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InnoSHM – Innovative SHM and Risk-informed SIM

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RAMBØLL Bright ideas. Sustainable change.

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Participants in R&D project InnoSHM

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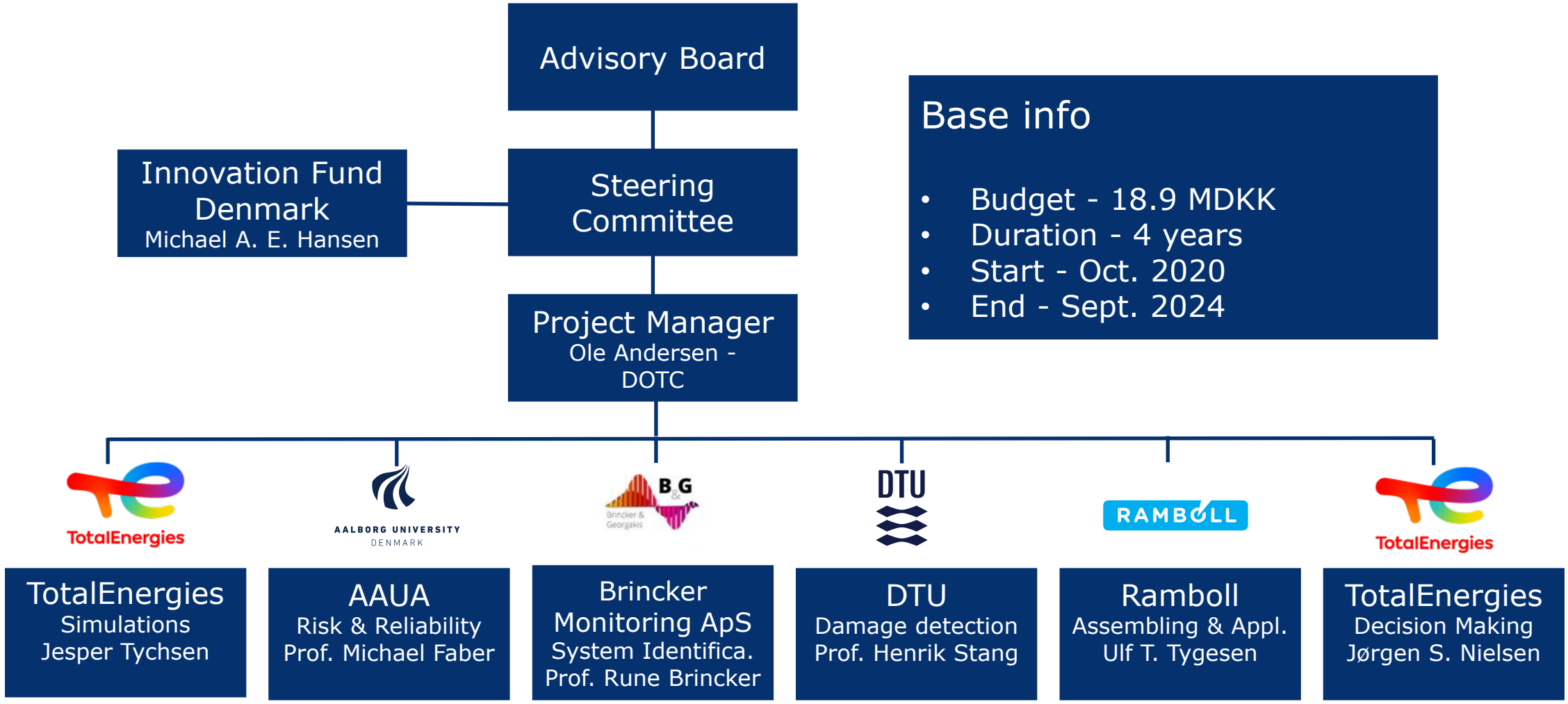
Bright ideas.
Sustainable change.

InnoSHM – Innovative SHM and Risk-informed SIM

Organization



Background - Challenge

Background – 20 Billion DKK investment in the Danish North Sea

The challenge:

- The **safety** for humans and the environment was **compromised** due to years of subsidence and discovery of knowledge gaps

Solution alternatives:

- **De-commissioning** of all Danish HC energy production in year 2018 (not selected)

or

- **Investing 20 billion DKK** on modifications (selected on-going)

Press release in 2017:

Largest Danish North Sea investment approved

by The Editorial Team — December 4, 2017 in Fuels

The Danish Underground Consortium (DUC) has approved an investment of approximately 21bn DKK, regarding the full redevelopment of the Tyra gas field. This will ensure continued production from Denmark's largest gas field and will protect Danish North Sea infrastructure.

InnoSHM funding by IFD, Grand Solution - Program – Sustainable Development Goals

Program goals to support

- "Affordable and clean energy"
- "Sustainable communities"
- "Industry innovation & infra-structure"

Sustainable change - InnoSHM

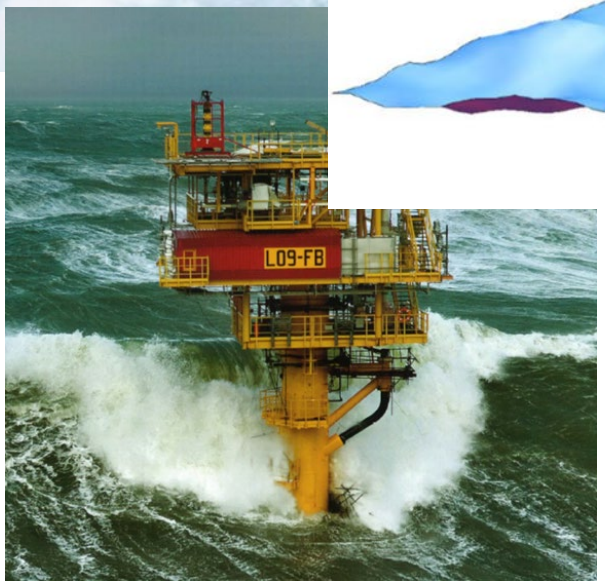
- Securing safe **transition** towards renewable energy in a period, where **production** from the Danish North Sea is **still needed**
- Supporting sustainable change – **reducing worlds consumption** of natural resources by re-using what is already there (infra-structure)
- Contribute to a **safer world** for both humans and the environment

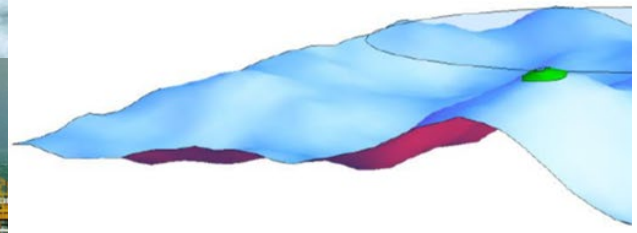
Value creation - InnoSHM

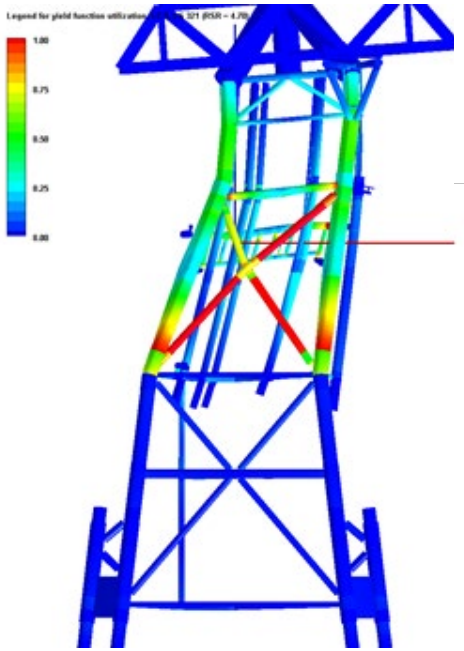
- **Reducing costs/materials (upgrade),** maintaining the oil & gas production in a transition period, and at the same time **increase the safety**
- Development of **multi-purpose** novel technologies not only for offshore structures - but **for all type of structures** such as wind turbines, bridges, buildings, towers etc.

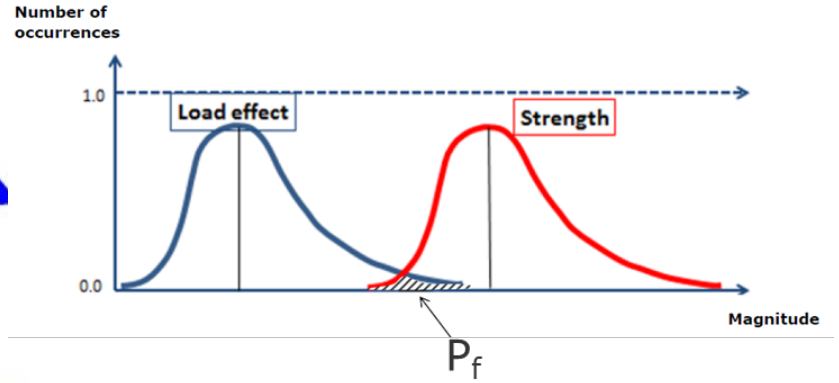
Solution to Challenge – Main Principle

10-15 Years of Extensive R&D -
Today's Safety in the Danish North Sea

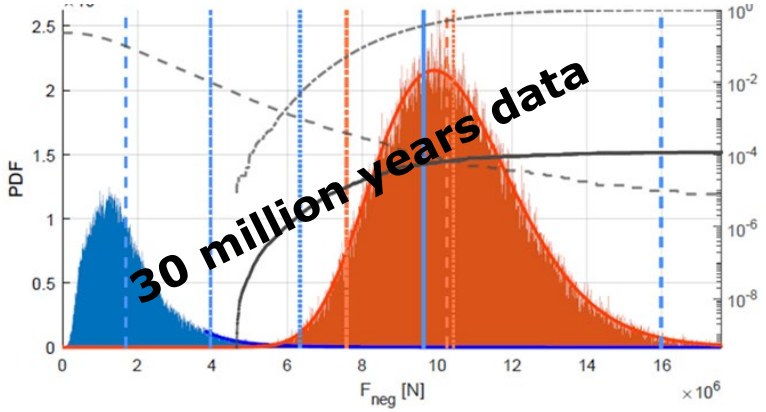






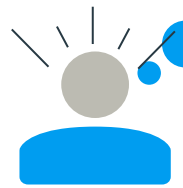


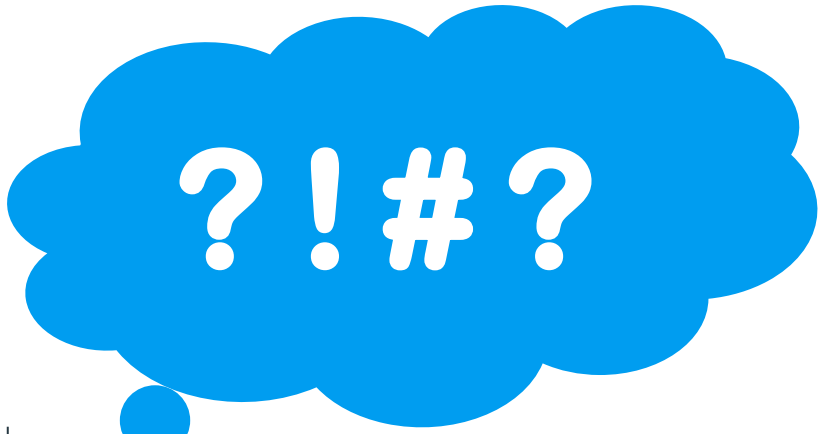
- **Today safety is in control**
- **Require huge investments**



Adding More Safety – Increasing Level of Information

Damage Detection (SHM) as Integrated Part of SIM





ASSET OWNER

NEED INFO –
DECISION MAKING

How to increase safety and create more value? - Implementation of Damage Detection as part of SIM

Increase safety

More information

Enabler for acting

Potential for acting and controlling and add more safety

Decision making - action & control

Integrity assessment

- Quick assessment of structural integrity and safety (damage detection)

Support decision making

- Continue production
- Shut-down production
- Evacuation
- Other mitigation (repair, safety procedures)

- Pre-defined action & control measures

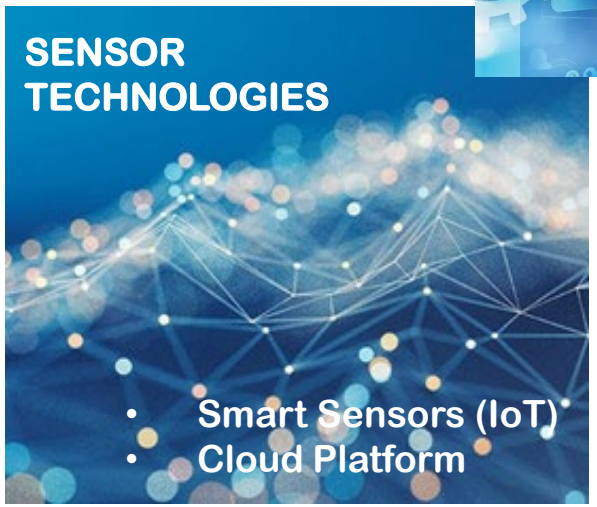
Value creation

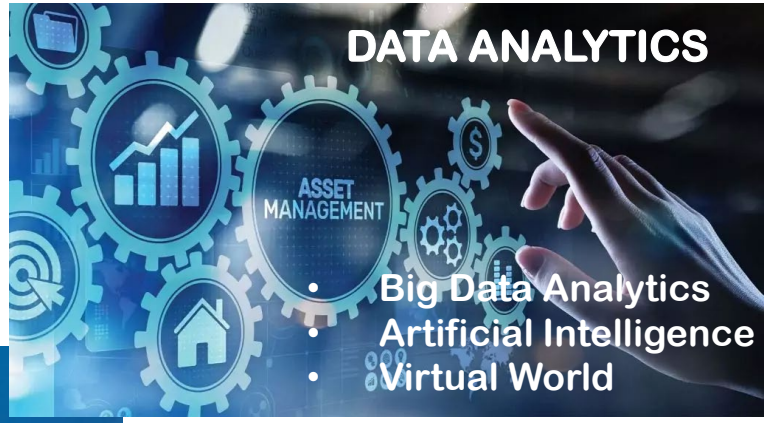
Value creation (cost & safety)

- Higher utilization of materials (activate more reserve capacity)
- De- and re-manning of platforms (evacuation)
- Early warning avoiding even larger structural problems and escalation
- Always knowing the real safety and being in control

Introducing Novel Technologies

Adoption of Novel Technologies -
Main Content in Project – 4 Themes



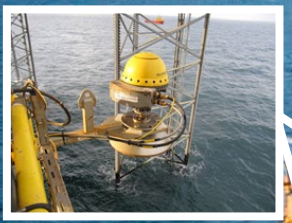


Sensor Technology – Sensing the World

Typical Sensors

ACCELEROMETER

WAVE RADAR



STRAIN GAUGE

CLOUD COMPUTING

Data Analytics – True Digital Twin (Existing Tech./ML)
Core Technology – All in one Integrated Analysis

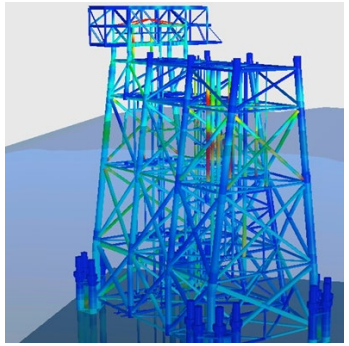
Creating a True Digital Twin

5 levels of the True Digital Twin is defined, where each level result in increasingly more value to the operator

Level 1
Sensing the world

Diagnostics, design & verification, increased safety

Level 2
Updating Models

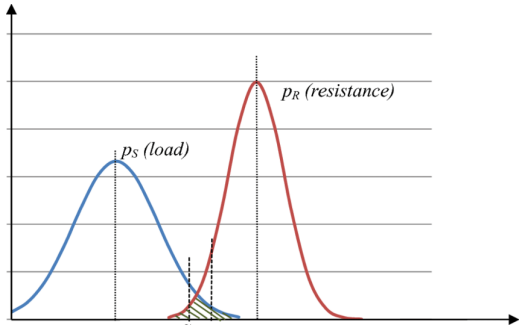


Increased safety

Level 3
Updating of Environment

Lifetime extension

Level 4
Safety Level - Probabilistic



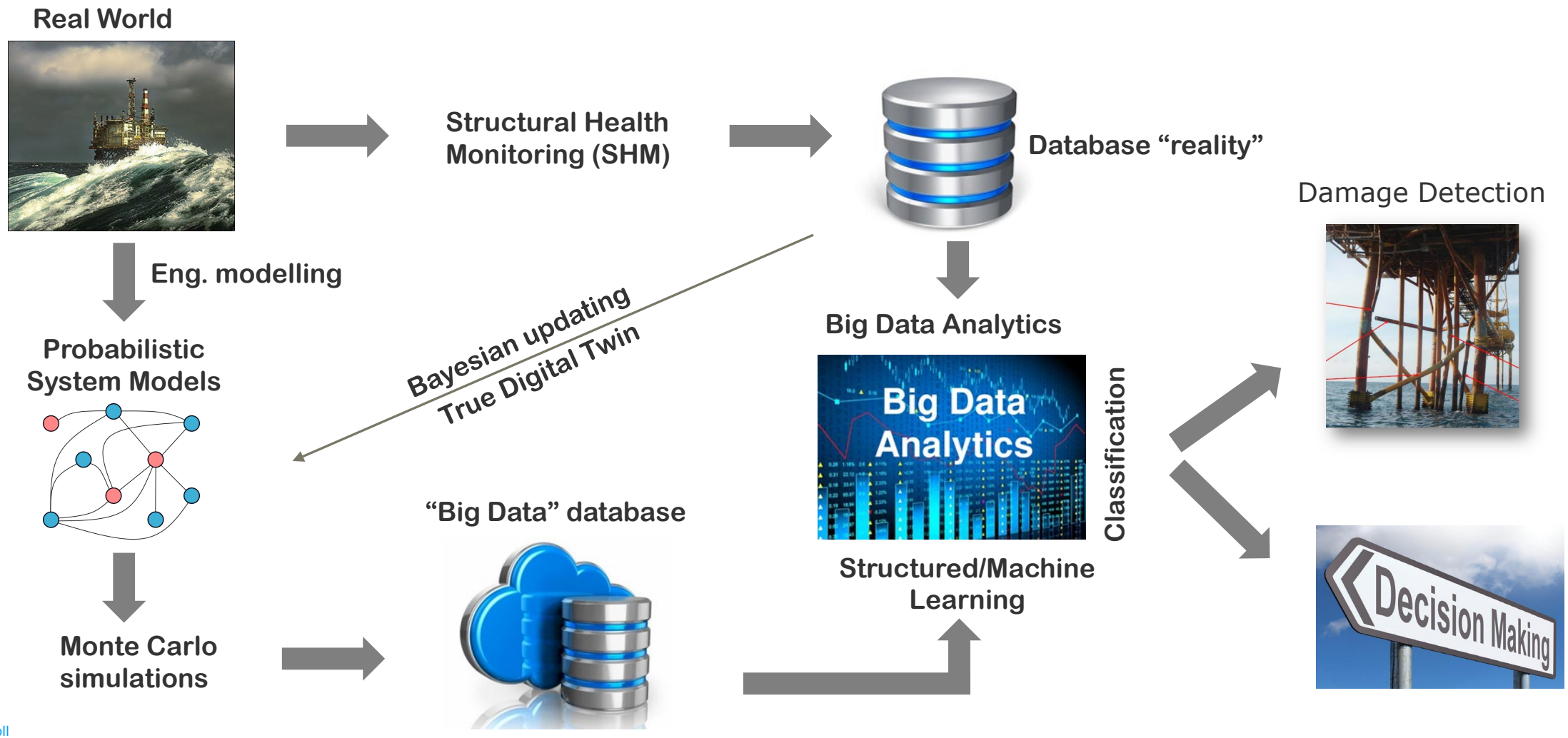
Increased safety, predictive maintenance, inspection planning, reducing operational costs

Level 5
Virtual world – Detecting changes - Decision making

Early warning, forecasting, evacuation, reducing full lifecycle costs, decision making

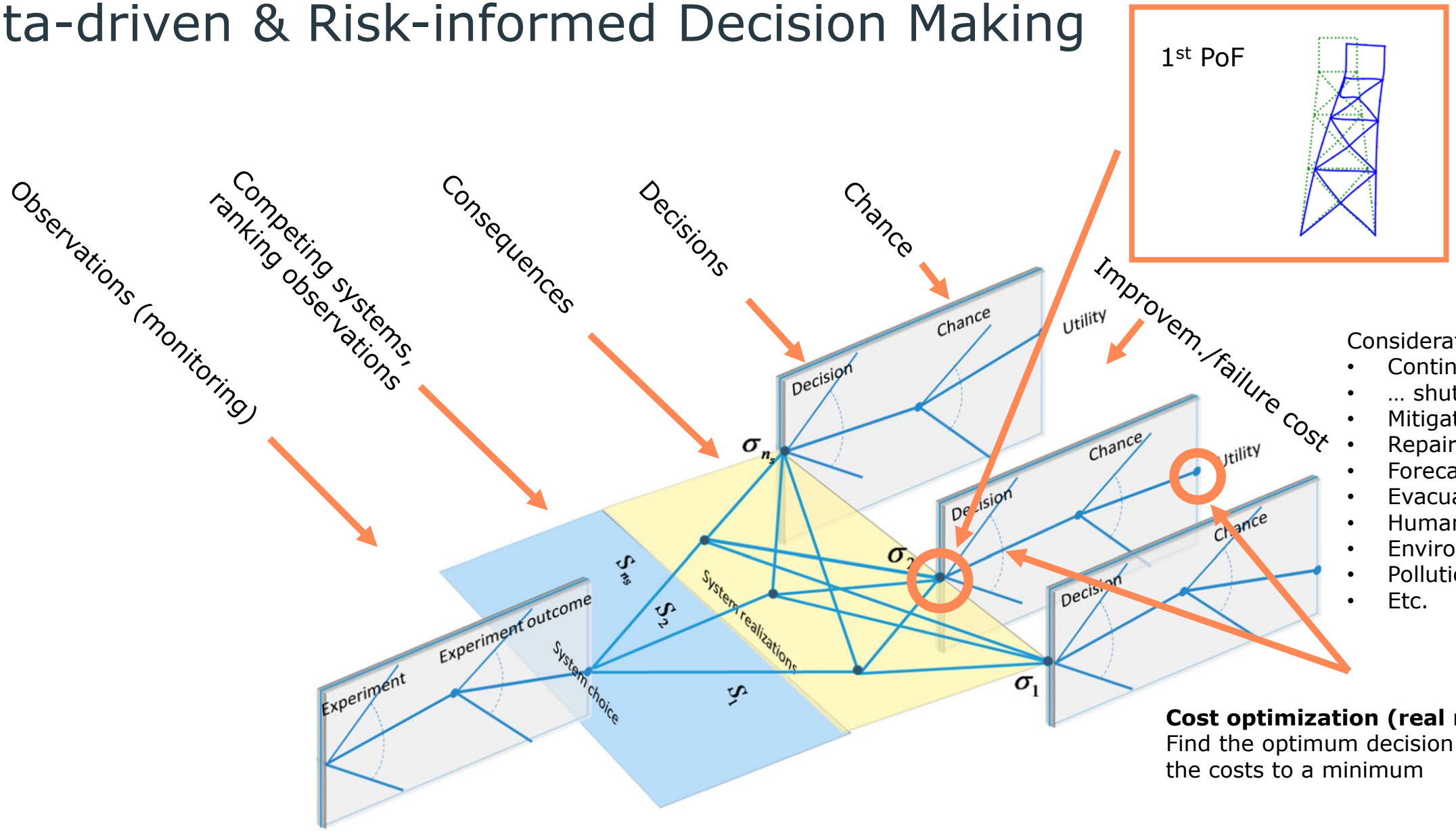
Data Analytics – Big Data Technology

Integrated Damage Detection in SIM incl. Decision Making



Decisions Making – Integrating Damage Detection

Data-driven & Risk-informed Decision Making



Considerations/actions:

- Continue or …
- … shut down
- Mitigation
- Repair
- Forecast
- Evacuation
- Human life
- Environment
- Pollution
- Etc.

Cost optimization (real risk):
Find the optimum decision reducing the costs to a minimum

Summary

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Summary -
Concluding Remarks

The Sustainable Change

- Background
  - - Facing huge investments in the Danish North Sea

- How to maintain the needed oil & gas production
  - - in a transitioning period towards renewables
  - - in a sustainable way (re-use of existing infrastructure)
  - - and at the same time increase safety
  - - for humans and the environment

- Benefit from implementing of the novel technologies
  - - Machine Learning & Big Data Analytics

- Value created by integrating damage detection in SIM
  - - in a Risk-informed and data-driven decision-making framework

- Multi-purpose technology applicable for all types of structures

Finish - Thanks

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