Predictive Cognitive Maintenance Decision Support System

06.03.2018 | Robin Kleinwort
What is Predictive Maintenance?

Introduction

Evolution of Maintenance

Corrective Maintenance → Time planned Maintenance → Condition Based Maintenance (CBM) → Predictive Maintenance (PdM) → Predictive Cognitive CBM

Conduct Maintenance Action *Just in Time* to utilize as much as possible of machine life

^{1}Condition Based Maintenance
## Purpose and objective targets

### Introduction

### Solutions for SMEs: For new and Retro-Fit of already in use production machines

<table>
<thead>
<tr>
<th>availability</th>
<th>quality</th>
<th>maintainability</th>
<th>safety</th>
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<tr>
<td><strong>Improved maintainability &amp; increased operating life</strong></td>
<td><strong>Synchronize maintenance with production planning &amp; logistics</strong></td>
<td><strong>Pred. Maintenance combined with integrated quality-maintenance</strong></td>
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<tr>
<td>• Early detection of damage initiation, follow up and prediction of its development</td>
<td>• Modification of process parameters to protect a degraded component until the next planned maintenance stop</td>
<td>• Comparison and evaluation of different data sources</td>
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<td>• Intelligence, self-learning towards machine self-healing</td>
<td>• Development of new business models</td>
<td>• Combination of sensor signals with information from the CNC</td>
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<tr>
<td>• Design of new components with improved maintainability and integrated sensors</td>
<td>• Maintenance integrated production planning approach</td>
<td>• Automatic calibration of trend reference models and physically-based models</td>
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<td>• Automated modal tracking</td>
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<td>• Include product quality as a target figure</td>
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<td>• Augmented Reality and Production Line Information Visualization to improve maintenance actions</td>
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Purpose and objective targets

Introduction

**Purpose**

Develop, deploy and test a Predictive Cognitive Maintenance Decision Support System able to:

- identify and localize damages, and assess damage severity
- predict damage evolution
- assess remaining asset life and reduce the probability of false alarms
- provide more accurate failure detection to conduct preventive maintenance actions at need
- optimize maintainability
- increase in-service efficiency of machines by at least 10%
- effectively share information between users
- reduce costs

**Objective targets**

- Increase *availability* and *maintainability* by 15%
- Reaching 30% of time spent on *predictive maintenance*
- Reduce failure-related *accidents* by 30%
- Reduce *energy* consumption by 6-10%
- Reduce *raw material* consumption by 7-15%

New sensors and data-driven knowledge-based models together with big data analytics, offer an unprecedented opportunity to track machine performance and health condition
Content

1 Introduction
2 Partners
3 Project Overview
4 Scientific Methodologies and Work Packages
Consortium includes 17 Partners from 6 countries

Advisory Board
## Content

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<td>Scientific Methodologies and Work Packages</td>
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PreCoM consists of 10 workpackages

Project Overview

- WP1: Project management
- WP2: Sensors & Data Acquisition
- WP3: Models & Big Data Analytics
- WP4: Maintenance integrated Production Planning
- WP5: AR & PLIV Applications
- WP6: System Integration & Tests
- WP7: Industrial Demonstrators
- WP8: Performance Analysis
- WP9: Dissemination & Communication
- WP10: Exploitation & Standarization
The aim of WP2 is to develop the **PreCoM sense Platform**: a real-time data acquisition module connected to embedded and external sensors. This platform will capture the condition of the production at component level and send it to the cloud though a multi-protocol gateway.
WP3: Models and Big Data Analytics

Scientific Methodologies and Work Packages

Physical models

- Sensors
- Real production machine
- Sensors
- Virtual sensors
- Predictive maintenance models

Statistical models

- PHYSICAL MODELS
- Statistical models
- Failure Probability Distribution

\[ \bar{\delta}_i \]
\[ \bar{p}_i \]
\[ \bar{\delta}_{i+1} \]

Kalman observer

\[ \dot{x}(t) = Ax(t) + Bu(t) + w(t) \]
\[ y(t) = Cx(t) + v(t) \]
WP4: Using Predictive Information to schedule Production and Maintenance activities

Scientific Methodologies and Work Packages

Generation of PdM-Information

Usage of PdM-Information

- Production Scheduling/Strategies
- Manufacturing Execution System (MES)

Goal: Maintenance will be optimized with respect to the reduction of unnecessary production stoppages
WP5: Augmented Reality & Production Line Information Visualization Applications

Scientific Methodologies and Work Packages

**AR-Guidance System**
- Live and Historical Data
- Instructions, Videos, 3D-Models, Notes etc.

**AR-Remote-Support System**
- Task durations, Augmented Screenshots etc.
- Supplier
- Expert
- Expert Colleague

**Goal:** Optimize maintainability through reducing maintenance task execution times by reducing communication and searching times
WP6: Predictive Cognitive Maintenance System Integration and Tests

Scientific Methodologies and Work Packages

- PreCom module
- Secure communication platform
- Sensing platform
- Production planning system
- Production Line Information Visualization (PLIV)
- Predictive Maintenance Algorithms
- Augmented reality to support maintenance
- Maintenance planning system
- Process control (automated actions)

PreCom module and Secure communication platform are connected to the hub of the diagram, which represents Predictive Maintenance Algorithms. From there, the connections lead to the specific components: Sensing platform, Production planning system, Production Line Information Visualization (PLIV), Maintenance planning system, and Process control (automated actions).
WP7: Predictive Cognitive Maintenance Demonstrators

Scientific Methodologies and Work Packages

### Low Volume Manufacturing

- SORALUCE Milling machine at SAKANA producing wind hubs.
- Critical components monitored:
  - Spindle head
  - Spindle gearbox
  - Feed drives
  - Machine geometry

### High Volume Manufacturing

- DANOBAT OVERBECK Grinding Machine at SPINEA producing reduction gears.
- Critical components monitored:
  - Spindle workhead
  - Grinding spindle
  - Feed drives
  - Process vibration and load

### Continuous Manufacturing

- Paper mill at GOMA-CAMPS with components from LANTIER.
- Critical components monitored:
  - Yankee dryer roll
  - Suction press roll
  - Forming roll
  - Creping doctor
WP8: Predictive Cognitive Maintenance Performance Analysis

Scientific Methodologies and Work Packages

- Increase 10% in-service efficiency
- Reduce cost and environmental impacts
- Increase energy (6-10%) and resource (7-15%) efficiency
- 30% reduction of failure-related safety accidents
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PreCoM Online

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- linkedin.com/in/PrecomEU2020

Upcoming events

Presentation of the PreCoM project at the forum Industrie 4.0 meets the Industrial Internet at Hannover Messe (23. – 27.04.2018)

Find more Information on: www.precom-project.eu
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