record Span
New Type of Design
High Visibility

Large System justified

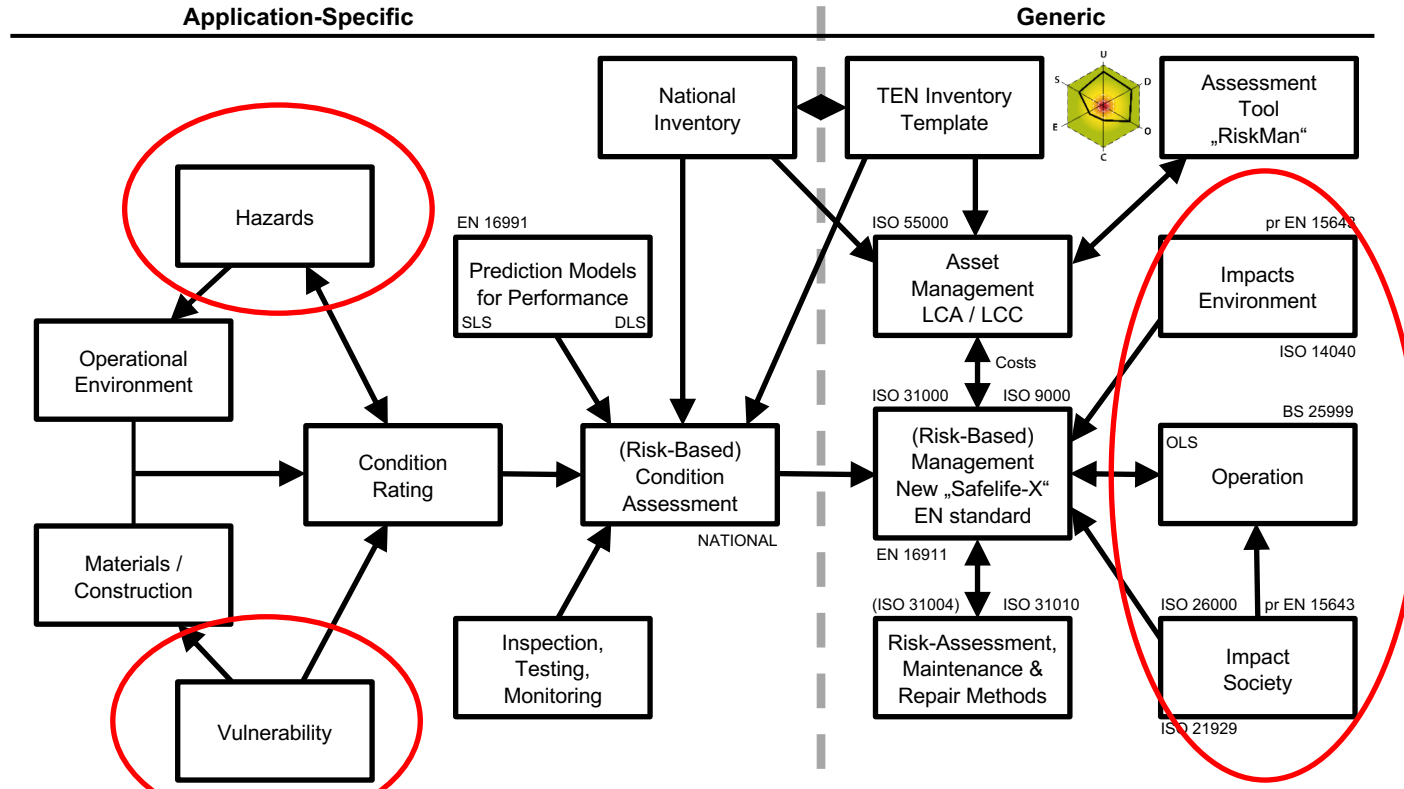
Relevant Standards for Risk Management

(helpful in practical implementation)

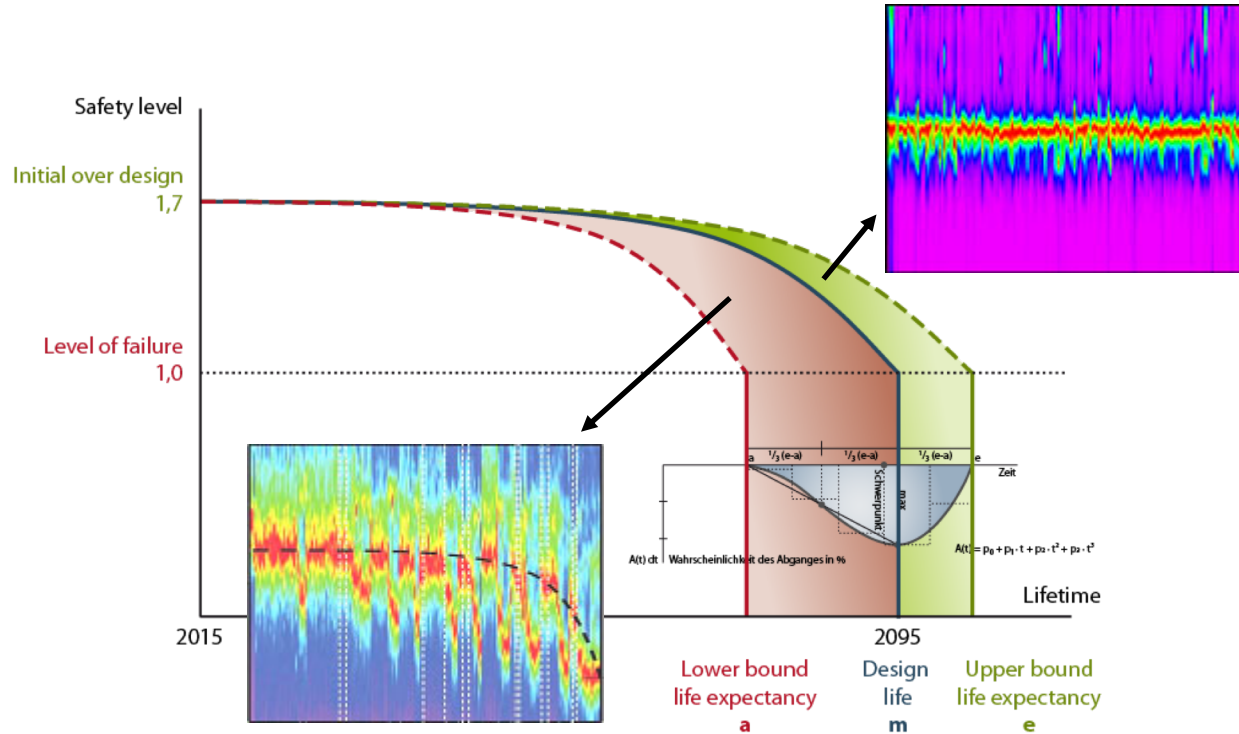
1. ISO 55000 Asset Management
2. ISO 31000 Risk Management Framework
3. EN 16991 Risk Based Inspection (2018)
4. ISO 21929 Sustainability of Construction Works (Draft only)
5. VDI 4551 Monitoring of Offshore Assets (2019 Germany)
6. RVS 13.03.11 Management of Bridges
7. OSHA Guidelines
8. National Safety and Security Guidelines
9. Individual Management Strategy (case specific)

Typical Risk and Asset Management in Industries and related Standards

Risk = Hazards * Vulnerability * Consequences

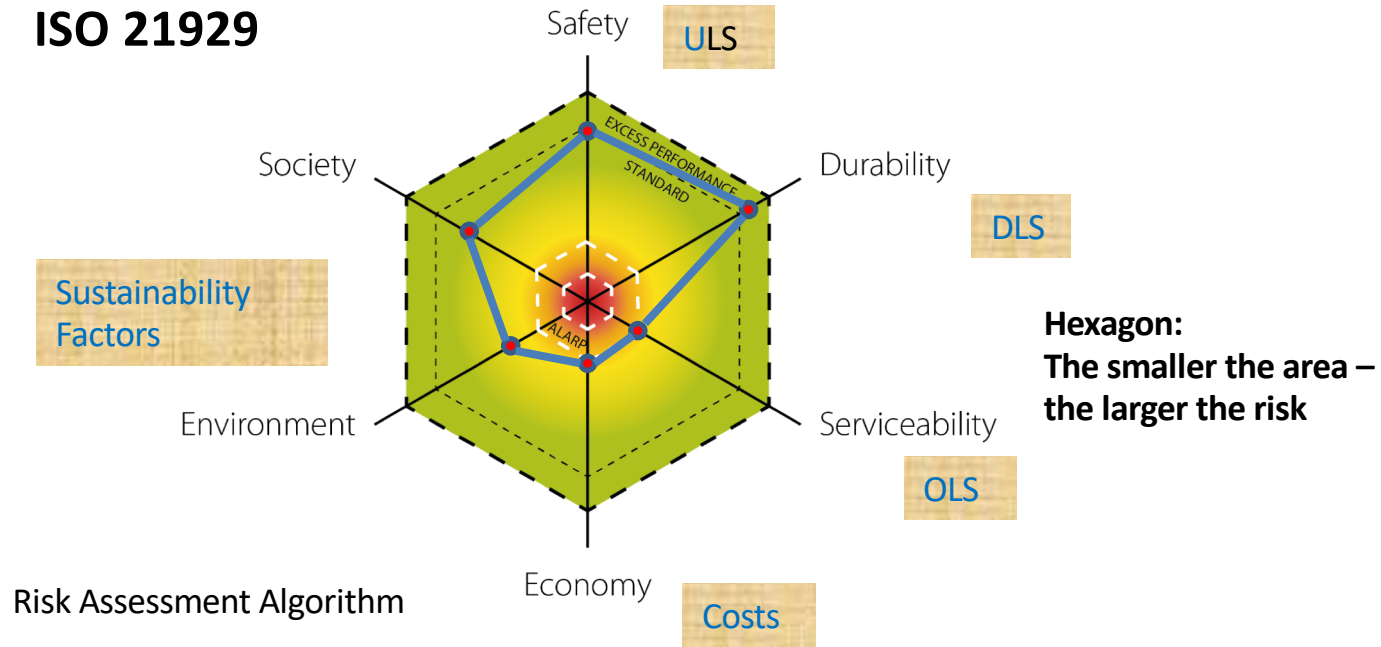


IRIS Aging Formulation (EN 16991:2018)



Quantification of Risk

ISO 21929



Summary (related to **New** Signature Structures)

- Risk and performance based approaches are key
- Apply Monitoring of specific depth initially
- A holistic risk management approach is recommended
- Ensure learning by doing (permanent operation)

Thank You !

helmut.wenzel@boku.ac.at

JCSS

Joint Committee
on Structural Safety

www.jcss-lc.org