Karsten Moholt started as an electromechanical workshop in 1945. We are a leading company in electromechanical industry through a sustained focus on developing new solutions for effective maintenance.

**New offices**

**New production facilities, warehouse and testing facilities**
We guarantee our customers lower total cost of ownership for rotating equipment, by keeping the operation on the inner loops.
The electromechanical industrial company Karsten Moholt AS must change the business model. This occurs as a result of digitization and a move by the world's original equipment manufacturers (OEM) from sales of motors as objects to the sale of motors as a service. The new model involves selling operating hours, thus taking responsibility for the motor from cradle to grave, including control of maintenance. Therefore also Karsten Moholt AS has to offer motor as a service, to ensure a sustainable business model. To sell a motor as a service we must at all times have control of the condition of the motor.
MEGATRENDS

The essential eight technologies

- Internet of Things
- Robots
- Augmented reality
- Virtual reality
- Drones
- 3D printing
- Blockchain
- Artificial intelligence
CONDITION MONITORING OF THE PAST

• Listen
• Smell
• Touch
• See

…..diagnose
Unplanned downtime!
Maintenance strategy

Reactive Maintenance Ratios

Proactive Maintenance Ratios
ROADMAP FOR IMPLEMENTATION OF MAINTENANCE STRATEGY

Necessary to look at existing maintenance strategy
Common strategies of today

• Predetermined maintenance
• Condition based maintenance
CONDITION MONITORING DEPT:

VIBRATION SERVICES & CM PROGRAMS WITH PORTABLE DATA COLLECTION, ALSO WITH REMOTE DIAGNOSTIC

VIBRATION ONLINE MONITORING & REMOTE DIAGNOSTIC

ELECTRICAL CONDITION MONITORING
PARTIAL DISCHARGE AND TANδ / INFRA RED

+ training in all of these
CBM WORKFLOW TODAY

1) DEFINITION
Example gearbox: RPM, bearing types, number of teeth, number of stages, etc.

2) DETECTION
Example: elevated overall vibration value on motor drive side

3) ANALYSIS
Analyze the increased vibration peaks and the characteristic frequencies: 1x, 2x, gear mesh = RPM x number of teeth, etc.

4) DIAGNOSTIC
Diagnose and describe the failure as per Level 2 measurements – formulate the root cause of failures

5) CORRECTION
Misalignment ⇒ align with laser alignment
Imbalance ⇒ perform dynamic filed balancing

Define and perform measurements of Level 1 & 2, depending on the machine and the typical failures expected to be detected (fast failure evolution / online measurements / Offline measurements / etc.)

Detection: trending of collected measurement data of overall values. Intelligent alarming is required here. (Level 1)

Analysis: when relevant changes occur to the values in the trends, analyze Level 2 measurements

Diagnostic: based on the interpretation of Level 2 measurements, formulate a diagnostic and action

Correction: select the appropriate correction method to correct the failure and eliminate the failure root cause*
KM DIAGNOSTICS CENTER:

Online monitoring and remote diagnostic of more than 1200 machines.

Periodic measurements and remote diagnostic of more than 10,000 machines.
EXAMPLES FROM THRUSTERS
DISADVANTAGES WITH CURRENT STRATEGIES

Can not predict breakdowns

We don`t use all available data

What to do with all the data?
THE FUTURE

- **Predictive Maintenance (PdM)** – more sensors, more data, real-time data/historical data, process data and sensor data analyzed in correlation with each other, algorithms visualization
PREDICTIVE MAINTENANCE

3 Effectiveness of maintenance methodology from standpoint of damage to equipment
PRODUCT CLOUD

Smart Product Applications
Software applications running on remote servers that manage the monitoring, control, optimization, and autonomous operation of product functions.

Rules/Analytics Engine
The rules, business logic, and big data analytical capabilities that populate the algorithms involved in product operation and reveal new product insights.

Application Platform
An application development and execution environment enabling the rapid creation of smart, connected business applications using data access, visualization, and run-time tools.

Product Data Database
A big-data database system that enables aggregation, normalization, and management of real-time and historical product data.

CONNECTIVITY

Network Communication
The protocols that enable communications between the product and the cloud.

PRODUCT

Product Software
An embedded operating system, onboard software applications, an enhanced user interface, and product control components.

Product Hardware
Embedded sensors, processors, and a connectivity port/antenna that supplement traditional mechanical and electrical components.

Integration with Business Systems
Tools that integrate data from smart, connected products with core enterprise business systems such as ERP, CRM, and PLM.

External Information Sources
A gateway for information from external sources—such as weather, traffic, commodity and energy prices, social media, and geomapping that informs product capabilities.
Actionable insight
FAILURE MODES MOTORS

MECHANICAL FAULTS

• Bearings
  – Contamination
  – Stress, Load, Fatigue
  – Vibration
  – Misalignment
  – Heat
  – Lubrication
  – Electrical discharge

• Rotor
  – Mass unbalance
  – Rotor bow
  – Uneven cooling

• External Misalignment
  – Foundation crack
  – Grouting degradation
  – Wrong thermal offset

ELECTRICAL FAULTS

• Electrical Unbalance
  – Voltage unbalance
  – Rotor bar failure

• Stator Problems:
  – Loose Iron
  – Stator Eccentricity
  – Shorted Turns

• Windings
  – Heat
  – Inverters
  – Supply Voltage problems
  – Load
  – Contamination

• Rotor Problems:
  – Broken/Cracked Rotor Bars
  – Loose Rotor Bars
  – Eccentric Rotor

Mechanical on LV.
Electrical on HV.
SENSORS FOR DATA ACQUISITION

• Vibration
• Temperature
• Motor circuit analysis
  - current
  - voltage
• Termography
• Ultrasound
• Partial discharge
• Oil analysis
• Insulation resistance
**Oil sensor**
Increase in particles

**Vibration sensor**
Trending anomalies

**Temperature sensor**
Increasing

**Acoustic sensor**
Increased noise

**Ultrasound**

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**Symptoms**

- Gear/bearing wear and tear
- Wear on tooth
- Tooth wear and tear, bearing wear and tear, lubrication
- Increased metal contact
- Increased friction

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**Diagnostics**

- Wear on gear tooth

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**Prognosis**

- 90 days until breakdown
- Advisory generation

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**Automated analysis**
PREDICTIVE MAINTENANCE

Single sensor - trending

Multiple sensors analyzed in correlation with each other

Pattern recognition alarm
PREDICTIVE MAINTENANCE

CBM framework

- Advisory Generation (AG)
- Prognosis Assessment (PA)
- Health Assessment (HA)
- State Detection (SD)
- Data Manipulation (DM)
- Data Acquisition (DA)

Lubricate bearing

CMMS/ERP; workorder
VIZUALISATION
PREDICTIVE MAINTENANCE

- Data to the expert, not expert to the data
- Real time analysis
- Decision support tool
Predictive maintenance solution

DB with historical data
What happened before?
- ERP
- CMMS
- Asset Management
- CM DATA

Live data
- Vibration
- Oil
- Temperature
- rpm
- pressure

Machine learning - predicting

Predictive maintenance solution

Interface live

- Feilhistorikk
- Reparasjonshistorikk
- Maskintilstand
- Maskinfunksjoner
- Driftsforhold
- Operatør attributter

ERP
CMMS
Asset Management
CM DATA

SKYWATCH
ML

Predictive maintenance

KARSTEN MOHOLT
PREDICTIVE MAINTENANCE - ARCHITECTURE

Solution components
Integration points

Dashboards
Iterative Functions, Tables, and Tasks (IFTTT)

Customer System

Predictions and alerts for presentation and log
- Fault probability
- Diagnostics
- Remaining Useful Life
- Alerts

Processing Service

Watson Predictive API

Raw and processed data

Persistent Storage

PI Web API

REST JSON

Liberty Websphere

Message Hub

PI Historian database
PREDICTIVE MAINTENANCE

«Those who move to data-driven maintenance programs will realize significant performance improvements and financial savings»
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