INTEGRERTE OPERASJONER

MULIGHETSROMMET VED DIGITALISERING AV DRIFT OG VEDLIKEHOLD

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Industry meets science, June 2017

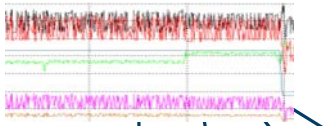
IO-historien om D&V

- IO Senter Fase I (2006-2011)
  - Retning I: Fysiske degraderingsmodeller, på systemer uten anerkjente metoder for tilstandskontroll (TK)
  - Retning II: Datadrevne og statistiske modeller, på systemer med anerkjente metoder for TK
- IO Senter Fase II (2011-2015)
  - Datadrevne modeller
  - Statistiske modeller
  - Prognoser og prediksjon
- IO Senter Fase III (foreslått)
  - Levetidsforlengelse og aldring
  - Tilstandsprognoser, prediktivt vedlikehold

INFORMATION FLOW FROM SENSOR TO DECISION-
IO Center research profile/focus

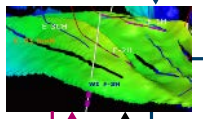
Offshore asset

Data/measurements



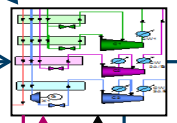
Simulators, data processing and models

Reservoir



Wells and pipelines

Process utilities



Pipelines/tankers Market

Information input from people

Advanced mathematical optimization

Advanced visualization

Information for visualization

Interaction between Software and people

Onshore engineer team

Interaction between people

Link video/ tele

Offshore control room

Link video/ tele

Supporting expert/ Manager in meeting

Information for visualization

Smartphone and tablet applications

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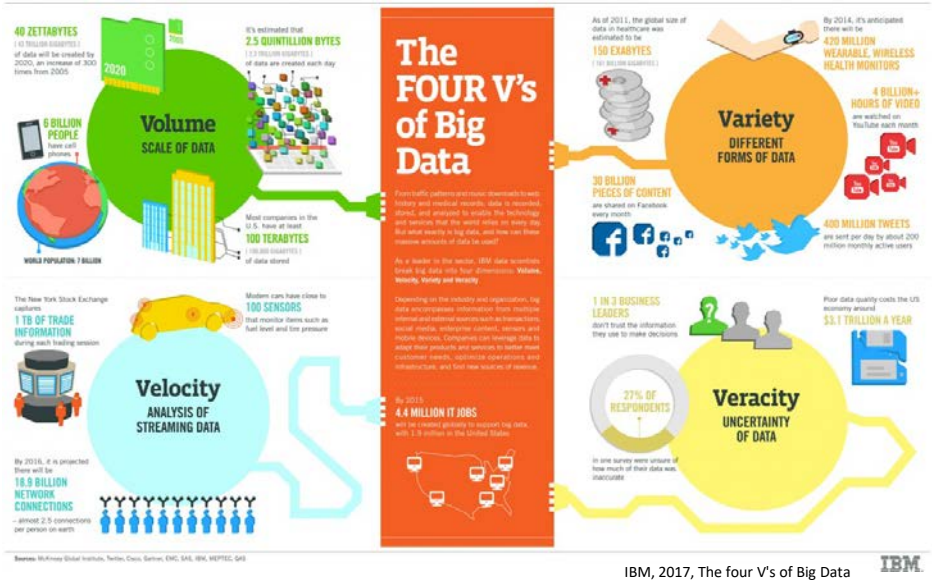
Digitalisering av D&V – hva må på plass?

- Felles rammeverk for datainnsamling og – kategorisering
- Metoder for rensing av data – kvalitetskontroll
- Metoder for håndtering av store datamengder
- Automatisering av prosesser og analyser
- Ingenting av dette fantes i 2006 da IO-senteret startet



IBM, 2017, The four V's of Big Data

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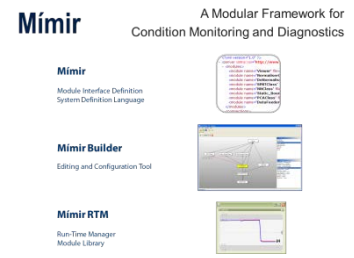
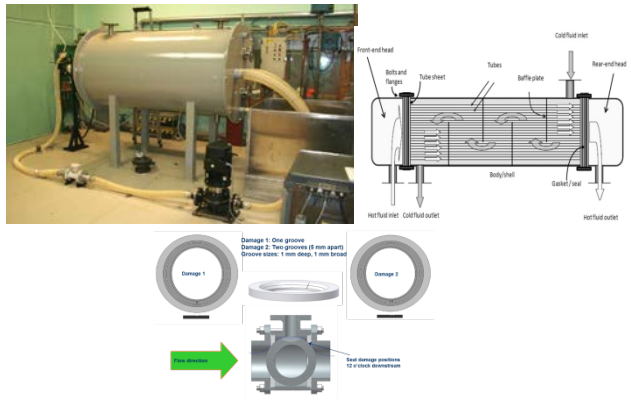
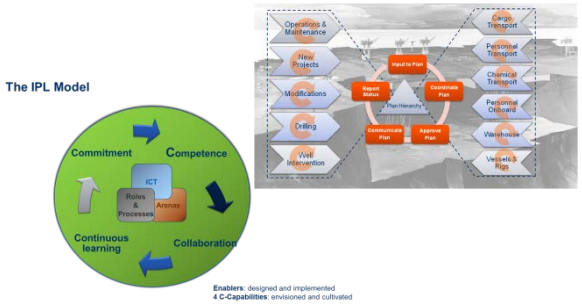
D&V i IO-senteret

- 3.1 Condition Based Operation and Maintenance Support
- 3.2 Condition monitoring of oil and gas facilities
- 3.3 Integrated Planning

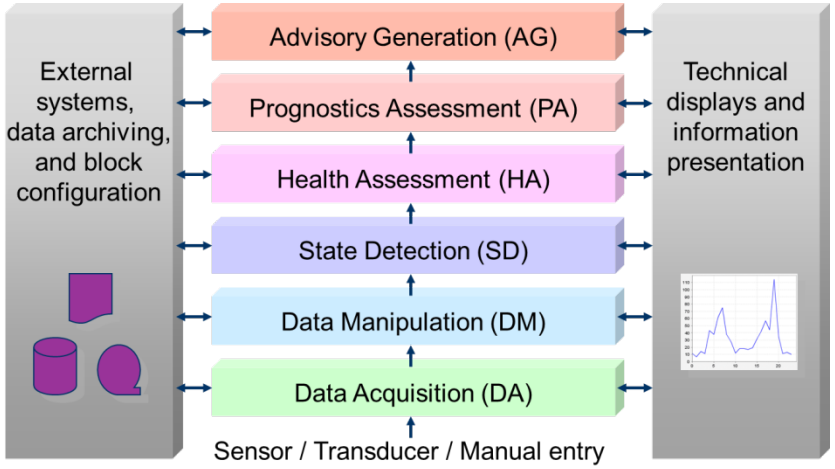


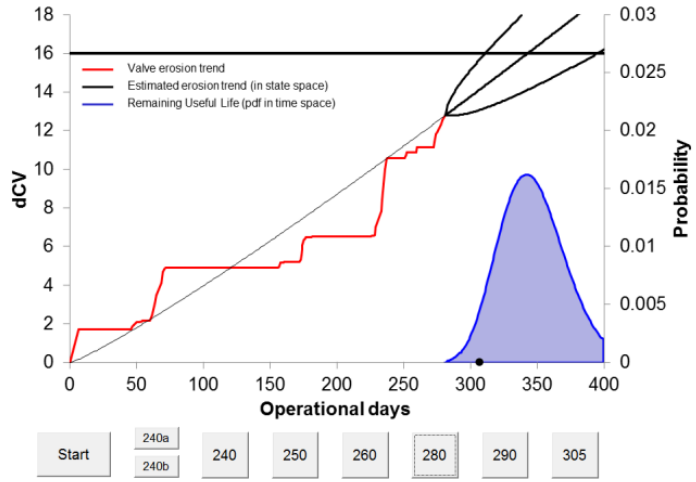




CBM Support – Summary of Results

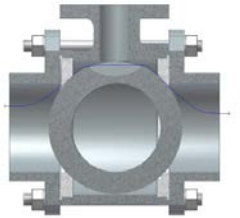
- Mímir modular platform
  - Research platform
  - Ready for pilot installation
  - Stress tested with regard to datastream handling capacity
- RUL Modelling & Case Study
  - Production choke valve Remaining Useful Life (RUL)
  - Bottom hole pressure estimation
- PhD - Technical health, RUL and Life extension decision, Pratichi Vaidya

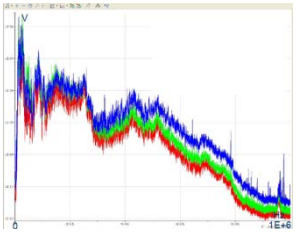


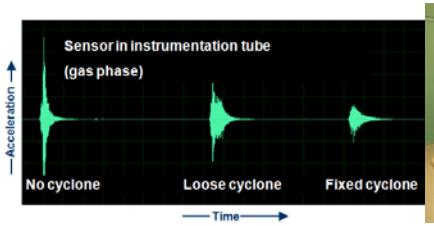


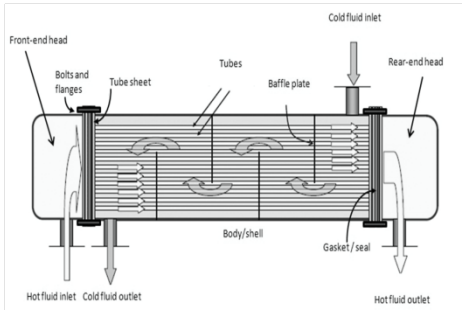
CM of oil and gas facilities – Summary of Results

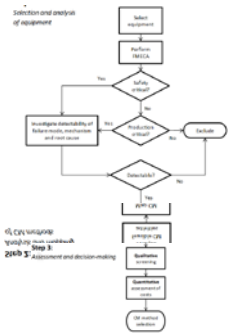
- Leakage detection in safety critical valves
  - Laboratory setup
  - Mapping of capabilities
  - Development of method for frequency domain analysis
- Non-intrusive inspection of production separators
  - Laboratory setup
  - Mapping of capabilities
- Non-intrusive inspection of heat exchangers
  - Litterature survey
  - Methodology for selection of appropriate CM method





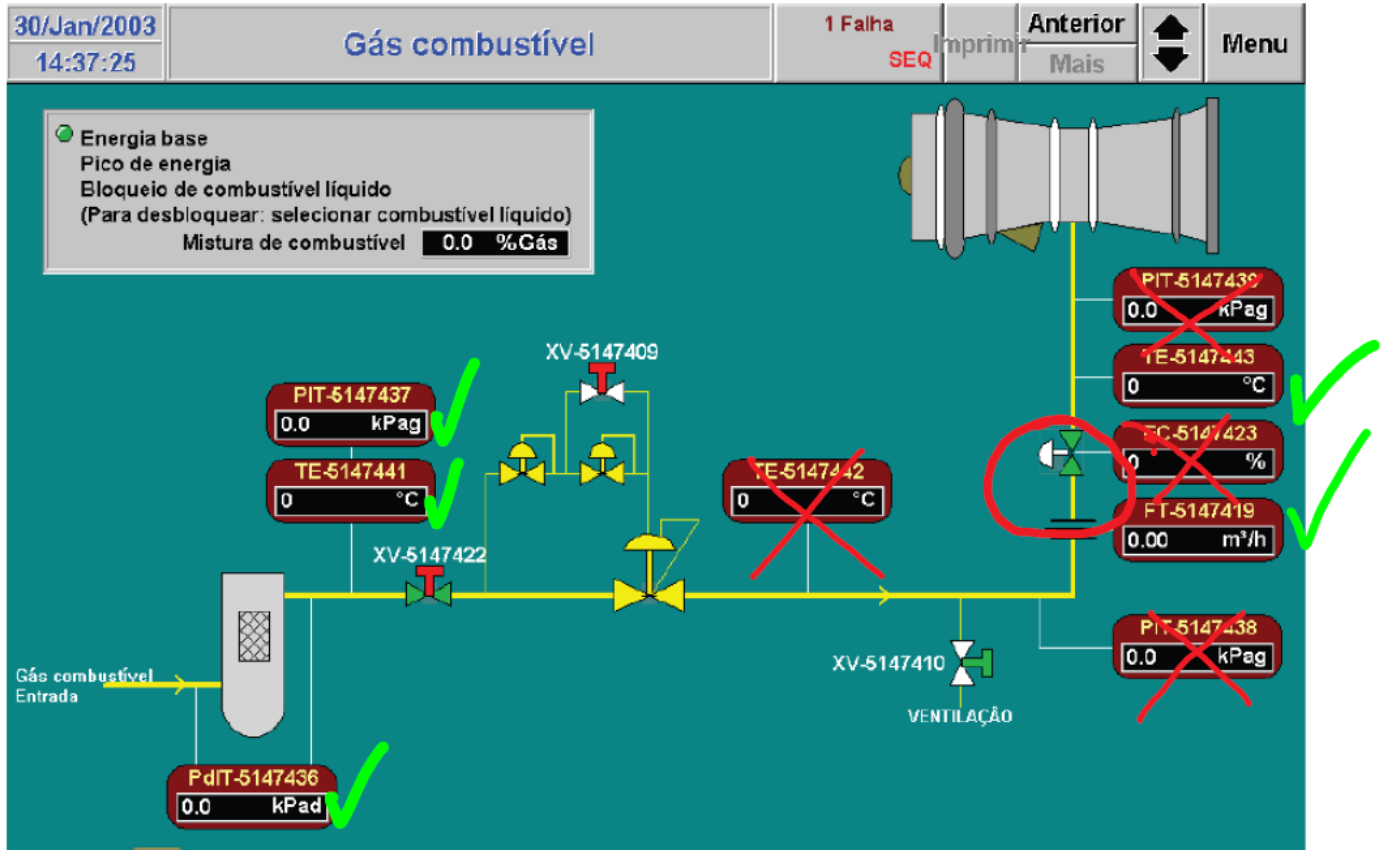






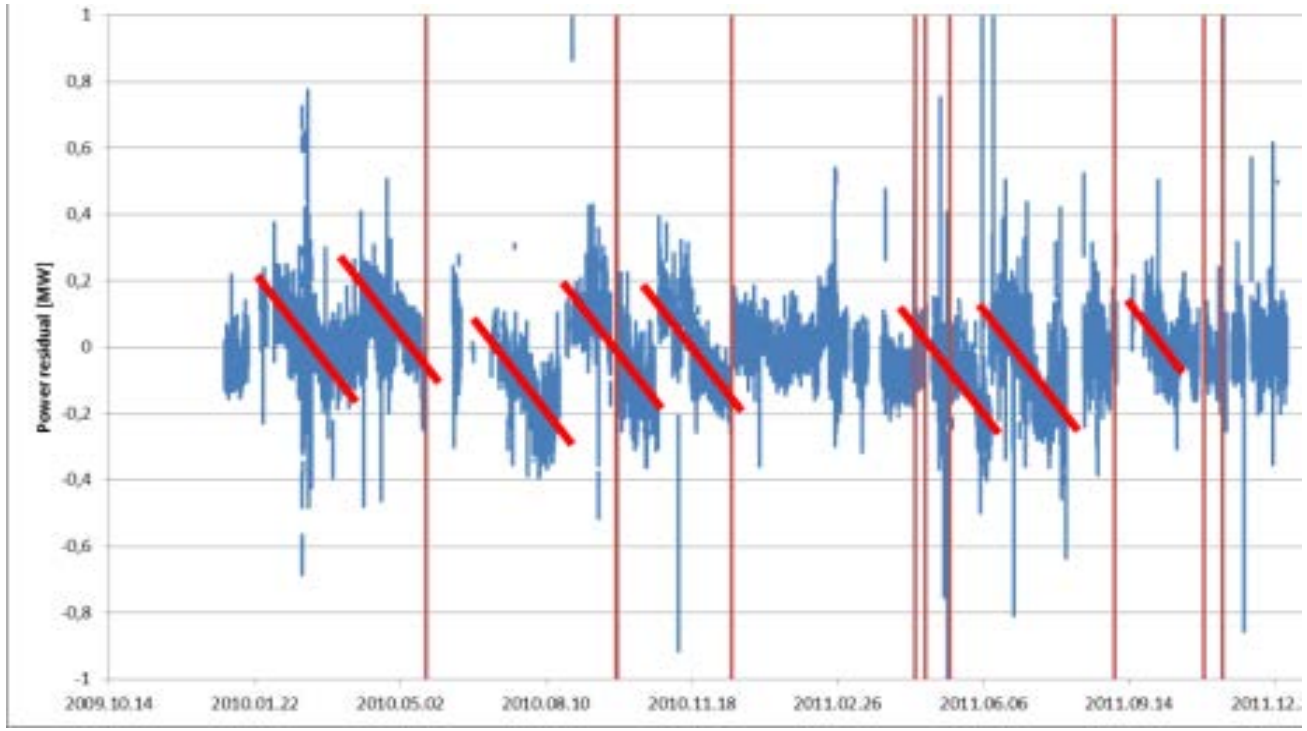
Feil på gassturbin – bruk av datadrevne modeller

- Failed start
  - Gas pressure increases in combustion chamber
  - Exhaust temperature rate of increase to exceed 10°C/s to verify combustion
  - Exhaust temperature recorded only every 10 minutes….
  - And several measured parameters not recorded in database



Model based diagnostics

PCA of TG's efficiency and its relation to FC: OVERFUEL TO IGNITION FAILURE SHUTDOWN



Trend of power residual for turbo generator TGC and fault occurrences

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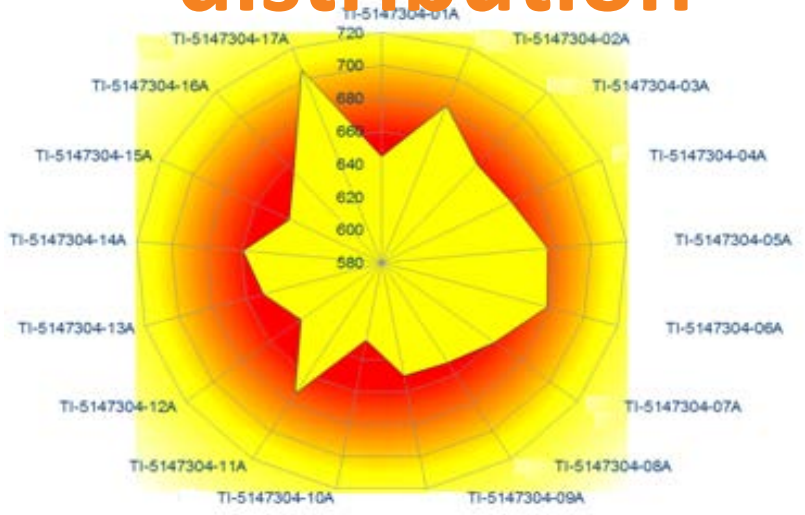
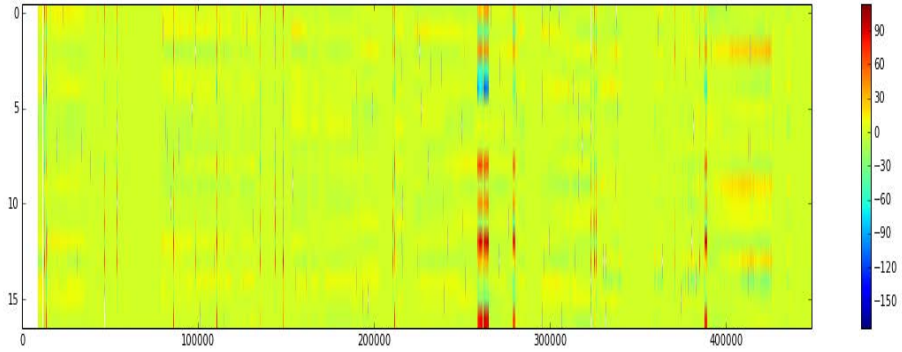
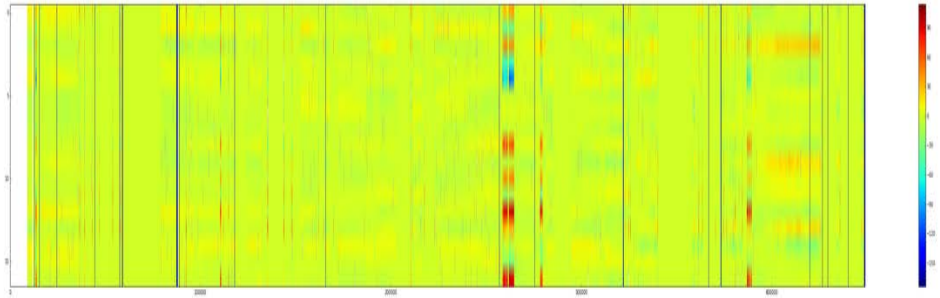
Data processing – Analysis of turbo generator exhaust temperature distribution



Median temperature distribution



Normalized exhaust temperature deviations



Faults overlaid on heat-map

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IO Big Data approach

What we wanted to achieve:

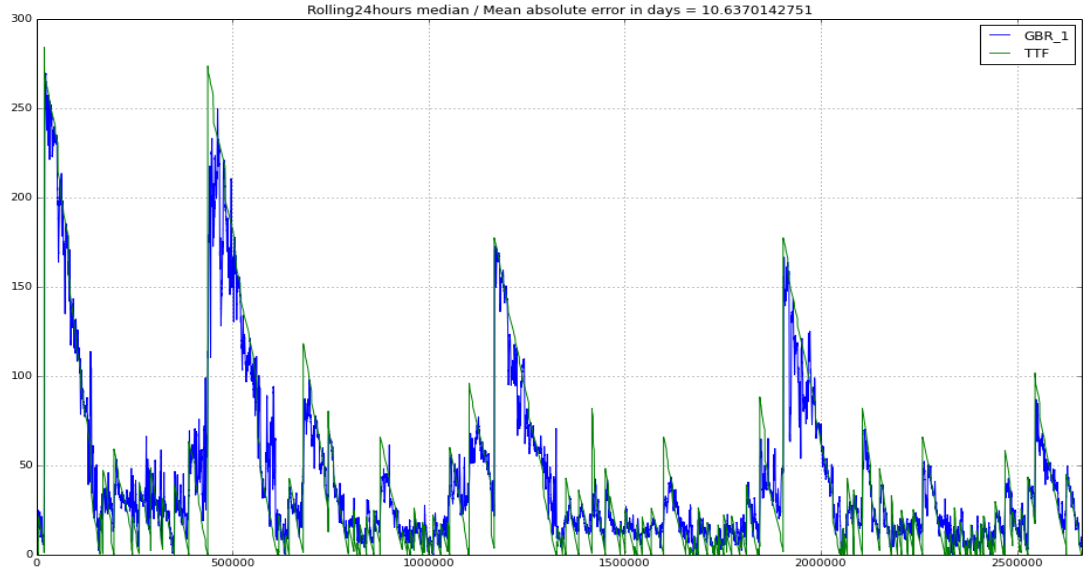
- Modelling of degradation in a known system with known failures

What we achieved:

- Testing of different modelling strategies
- System is known
- Failures are known
- Data is sparse

What we learned:

- Modelling of physical degradation – not preferable method
- A need for models based on data, statistical methods and patterns
- A need to learn how to make prognosis on failures and problems



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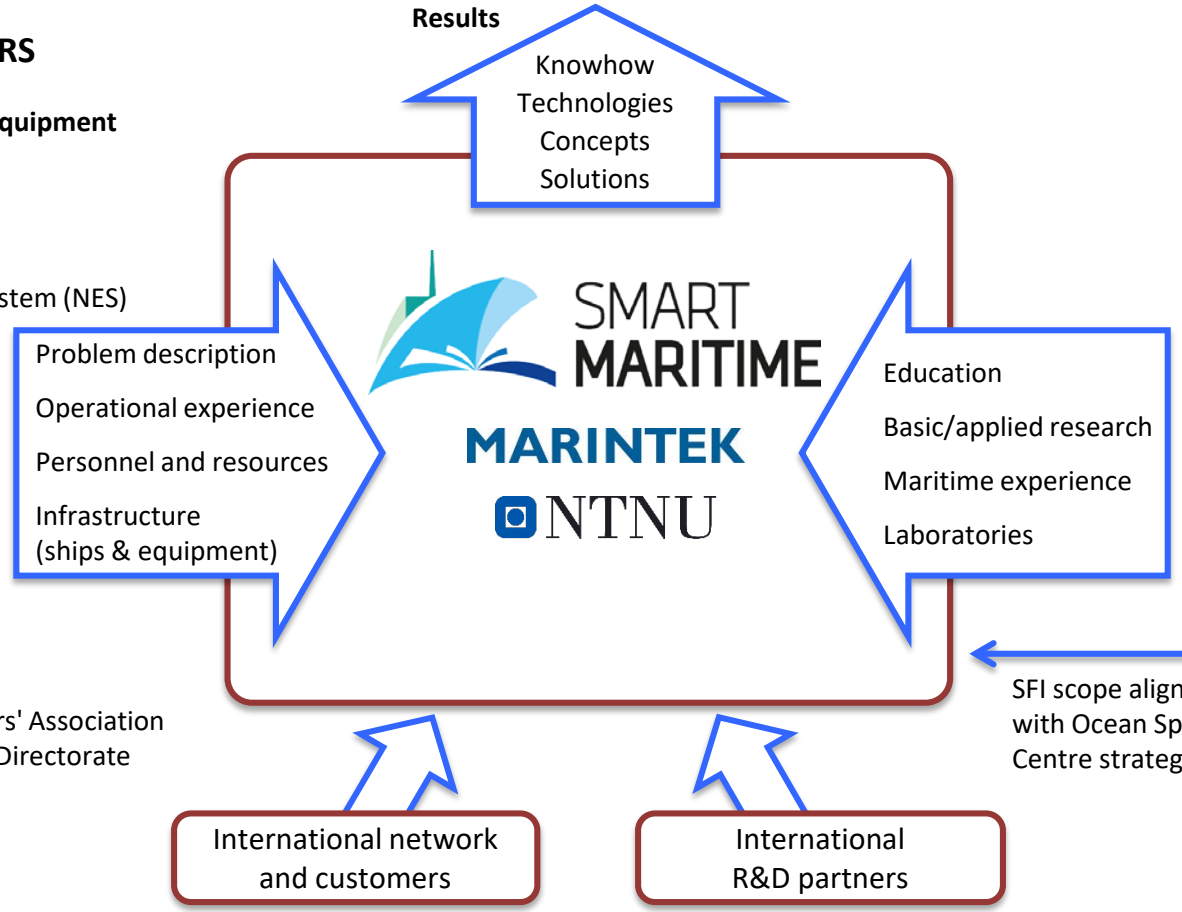
IO Big data brukt i ny sammenheng

INDUSTRY PARTNERS

Design, shipbuilding & equipment
- Rolls-Royce Marine
- Bergen Engines
- Vard Group
- Havyards
- Norwegian Electric System (NES)
- ABB
- Siemens
- Jotun
- Wärtsilä Moss

Ship operators
- Wilh. Wilhelmsen
- Solvang
- Grieg Star
- KGJ Skipsrederi

Other partners
- DNV-GL
- Norwegian Shipowners' Association
- Norwegian Maritime Directorate
- Kystrederiene



RESEARCH PARTNERS

MARINTEK (host)

NTNU
- Department for Marine Technology
- Industrial Ecology Programme

NTNU - Ålesund
Faculty of Maritime Technology and Operations

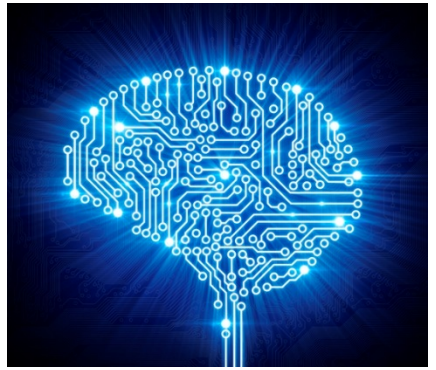
SFI scope aligned with Ocean Space Centre strategy

SFI Smart Maritime project based on IO

- Big Data Solutions play an important role in **Future Research and Industrial Applications**.
- **Strategic Priority Area** for SINTEF Ocean.
- Research and Industrial Applications:
  - **Data Management:** Appropriate actions to develop a bunch of data in a structured collection.
  - **Data Analytics:** The science of examining these data with the purpose of drawing meanings about the information.
- **The size** of these data sets may not make **a big difference** in these applications.
- **The outcome** of the Data set, the meaning, is **the most important aspect** of these research and industrial applications.
- **Many Fundamental Challenges**.

Data analytics & sensors

- **The main focus point**
- **Conventional Models**
  - Various Conventional Models have been developed in shipping.
  - Some challenges in handling Big Data.
- **Machine Intelligence & Statistical Analysis**
  - Machine Intelligence (MI) will play an important role in the outcome of Big Data applications.
  - Statistical Techniques will guide MI Applications.
  - Such tools and techniques and their applicability as **Data Driven Models.**
- **Domain Knowledge**
  - Ship Dynamics/Hydrodynamics
  - Automation and Navigation Systems
  - **Engine Propeller Combinator Diagram**



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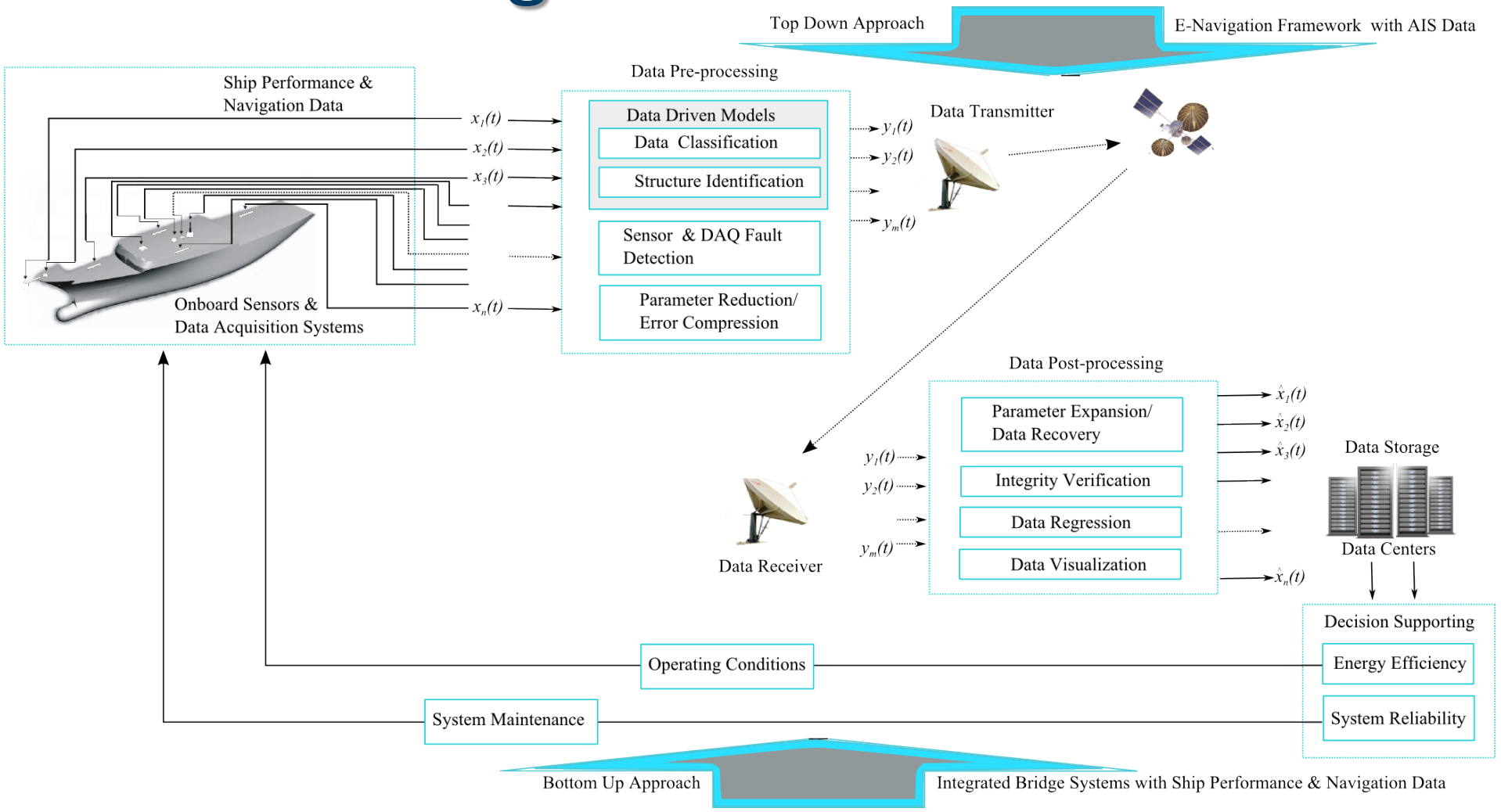
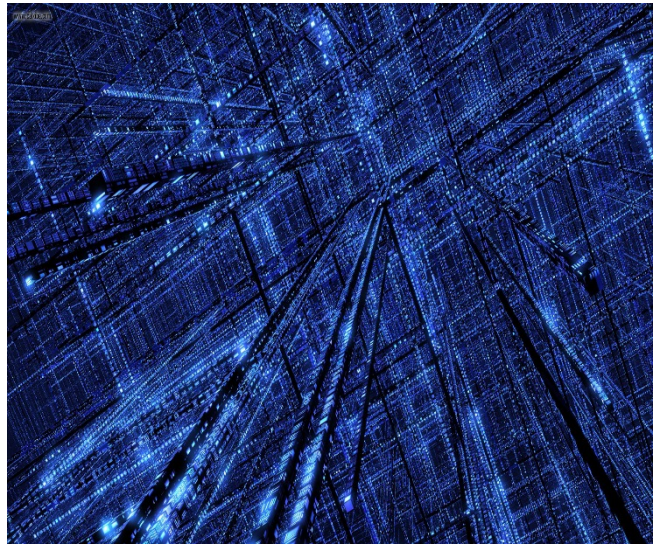
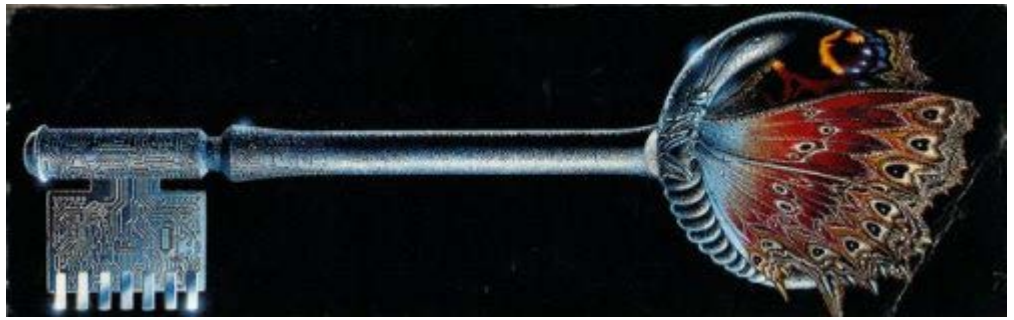
Data Handling Framework





" The data has a structure and the structure has a meaning"

A Journey towards Meaningful Data Structure…



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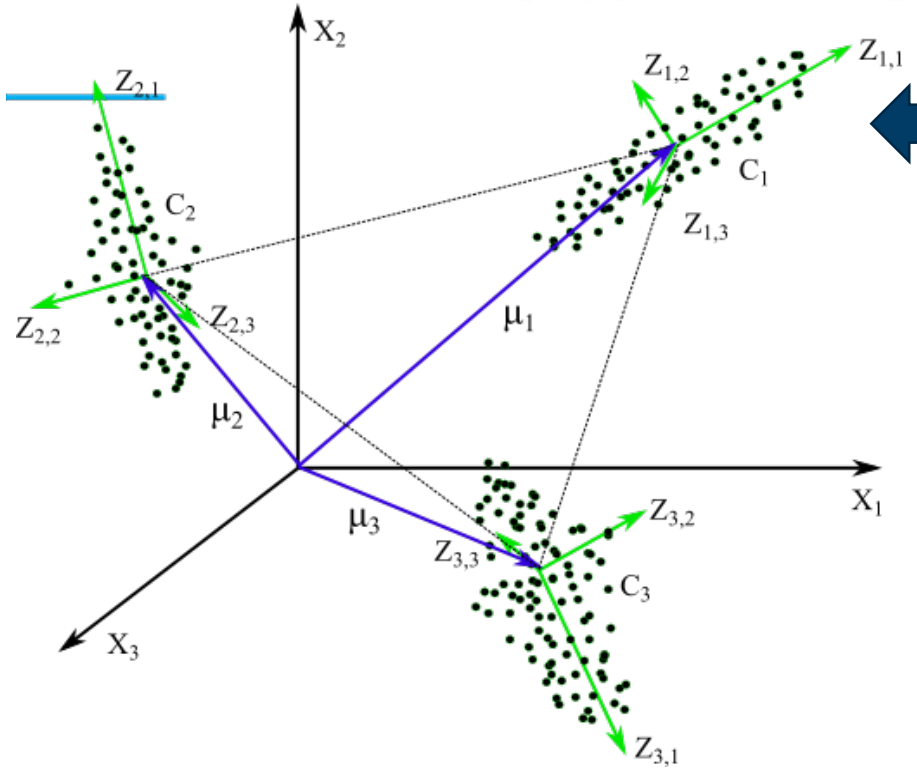
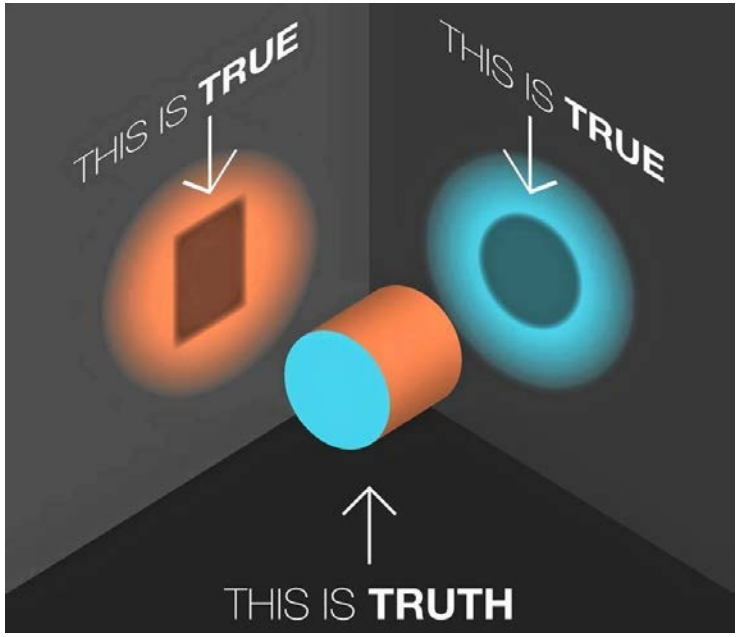
Data Driven Models





- **Unsupervised Approach**
  - Self learning
  - Self cleaning
  - Self compression-expansion
  - Multi-purpose structure
    - Efficiency & Reliability

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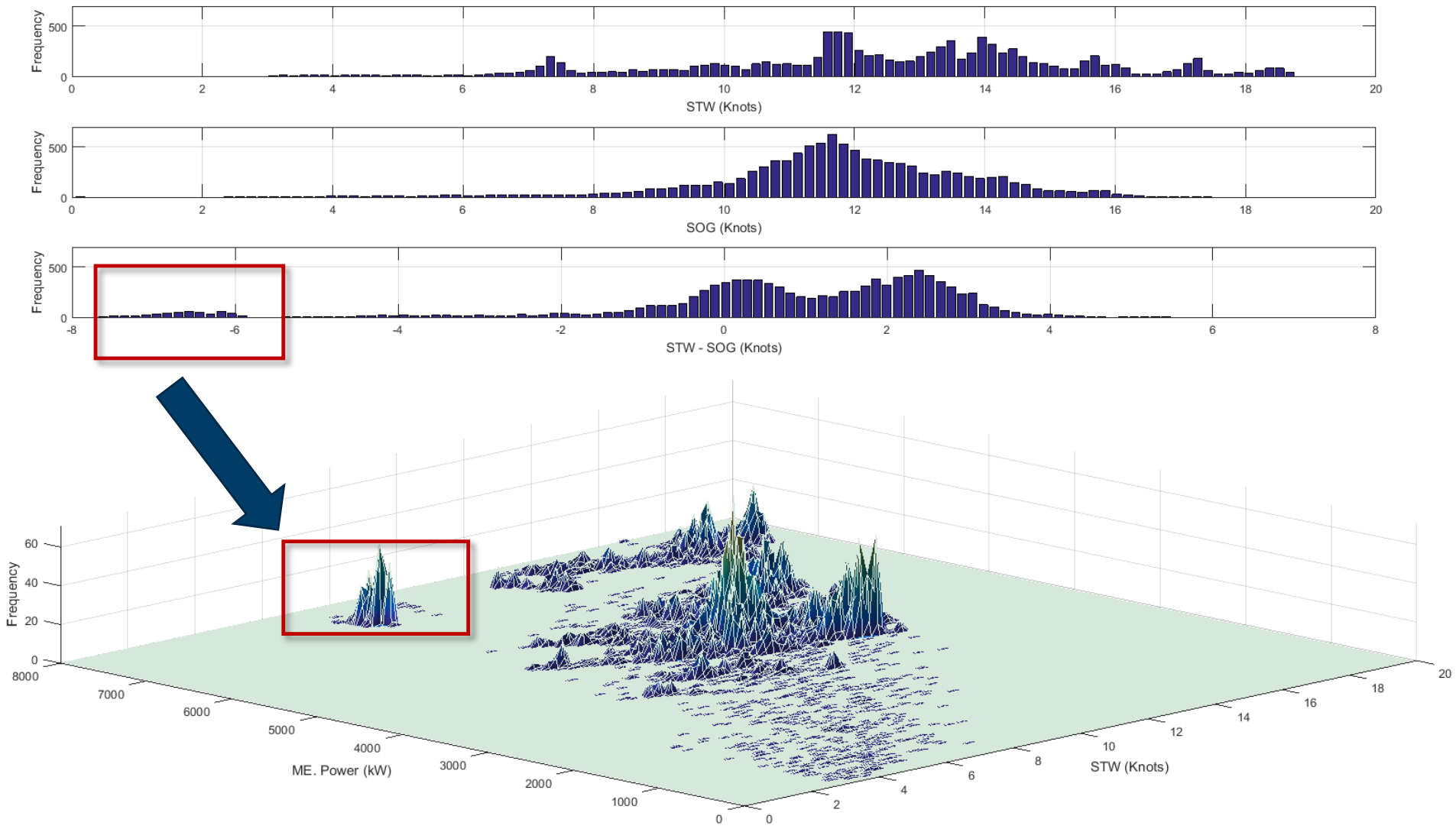
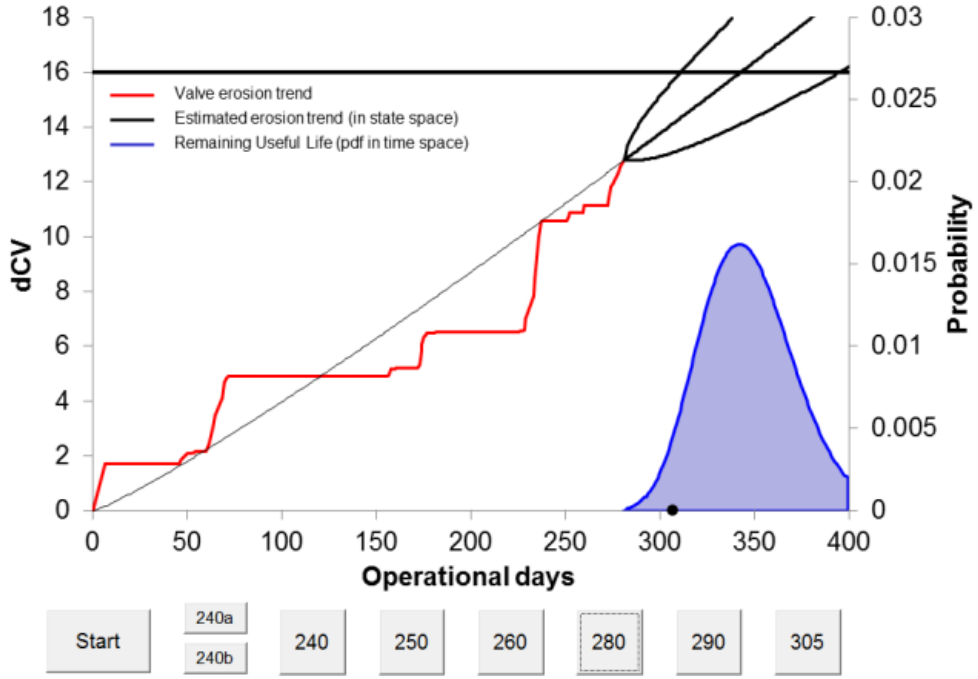
Ship Speeds: STW, SOG and STW-SOG



Prediksjon – et IO-case

- Når forplikter du deg til handling?
- Når må du forplikte deg?



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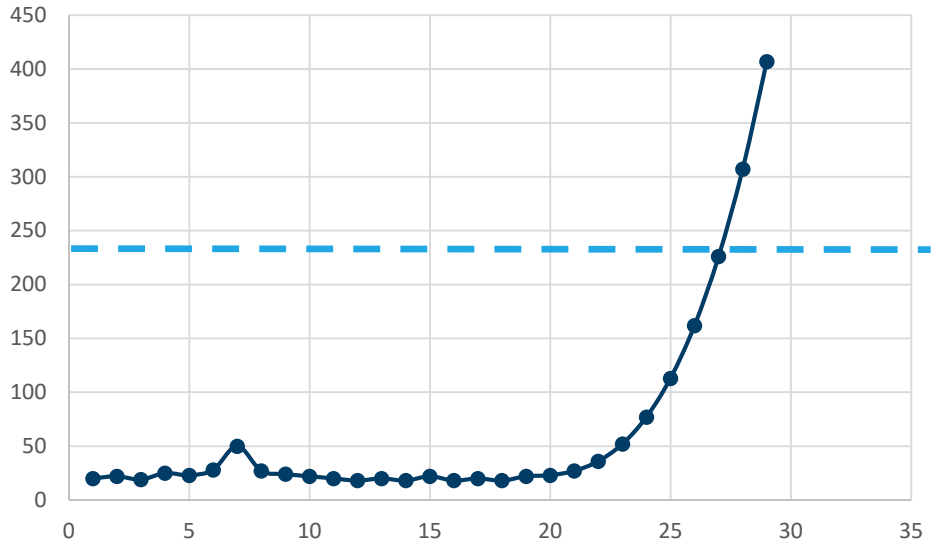
Vindkraft D&V – prediksjon…

- Når forplikter du deg til handling?
- Når må du forplikte deg?



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De fire V'ene i digitalisering

- Velocity
  - Hastigheten på data
  - Båndbredde, kommunikasjonssikkerhet
- Volume
  - Lagring
  - Båndbredde
- Variety
  - Hva måles og hvordan
  - Data typer
  - Formater
- Veracity
  - Kan man stole på data?
  - Datakvalitet

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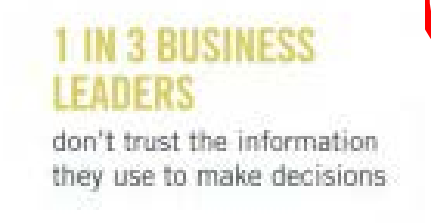

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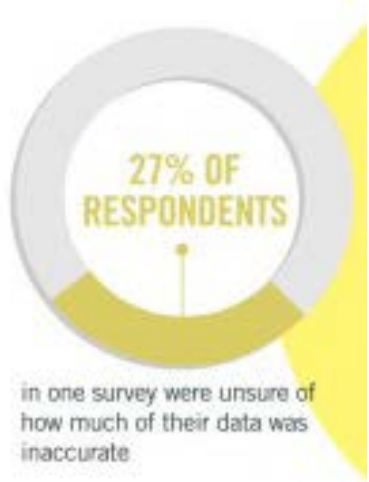

- Veracity
  - Kan man stole på data?
  - Datakvalitet

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De fire V'ene i digitalisering - vindkraft D&V

- Velocity
  - Skal i utgangspunkt ikke være problematisk – fiber med kabel
- Volume
  - Små datavolum, selv med vibrasjonsmålinger
  - Lagringskapasitet ok
- Variety
  - Mellomstore serier av maskiner
  - Utfordrende med proprietære løsninger
- Veracity
  - Hvem eier data?
  - Kan man stole på data?
  - Datakvalitet

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Teknologi for et bedre samfunn