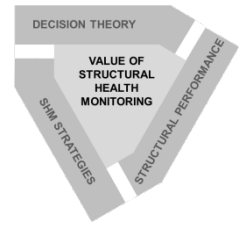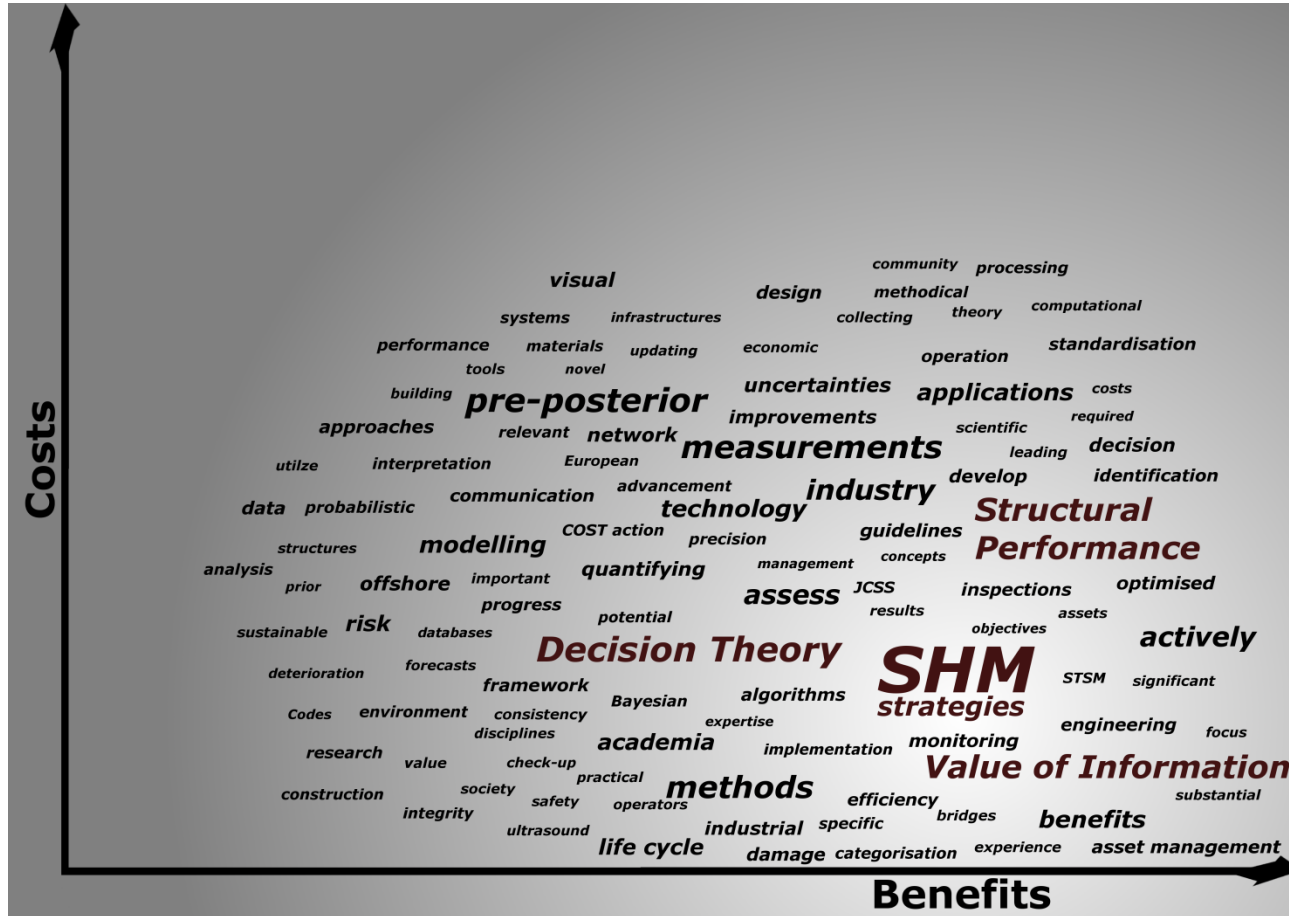# Classification for a Value of SHM quantification

Sebastian Thöns
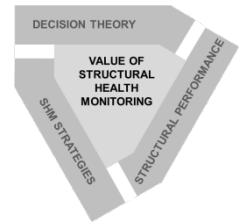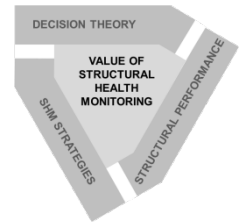
Introduction

Text Analysis produced by Henning Brüske

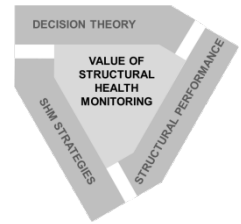# COST TU1402: Quantifying the Value of Structural Health Monitoring

Title:		
Classification		
Case description	Structure	
	Structural performance model	
	SHM strategy	
	SHM strategy model	
	Technology readiness level	
Value of Information	Results	
	Analysis type	
Structural performance	Structural reliability	
	Structural Integrity Management	
	Consequences	
Measurement information	Type	
	Relation to structural performance	
	Temporal characteristic	
	Spatial characteristic	
	Precision	Measurement uncertainty
		Operation uncertainty
		Data analysis (model) uncertainty
		Dependencies
	Costs	Investment
		Installation
		Operation and maintenance
		Replacement
Measurement system deployment	System	
	Technology	
	Handling	
	Analysis	

COST TU1402: Quantifying the Value of Structural Health Monitoring

Title:		Specification	Reference
Classification		Specification	Reference
Case description	Structure		
	Structural performance model		
	SHM strategy		
	SHM strategy model		
	Technology readiness level		H2020
Value of Information	Results	<Specify the value (e.g. risk reduction, expected cost reduction…)>	
	Analysis type	▪ Value of Information analysis ▪ Cost benefit analysis ▪ …	
Structural performance	Structural reliability	▪ Degradation mechanism ▪ Limit state Component analysis ▪ System analysis ▪ Time range ▪ …	
	Structural Integrity Management	▪ Non ▪ Time based ▪ Reliability based ▪ Risk based	
	Consequences	▪ Component repair, failure ▪ System repair, failure ▪ …	

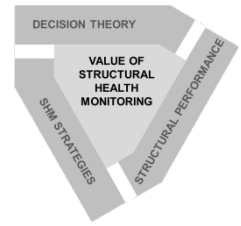# COST TU1402: Quantifying the Value of Structural Health Monitoring

Measurement information	Type		- Continuous - Discrete - Binary	
	Relation to structural performance		- Input variable of damage models - Direct measurement of damage - Indirectly coupled size	
	Temporal characteristic		- Discrete - Continuous - Time range	
	Spatial characteristic		- Local - System - Subsystem	
	Precision	Measurement uncertainty	<Specify probabilistic model and boundaries>	
		Operation uncertainty	<Specify probabilistic model and boundaries>	
		Data analysis (model) uncertainty	<Specify probabilistic model and boundaries>	
		Dependencies	<Specify correlation in precision model>	
	Costs	Investment		
		Installation		
		Operation and maintenance		
		Replacement		
Measurement system deployment	System		<Describe system components>	
	Technology		<Name technology>	
	Handling		<How are the measurement performed>	
	Analysis		<Specify analyses resources needed, e.g. time, computational resources>	

Classification and specification for application by industry and authorities

Title:		Specification	Reference
Classification		Specification	Reference
Case description	Structure		
	Structural performance model		
	SHM strategy		
	SHM strategy model		
	Technology readiness level		H2020
Value of Information	Results		
	Analysis type		

Classification and specification for selection of case studies

Title:		Specification	Reference
Classification		Specification	Reference
Case description	Structure		
	Structural performance model		
	SHM strategy		
	SHM strategy model		
	Technology readiness level		H2020
Value of Information	Results		
	Analysis type		
Structural performance	Structural reliability		
	Structural Integrity Management		
	Consequences		
Measurement system deployment	System		
	Technology		
	Handling		
	Analysis		

Example: Offshore Wind Turbine Structures Monitoring

Title: Offshore Wind Turbine Structures Monitoring			
Classification		Specification	Reference
Case description	Structure	Wind turbine support structure (tower and tripod)	Thöns, Faber et al. (2013)
	Structural performance model	Fatigue degradation, SN approach	
	SHM strategy	Hot spot strain gauge monitoring	
	SHM strategy model	Assumed stress range data from Rainflow counting	
	Technology readiness level	8	
Value of Information	Results	▪ Total life cycle costs saving up to 11% ▪ Risk reduction up to 33% ▪ Expected cost reduction for inspections up to 3.9%	
	Analysis type	Service life cost benefit analysis with assumed strain measurements	
Structural performance	Structural reliability	▪ Fatigue degradation mechanism ▪ Wind turbine structural system analysis ▪ Time range: service life	
	Structural Integrity Management	▪ Reliability based inspection and repair planning	
	Consequences	▪ Component inspection, repair, failure	
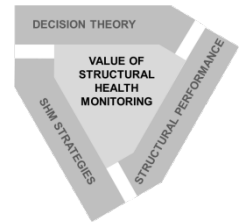
Example: Offshore Wind Turbine Structures Monitoring

| Measurement information	Type		▪ Continuous
	Relation to structural performance		▪ Input variable of damage models
	Temporal characteristic		▪ Continuous
	Spatial characteristic		▪ Local
	Precision	Measurement uncertainty	Varied
		Operation uncertainty	Not explicitly modelled
		Data analysis (model) uncertainty	Not explicitly modelled
		Dependencies	Not accounted for.
	Costs	Investment	1.33×10^{-4} 1/channel
		Installation	1.33×10^{-4} 1/channel
		Operation and maintenance	2.00×10^{-4} 1/channel
		Replacement	Not explicitly modelled
Measurement system deployment	System		Strain gauges, amplifier, data recording unit
	Technology		Strain gauge
	Handling		Installation and cabling of sensors (size a few centimetres) by qualified personal
	Analysis		Near real time, desktop computer, Absolute strain measurements
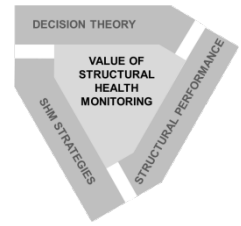
Conclusions

The proposed classification facilitates a consistent analysis, communication, comparison and dissemination of relevant information related to the Value of SHM.

The main functions are:

- Organization and performance of a Value of Information analysis by scientists and engineers
- Development and optimization of SHM strategies by industry
- Identification of efficient SHM strategy by infrastructure owners, operators and authorities
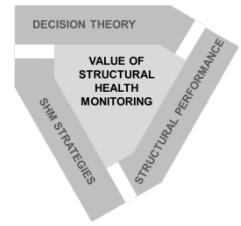
Outlook

Network contribution

- Further development/detailing of classification
- Collection and documentation of analyses

Please provide me with your feedback!

COST TU1402: Quantifying the Value of Structural Health Monitoring