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ABB
Transition to Condition Based Maintenance – Human in the Loop

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- Background and introduction
  - The vison and salespitch
  - «The salesman perspective».
- Making of a maintenance master-plan
- Facts and irony behind «safe operations»
- Example case
- New technology (information) new challenges

Definitions

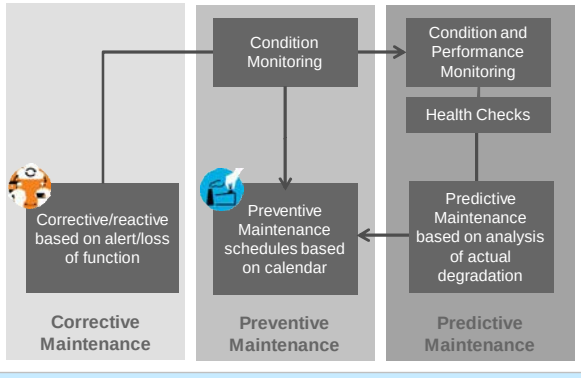
- Condition monitoring (NORSOK Z 008):
  - *Continious or periodic measurement and intrepetation of data to indicate the degrated condtion (potential failure) of and intem and the need for Maintenance*
- Condition Based Maintenance (Wikipedia)
  - ***Predictive maintenance** (**PdM**) techniques are designed to help determine the condition of in-service equipment in order to predict when maintenance should be performe*

Concepts and myths

Data Scientists vs. Decision Makers vs. Business Process Automation
ARC has been in several (user) client meetings where data scientists, engineers, and operations people have struggled with machine learning. The problem statement seems clear: "We want to use machine learning to do predictive maintenance." But it turns out everyone in the room has their own interpretation. Is the solution a technology (machine learning), a platform (analytics engine), or an application (predictive maintenance)? Any of these could be the best solution, but there are different tradeoffs to be made depending on which solution is selected.

https://industrial-iot.com/2016/09/whatdoyoumeanbyanalytics/

Maintenance practices
Transition to predictive



Evolution towards preventive & predictive maintenance

Background
The vison and salespitch

- 30-40% more cost efficient than reactive maintenance (*)
- 8-12% more cost efficient than preventive maintenance (*)
- Increased lifetime
- Less need for storage
- Safer (HSE)

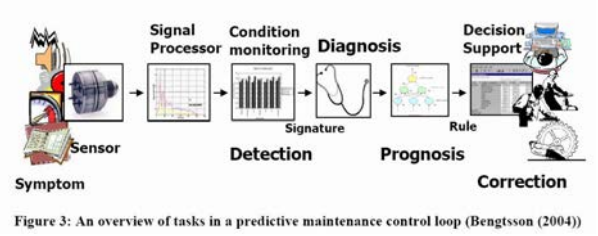
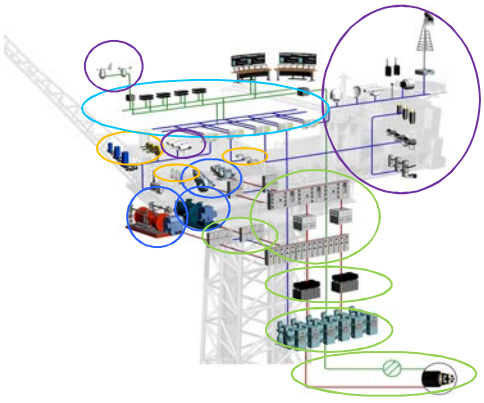


Figure 3: An overview of tasks in a predictive maintenance control loop (Bengtsson (2004))

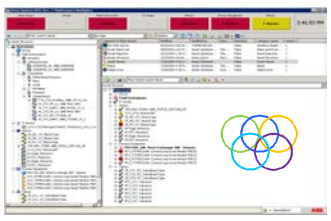
* Source: US Department of Energy (http://www1.eere.energy.gov/femp/program/om_predictive.html)

Background
The “salesman perspective” – the ABB offering



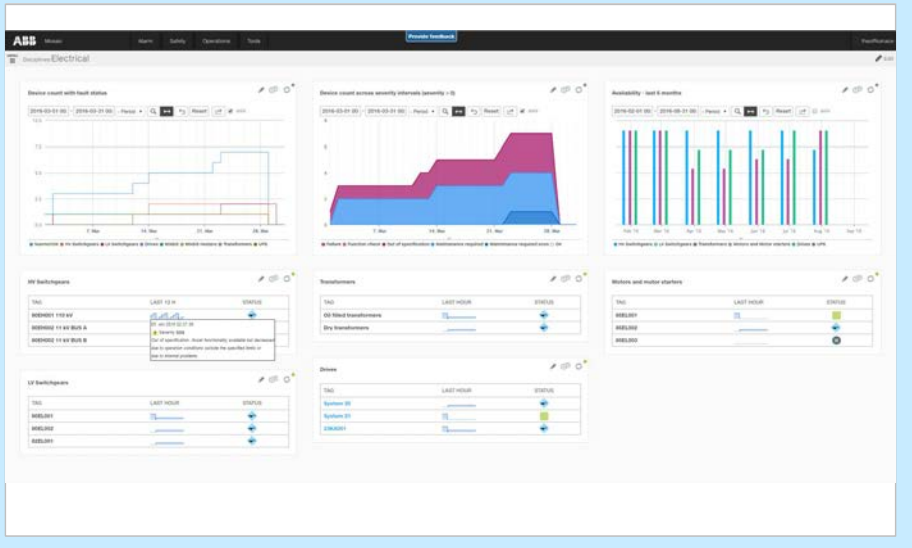
Condition monitoring:

- Electro
- Vibration
- Instruments and valves
- Telecom systems
- Servers and systems



Background

The “salesman perspective” - the ABB offering

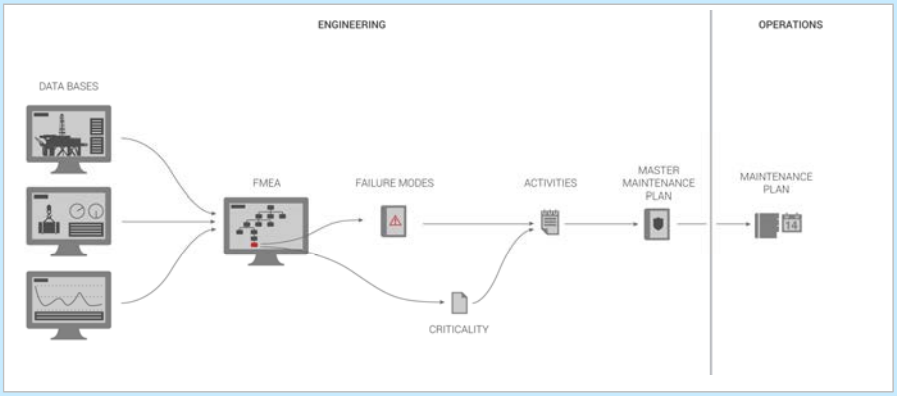


So what?

Here comes the “oil crisis”

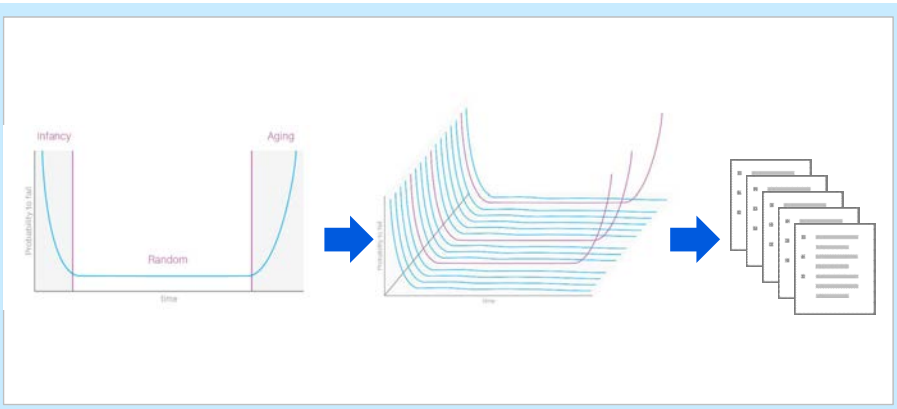
Condtion monitoring, so what?

Making a maintenance plan
Simplified workflow



Standardized process

Maintenance plan
Demystifying predictive maintenance – maintenance planning



The structure and methodics are in place

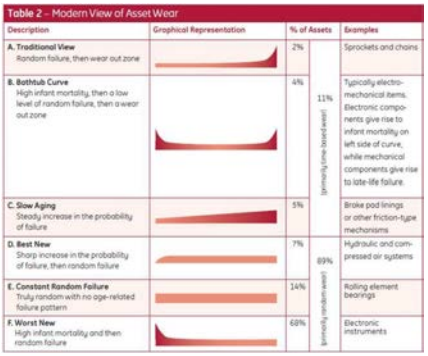
Demystifying predictive maintenance
Failuremodes – Facts

15-20 % of equipement failures are related to aging.

- The remaining % are time-random (with exeptions)

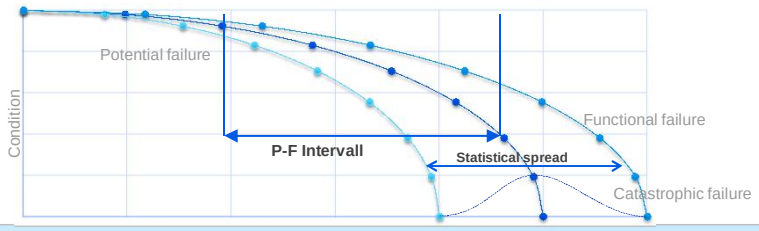
Preventive based maintenance will among others result in:

- Safety issues?!
- To frequent maintenance
- Increased OPEX
- Infant mortality Issues
- Personell/maintenance induced failures



So why do we do it?

Predictive maintenance
Key Information



P-F intervall, intervall between Potential Failure and Functional Failure, based on documented knowledge and data

Good statistical knowledge important for accurate predictive maintenance

P-F interval must be larger than Mean Time To Repair, MTTR

Integrating and analyzing monitoring data from a variety of installations of the same device type is essential

Transformation to predictive maintenance
8 steps to a maintenance plan including CBM and PBM

1.Input: Maintenance strategy

Decide on overall strategy equipment or system based on cost vs. benefit.

1. Run to failure
2. Preventive Maintenance
3. PBM and/or CBM

2. Input: FMEA/RCM Analysis

Analysis will indicate critical equipment, failure modes and availability. Risk assesment of maintenance strategy decitions.

3. Input: Maintenance Manuals

Gather preventive Maintenance activities and time intervals.

Prepare overwievs with all maintenance activites related to subjected device or system

4. Define: Required Sensoring

Define sensors or solution to monitor a failure mode on critical equipment

Implement a system for data collection for CM and PM

5. Identify: Gaps and overlaps

Compare maintenance activities with failure modes and potential monitoring.

Where there are no failuremode and maintenance activity, criticality defines the action

6. Improve: Procedures

Refine

- Maintenance procedure implementation
- Sparepart solution implementation
- Maintenance Strategy

7. Implement

Implement system to follow up both CBM and PBM

Secure competency by training

Tune and adapt

8. Sustain and improve

Establish procedure:

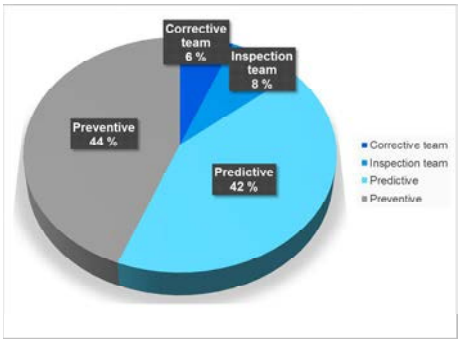
Continious improvement

Handle changes in operation profile,

System upgrades,

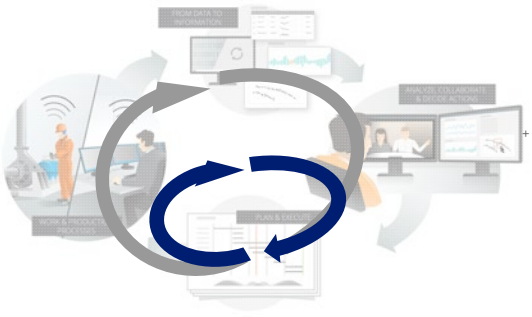
Case - Electrical system on Drilling Ship
Results of RCM process

+ No additional instrumentation in the electrical components
+ System in place to gather/analyse data
+ Only direct failuremodes counted



Human in the Loop
Challenges

Human in the Loop
Planning - Preventive

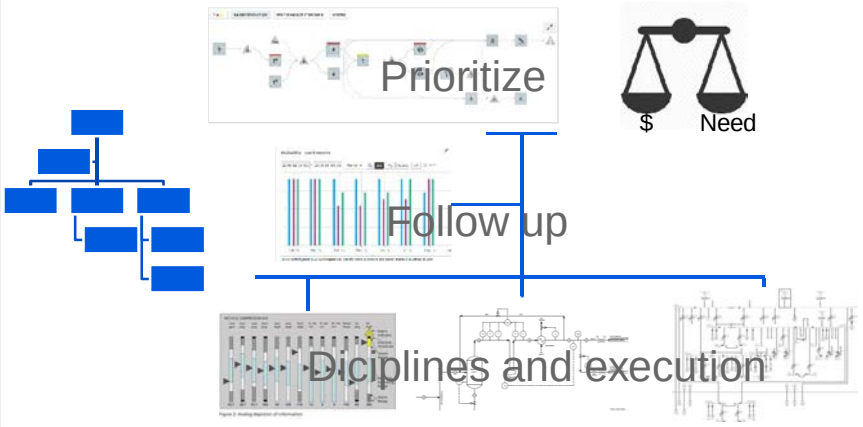


- **Long term**
  - Predictable workload -> years in advance (?)
  - Easy to plan and coordinate
  - «known» workforce
- **Short term**
  - Corrective maintenance activities ($$)

Human in the Loop
Planning

- **Long term**
  - Predictive activities planned according to P-F intervall
  - Higher demands on flexible accxess to speciality resources
  - Base workload from peventive activities
- **Short Term**
  - Maintenance is done as «planned corrective»
  - Still be «corrective»

Human in the Loop
Challenges - > Mental models and need for information



Transition to predictive maintenance

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