

Floating Wind Solutions

Cost effective O&M strategy for offshore wind farms

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BUREAU VERITAS



Organized by



Quest Offshore



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Cost effective O&M strategy for offshore wind farms



Bureau Veritas at a glance

Offshore & Floating Wind market insight

Asset Integrity Strategy

Risk-based inspection (RBI)

Structural Health Monitoring (SHM)

Remote Inspection Techniques (RIT)

Digital platform / Digital Twin



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THE LARGEST TIC* BODY INVOLVED IN MARINE & OFFSHORE CLASSIFICATION

€4.6bn

REVENUE IN 2020

400,000

CLIENTS

75,000

EMPLOYEES

1,600

OFFICES AND
LABORATORIES

(*) TIC = Testing, Inspection & Certification

KEY FIGURES IN OFFSHORE WIND

340+

Dedicated OSW
professionals

16+

GW installed
capacity

9+

Active countries
and regions

55+

Offshore wind
projects globally

12+

Years experience

6+

New markets in
development

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Offshore & Floating Wind market insight

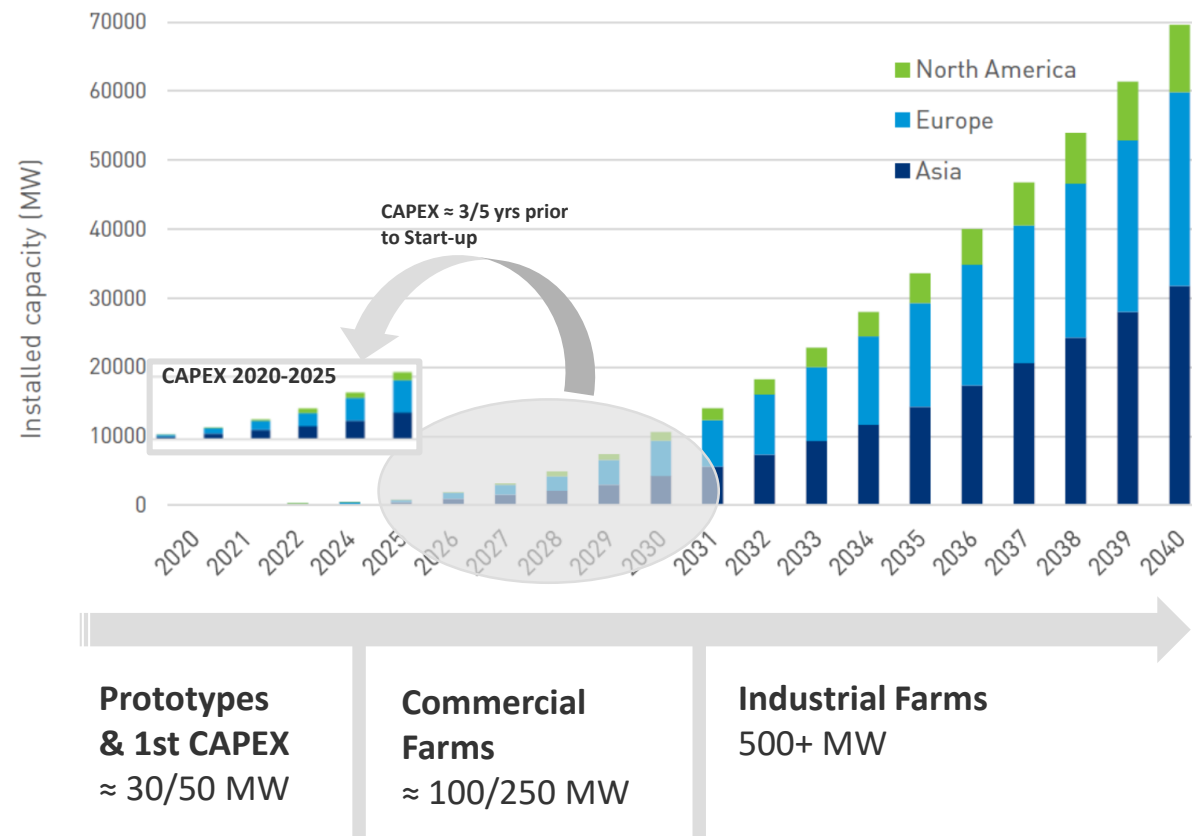
OUTLOOK

- Global potential for Floating Wind is **huge**
- +4 TW potential capacity in Europe
- +2.5 TW potential capacity in the USA
- Expected installed capacity by 2030: **10-20 GW globally**
- From 2023: Commercial Floating Wind production
- 2020-2023: **30+ projects** announced: prototypes + EPC phases for large projects
- BV is **#1 on Floating Wind** Certification

KEY GEOGRAPHIES

- UK
- JAPAN
- USA
- KOREA
- FRANCE
- BRAZIL, INDIA, VIETNAM...

FLOATING WIND CUMULATED CAPACITY (MW)



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Asset Integrity Strategy: Offshore Wind & OFFSHORE O&G

• What's similar?

		Impact for Offshore Wind operator
Offshore  Wind = O&G 	• Need to handle complex Offshore environment • Complex and weather-dependent logistics for maintenance personnel • Harsh environment for structural fatigue and corrosion • Need to ensure highest safety standards for offshore personnel • Need to supervise different maintenance subcontractors (turbine, cables, etc.) • Unmanned platforms hindering reactive maintenance • No homogeneity of regulations across countries	• Advanced expertise to inspect and assess structures and equipment • Advanced offshore HSE procedures • Strong supplier QA/QC audit scheme • Predictive maintenance schemes • Global approach customized to local regulations

Asset Integrity Strategy: Offshore Wind & OFFSHORE O&G

• What's different?

		Impact for Offshore Wind operator
Offshore  Wind ≠ O&G 	• Different risks (people, environment, assets) in Offshore Wind	• Adapted (structural and mechanical) safety standards, no safety case regime (UK)
	• Less process equipment, higher electrical component • Lower Number elements and but higher number systems/disciplines	• Strong RoI to invest in maintenance monitoring & analytics (e.g. oil condition monitoring) and risk-based inspection schemes (e.g. RBI schemes) • Digital Twin opportunity
	• Fully unmanned Offshore Wind farms	• Strong business cases for maintenance digitization (Remote inspection , instrumented assets, etc.)
	• Redundancy at global WF level • Variability in the wind resource • Financial dynamics (subsidies, etc)	• Different fatigue patterns for rotating equipment (variable cycles instead of steady flows) • Adapted Asset management strategy (optimum between production and long-term availability)

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Asset Integrity Strategy: Key Points

Global
OpEx approach
(HSE, Integrity,
Performance)

customized
to local regulation
(statutory
inspections)

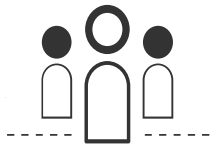
Advanced expertise
to inspect and
assess condition of
structures, rotating and
electrical equipment

Risk-based approach
(not prescriptive)

Adapted safety standards for
structural
and mechanical matters

Digital twin supporting
asset instrumentation and
remote inspection techniques

Asset Integrity Strategy: Our Vision for Offshore Wind Asset Management



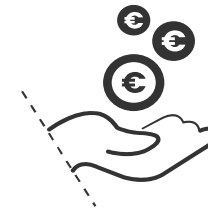
SAFETY

Always first



INTEGRITY

Inspections, monitoring and
maintenance to preserve
your asset



PERFORMANCE

Output optimization to
maximize the return

Asset Integrity Strategy

OPERATIONS

To preserve integrity and functionality

- Maintenance: preventive, predictive, corrective, spare parts / supply chain, logistics, etc.

COST

To regulate (maximize) output and life

- Active power, reactive power, availability
- Electricity price dependency?
- Life management

INCOME

**RIGHT *BALANCE* DEPENDING ON
CLIENT OBJECTIVES**

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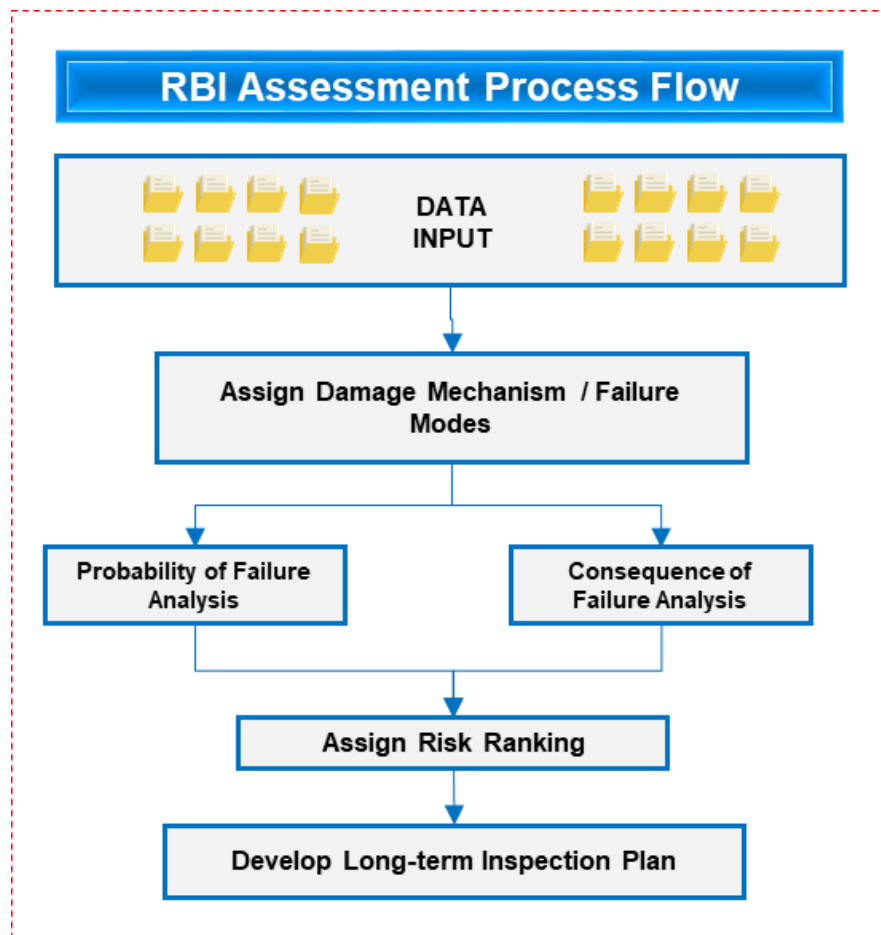


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RISK BASED INSPECTION PROGRAM (ENGINEERING & INSPECTION)



RBI methodologies already developed by BV for the O&G Industry:

Jacket Structures	BV NI 624
Topsides Structures	BV NI 653
Hull structures	BV NI 664

Adapted inputs for Offshore Wind

- What is client objective? Availability? Efficiency? Safety?
-> combination of all that.
- What is the unacceptable event that underpins the concept of risk:
Safety incident? Pollution? Loss of asset availability?

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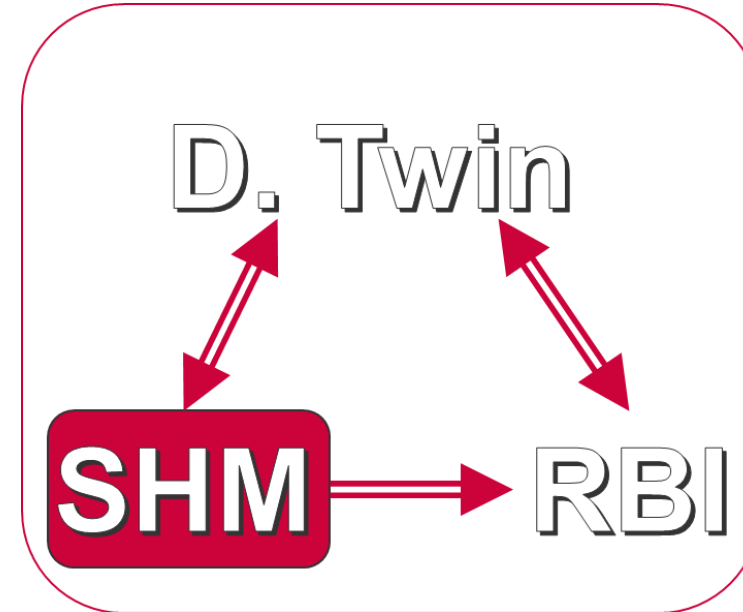
Structural Health Monitoring (SHM)

- Structural Health Monitoring (SHM):
 - “assess health of a structure at any given moment in time”
 - Predict remaining service life
 - Inspection & Operations support
 - Lifetime extension
 - Rules & software development



Structural Health Monitoring (SHM)

- SHM: a brick in the AIMS



Whole SHM system



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Structural Health Monitoring (SHM)

- OBJECTIVE: “assess structural health at any given moment in time”

- 3 main types of SHM

- Sensor Based SHM:

Classical method

Measured response (stress, accelerations, motions)

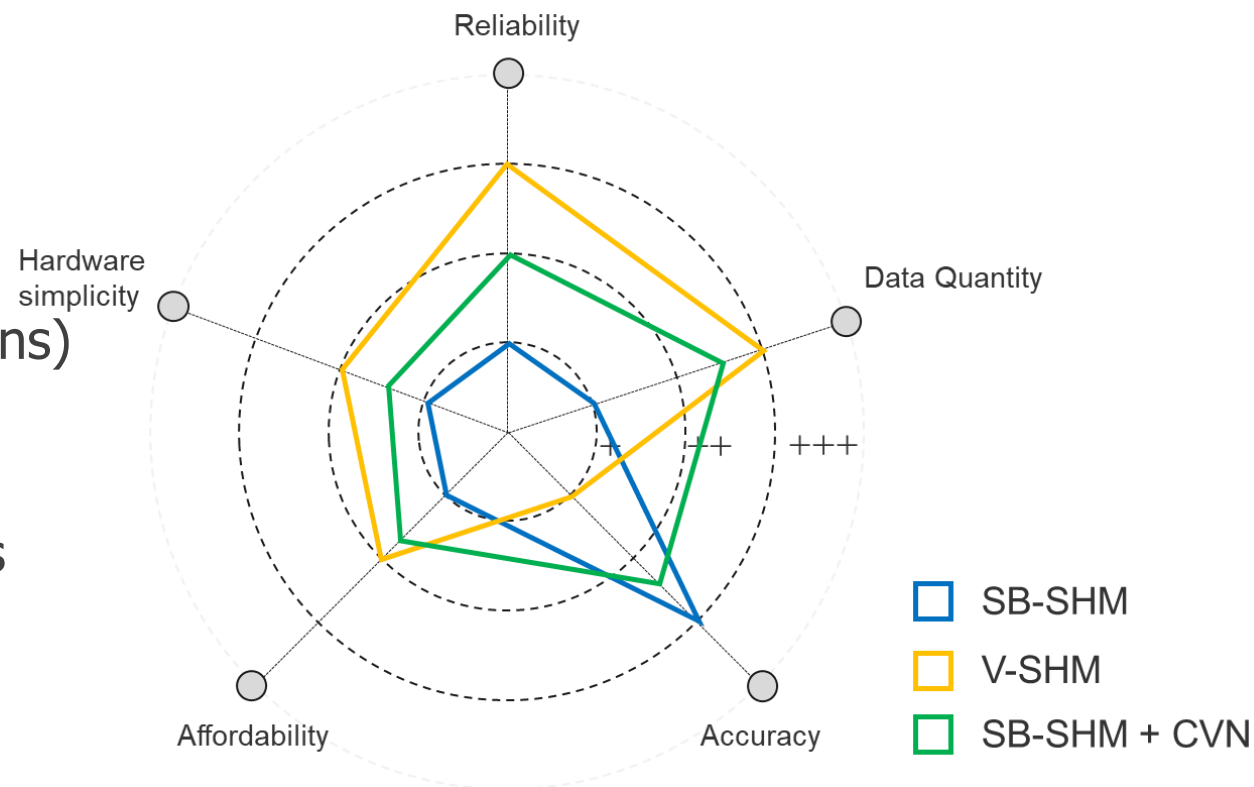
- Virtual SHM:

Computed response via Hydro-structure analysis

- Sensor Based + Conversion matrix:

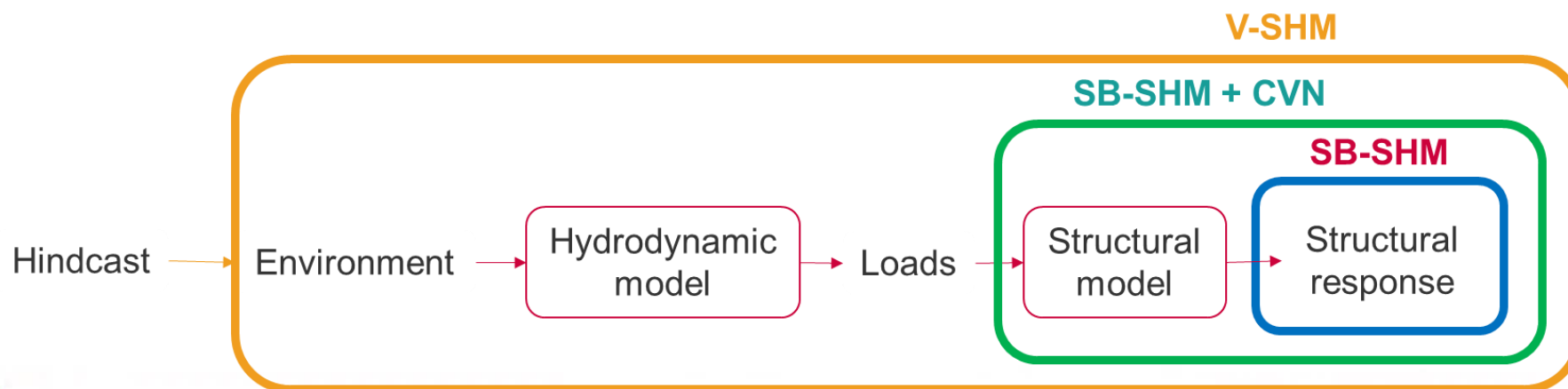
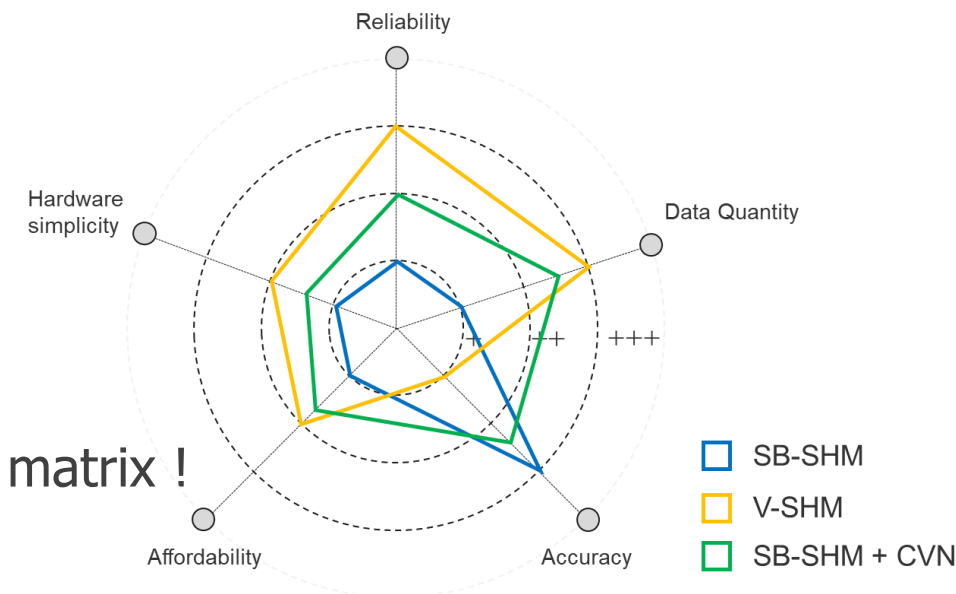
Innovative approach (R&D stage)

Extension of classical method



SHM: Sensor Based + Conversion matrix

- Accuracy of Conversion matrix approach
- Less simulation uncertainties compared to V-SHM
 - No hydrodynamics
 - Environment knowledge is not needed
 - Only need a representative structural model
 - ... and the proper methodology to compute the conversion matrix !



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Remote Inspection Techniques (RITs)

NoMan Camera
Visual Inspection



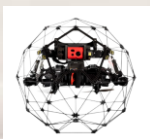
Pole
UTM & Visual Inspection



ROV
Under Water Survey
WBT survey



Drone
Visual Inspection



Computer vision
IA corrosion detection
Internal Development



RITs: Which Technologies?



Drone
UTM

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Remote Inspection Techniques (RIT)



1

SAFETY

- ✓ No access to confined spaces
- ✓ No working at height



2

TIME SAVING

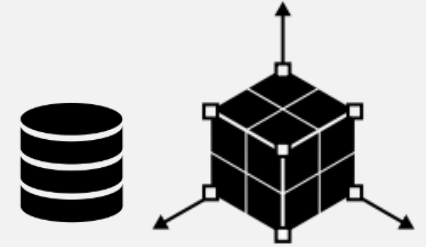
- ✓ Reduce confined space preparation time
- ✓ No need preparation onboard
- ✓ Up to 30~50% inspection time reduction
- ✓ Better planning and better anticipation of the immobilization



3

COST SAVING

- ✓ Reduce the extent of the means of access



4

QUALITY RECORDS

- ✓ Complete record of structure condition
- ✓ Data driven opportunities for condition monitoring and predictive maintenance
- ✓ New opportunities based on 3D modelling

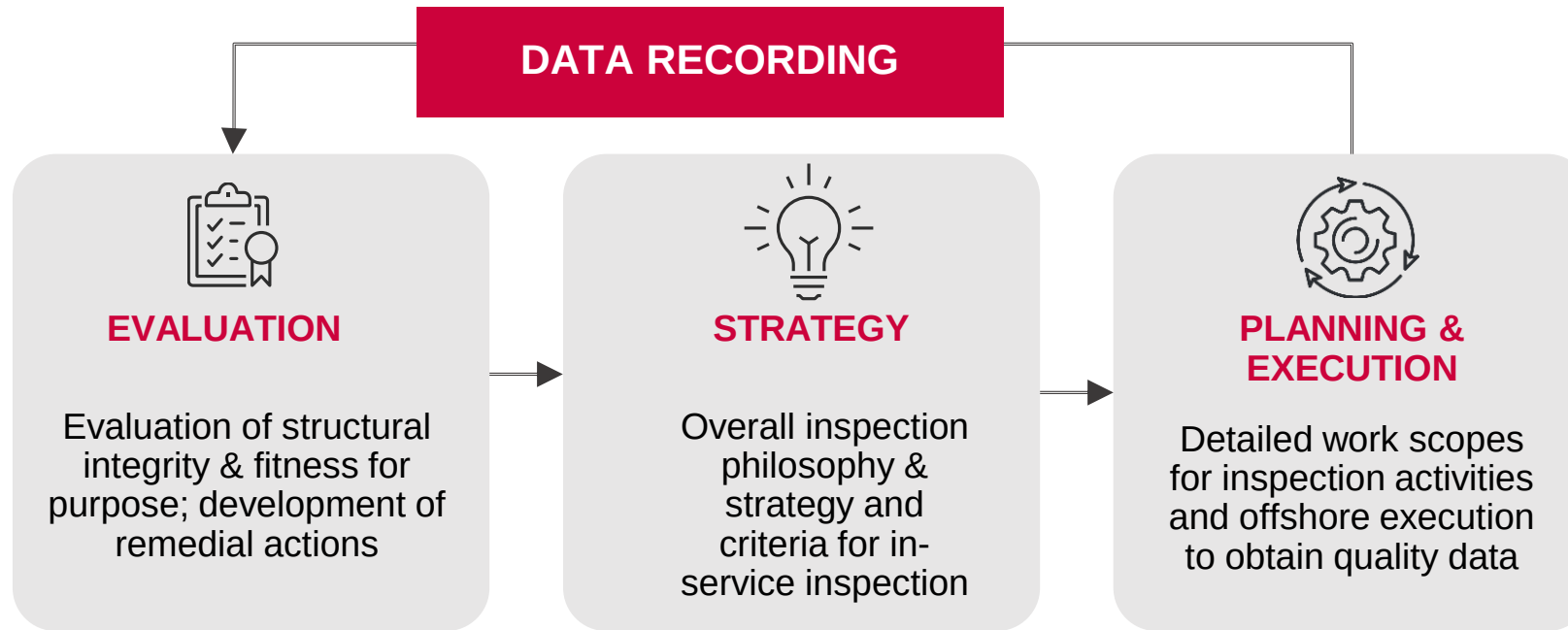
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Digital platform / Digital Twin

Managed system for archive and retrieval of structural integrity data
& other pertinent records



Ensure optimum alignment between the efforts invested in IMR and the ROI ("Pareto" principle)

Digital platform / Digital Twin

- What is a DIGITAL TWIN?

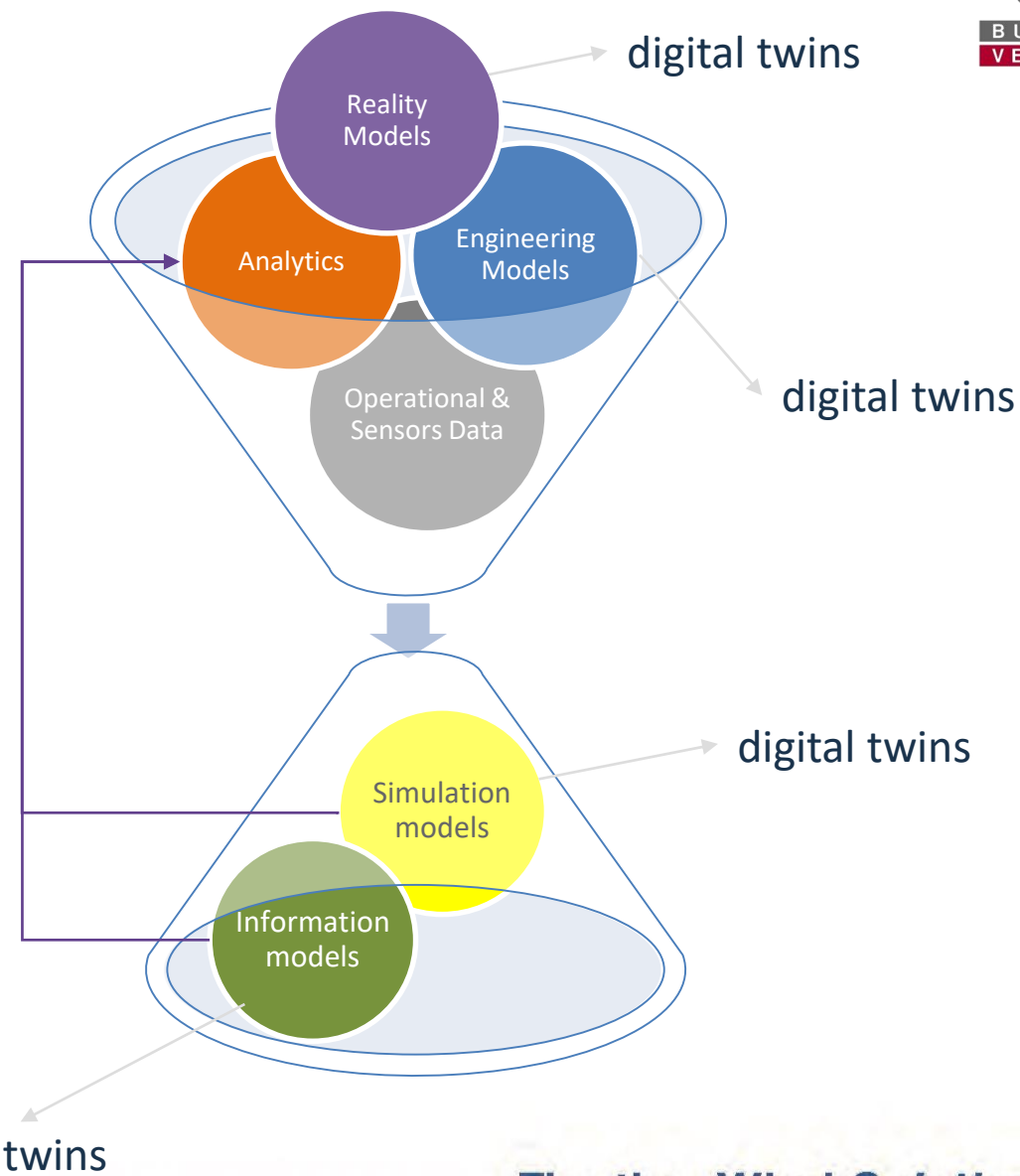
HOLISTIC CONCEPT:

A multiphysics and comprehensive virtual model of a physical asset

Digital Representation of:

- Asset
- Related processes
- Systems
- Information

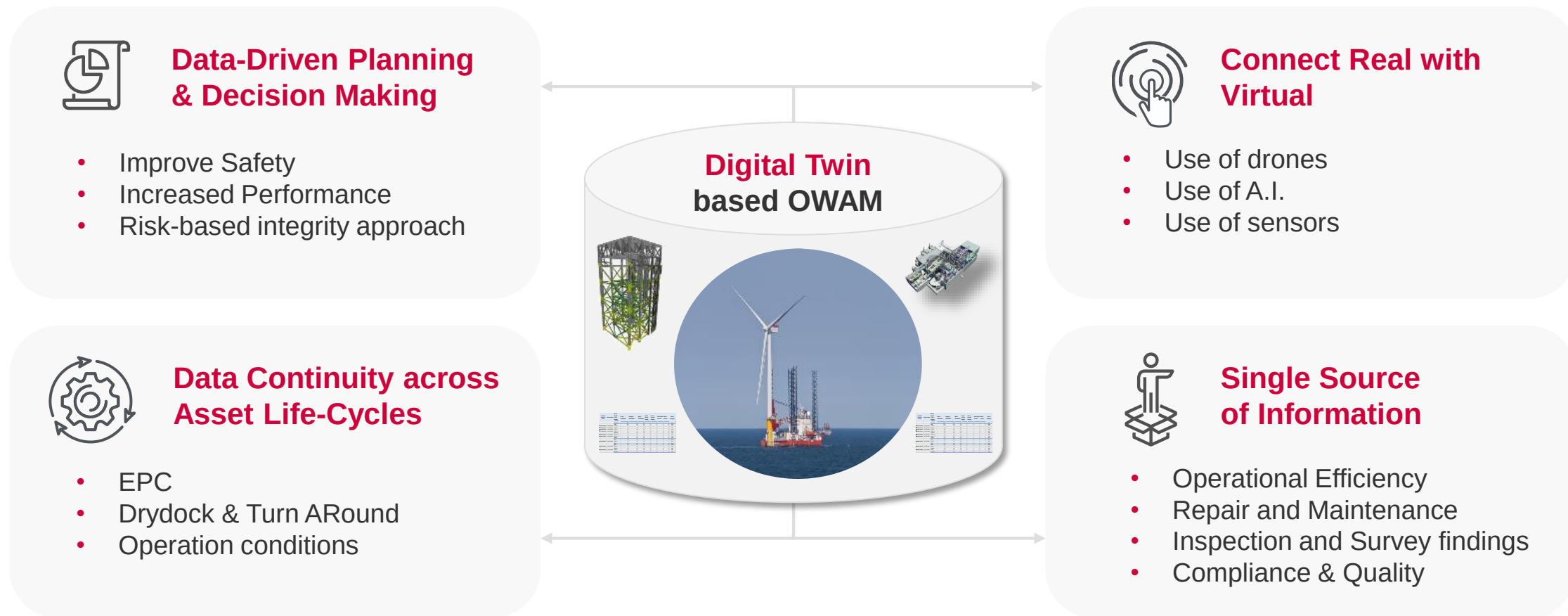
Digital Twin



OUYANG, A. 'Implementation of new Business Models based on Digital Twins in the context of Servitisation and Digitalisation',
LUDVIGSEN, K.B., ØYVIND S., 'Digital Twins for Blue Denmark'

Digital platform / Digital Twin

• The Added Value of a DIGITAL TWIN



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CONCLUSION

- Digital Classification

Develop and train the owners/operators on the different technologies / solutions for **Remote Survey** and **Remote Inspection Techniques**.

- **BV NI 672 – Guideline for Remote Survey** published in June 2021
- Develop new technologies to inspect the internal & external Structure: UAV (Drone), ROV & AI
- Our objectives is to explore the future by carrying out Test / PoC / Pilots
- Define future opportunities based on Digital Survey (3D classification, Machinery Maintenance systems, RIT, etc.



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WANT TO KNOW MORE?

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