Before we start… A Penny for Your Thoughts

How was it? At the end of the session, share your feedback on the presentation you’ve attended via MiA App.

Ready to say more? Providing your feedback on MiA event in the exit survey on the app will get you an entry into a raffle for a 4-pack Opening Day Detroit Tigers tickets!
Introduction to OEE

Overall Equipment Effectiveness (OEE) is a measurement of performance for industrial equipment.

It is based on 3 major components: Availability, Performance and Quality

\[ \text{OEE} = \text{A} \times \text{P} \times \text{Q} \]
Introduction to OEE

**Availability** – A percentage measurement based on how much time a machine is “available” to run production versus a fixed period of time

\[
\text{Availability} = \frac{\text{Available time}}{\text{Fixed Period}} = \frac{6 \text{ hours}}{8 \text{ hour shift}} = 75\%
\]
Introduction to OEE

**Performance** – A percentage measurement based on the actual production rate versus a fixed maximum production rate.

Productivity = \( \frac{\text{Product produced}}{\text{Max. Product}} \) = \( \frac{80 \text{ units/hr.}}{100 \text{ units/hr.}} \) = 80%
Introduction to OEE

**Quality** – A percentage measurement based on good parts versus total parts produced

\[
\text{Quality} = \frac{\text{Good produced}}{\text{Total produced}} = \frac{90 \text{ units}}{100 \text{ units}} = 90\%
\]
Introduction to OEE

IDA – A simple methodology for driving improvement of OEE.
It stands for:
Information, Decision and Action…drive Results

I \times D \times A = R
Introduction to OEE

Let's Focus on the Downtime

Availability = \[
\frac{\text{Available time}}{\text{Fixed Period}} = \frac{6 \text{ hours}}{8 \text{ hour shift}} = 75\
\]

2 Hours of Downtime

(How do you improve this)
How to Reduce Downtime

**Diagnostics**
- Recover faster from failures that already occurred

**Condition Monitoring**
- Detect conditions before a failure occurs
What is Condition Monitoring?

There is no machine without rotation!

Everything that rotates is subject to wear!

SIPLUS CMS provides vibration monitoring of machine components → THE tool for preventive maintenance
SIPLUS CMS
Possibilities of Condition Monitoring

Watch
Smoke
Minutes

Feel
Heat
Days

Hear
Noise
Weeks

SIPLUS CMS
Early detection
Months

Reaction time until breakdown
SIPLUS CMS - Real example
Bearing failure Gearbox

Drawing

Resulting damage at the inner ring

Picture

Trend

Warning

Unrestricted © Siemens 2019 All rights reserved.
Condition Monitoring with SIPLUS CMS
What sort of damage can be detected?

### Mechanical damages

<table>
<thead>
<tr>
<th>Pumps / fans</th>
<th>Gears units</th>
<th>Drives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blade passing frequency</td>
<td>Resonance</td>
<td>Resonance</td>
</tr>
<tr>
<td>Unbalance</td>
<td>Resonance</td>
<td>Field faults</td>
</tr>
<tr>
<td>Resonance</td>
<td>Unbalance</td>
<td>Misalignment</td>
</tr>
<tr>
<td>Unbalance</td>
<td>Meshing faults</td>
<td>Bearing damage</td>
</tr>
<tr>
<td>Meshing faults</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rotor bar breakage</td>
</tr>
</tbody>
</table>

### Electrical errors

<table>
<thead>
<tr>
<th>Mechanical damages</th>
<th>Electrical errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resonance</td>
<td>Stator field faults</td>
</tr>
<tr>
<td>Bearing damage</td>
<td>Meshing faults</td>
</tr>
<tr>
<td>Misalignment</td>
<td>Blade passing frequency</td>
</tr>
<tr>
<td></td>
<td>Rotor bar breakage</td>
</tr>
</tbody>
</table>
What is the advantage of permanent data acquisition and trend analysis of mechanical components?
Why monitoring a fan?

Applications for fan monitoring can be e.g.
- Paint Shop to ensure the quality of the paint
- All kind of exhaust extraction systems

→ For this reason, a unimpressive fan will become an essential element for production
AND SHOULD NOT BECOME INOPERATIVE

Following key data should be effective

- Motor power: 20kW
- Motor speed: 2970rpm
- Shaft height: 100mm
- Count of blades: 30
- Count of rotor bars: 17
- The fan runs in a housing
- Fan and motor are close-coupled
- The fan is supported by two roller bearings
- The Basement is rigid
- The fan is newly commissioned
Apply SIMATIC S7-1200 and SIPLUS CMS1200

**S7-1200 CPU**

- Features
  - Integrated Profinet
  - all TIA Portal advantages
  - High system modularity
  - High number of interfaces and inputs/outputs on the hardware
  - High operational reliability

**SM 1281 Condition Monitoring module**

- Features
  - Characteristic value-based diagnosis
  - Frequency selective diagnosis
  - raw data output
  - SIMATIC- AND Web-based
- Ports
  - Up to 4 vibration sensors
  - One rotation speed input
  - Ethernet
  - Power supply 24VDC (sensor power supply)
- Expansion option
  - Up to 7 modules can be connected (depending on the used S7-1200-CPU)
Fan Monitoring System – CMS Solution

Imbalance
Alignment
Mounting
Electrical field
Bearing
Blade passing frequency
Resonance
Fan Monitoring System – CMS Solution

- Imbalance
- Alignment
- Mounting
- Electrical field
- Bearing
- Blade passing frequency
- Resonance
Fan Control/Protection

- Full Voltage
- Reduced Voltage
- Variable Speed

Unrestricted © Siemens 2019 All rights reserved.
Fan Control/Protection - Available Electrical Data

Applications

3UF7 SIMOCODE
- Compressors
- Conveyors
- Crushers
- Filtering
- Mixing
- Pumping
- Ventilation

3RW5 Soft Starter

Available Data
- Current
- Voltage
- Active Power
- Apparent Power
- Power Factor
- Asymmetry
- Frequency
- Temperature
- Phase Loss
- Phase Reversal
- Cool down Time
- Time to Trip
- Configurable Faults
- Configurable Warnings
- Number of starts
- Operating Hours
- Number of trips
- Digital Diagnostics
Introduction to OEE

Does this “Availability” measurement tell the whole story?

- Availability
- Operator Idle Time
- Waiting for Maintenance
- Repair Time
- Time (hr.)
Another step in improving “Availability” is by improving “Accountability”. (Identifying Who does What and When)

How Do We Currently Do This?

1) Key Switch
2) Password
3) Paper Log
Another step in Improving “Availability” is by Improving “Accountability”. (Identifying Who does What and When)

How Can We Do This Better?

RFID Key Switch
Benefits – RFID Key Switch

RFID Keys

1) New keys can easily be assigned by a supervisor
2) Lost keys can be identified if ever used again
3) Multiple Keys can be assigned to a single owner
4) Unique shape provides protection against tampering or duplication
Improving OEE

- Every key has a unique hex code ID assigned at the factory
- Similar to a MAC ID to Ethernet products

<table>
<thead>
<tr>
<th>Key #</th>
<th>Unique ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>04 D7 C8 18 04</td>
</tr>
<tr>
<td>2</td>
<td>04 9A 45 1A 04</td>
</tr>
<tr>
<td>3</td>
<td>C1 F5 C8 18 04</td>
</tr>
<tr>
<td>4</td>
<td>40 D9 C8 18 04</td>
</tr>
</tbody>
</table>
Improving OEE

- PLC matches ID code from the RFID key to previously stored values to identify owner
Improving OEE

- PLC records date, time and action every time a key is inserted or removed
Improving OEE

**Action**

- Operator inserts key at start of shift
- Operator removes key and requests maintenance
- Maintenance inserts key and begins maintenance
- Maintenance removes key and completes maintenance

**What is Recorded in the System**

<table>
<thead>
<tr>
<th>Who</th>
<th>What</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>04 D7 C8 18 04</td>
<td>Start of Shift</td>
<td>8:00 am</td>
</tr>
<tr>
<td>04 D7 C8 18 04</td>
<td>Maint. Req.</td>
<td>9:00 am</td>
</tr>
<tr>
<td>C1 F5 C8 18 04</td>
<td>Maint. Started</td>
<td>10:45 am</td>
</tr>
<tr>
<td>C1 F5 C8 18 04</td>
<td>Maint. Completed</td>
<td>11:00 am</td>
</tr>
</tbody>
</table>
Now “Availability” measurement tells a more accurate story?
Improving OEE

Solution – Raw Data vs. Knowledge

WinCC

- WinCC HMI software displays recorded events
Improving OEE

Solution – Raw Data vs. Knowledge

WinCC Performance Monitor Analyzes the Data

- The WinCC Performance Monitor offers reliable analyses on:
  - OEE - Overall Equipment Effectiveness
  - MTBF - Mean Time Between Failures
  - MRT - Mean Repair Time
  - and further Key Performance Indicators (KPI).
- The production equipment can be defined individually depending on the specific plant.
Improving OEE

Solution – Raw Data vs. Knowledge

MindApps
- Use apps from Siemens, partners or develop own apps
- Gain asset transparency and analytical insights
- Subscription based pricing model

MindSphere
- Open interface for development of customer specific apps
- Various cloud infrastructures: SAP, AtoS, Microsoft Azure offered as public, private or on-premise (planned)

MindConnect
- Open standards for connectivity, e.g., OPC UA
- Plug & play connection of Siemens and 3rd party products
- Secure and encrypted data communication
Improving OEE

Solution – Raw Data vs. Knowledge

- Field Asset – SIMOCODE
- PLC/DCS
- PROFINET
- OPC
- MindConnect Nano
- Internet Router
  - Optional: Proxy
- MindSphere - Siemens Cloud for Industry
- Corporate / Office Network with route to the internet
  … or direct internet access, e.g. via a DSL modem

Production / Machine Network

Unrestricted © Siemens 2019 All rights reserved.
MindSphere – the cloud-based, open IoT operating system

Solution – Raw Data vs. Knowledge

MindApps
Data analytics applications to increase uptime, optimize energy efficiency and enhance cyber security.

- MindApp Fleet-manager
- OEM App
- Mobile Plant Dashboard
- Production Confirmation
- Build your own Dashboard
- Analytics App
- Manufacturing Sustainability
- Augmented Quality Mgmt. Worker
- Defect Reporting

Siemens products and systems or 3rd party products and systems

Siemens OEM Apps App developers End-customers

Unrestricted © Siemens 2019 All rights reserved.

Improving OEE

Solution – Raw Data vs. Knowledge

Mobile Plant Dashboard
- An app summarizing all relevant production/plant information, e.g. on a tablet or smartphone.

Production confirmation app
- Can read all different kinds of bar-, QR-, dmc-, ... codes via the camera of the device and capture manual data inputs from a keyboard AND change values in a database via a generic adaptable web service (production status, production steps, amount produced, ...)

Manufacturing sustainability app
- Manufacturing intelligence app focusing on sustainability KPIs (KWh, h, CO2, ...). Can be added to manufacturing intelligence app. The user shall be able to drill through the plants down to the machine in a hierarchical tree view (show the plants on google maps > show the lines of a plant plan > show the machines in a line plan > machine). (Optional: Location based viewing of the nearest machine via iBeacon, ...)

Quality management worker app
- Focusing on supporting the QM worker by showing data (KPIs, MES, ERP, PLM, QM) which is crucial for his/her work (to have insight to the production and product – this way he/she is able to find production/product issues that have an impact on quality).  

App “Maintenance Planner”
- Service technician will be informed via the app about the new maintenance job. Technicians will receive the relevant information (location, time, first information about the problem, ...). Arriving at the place to be technicians could identify the machine to be checked. After successful completion of the maintenance job, the technician can provide immediate feedback via app (Maintenance job is done).

Manufacturing intelligence app
- Show order/production status and production KPIs (OEE, ...). The user shall be able to drill through the plants down to the machine in a hierarchical tree view (show the plants on google maps > show the lines in a plant plan > show the machines in a line plan > machine). (Optional: Location based viewing of the nearest machine via iBeacon, ...)

1) To be developed & to be matched with Siemens MindApp development roadmap.
Benefits – SIPLUS CMS

• Early detection of mechanical damage
• Planned maintenance instead of spontaneous repair
• No additional software needed for diagnosis and visualization
• Easy data archiving
• Analyses down to the smallest detail, e.g. for detecting tooth wear in a gear unit
• Monitoring of variable-speed drives

Optimized serviceability
Improved performance
Increased availability
Benefits - SIPLUS CMS Analytics and Display

Parameter-based analysis
- Is damage imminent?
- Trend history of characteristic values

Frequency-selective analysis
- What damage is imminent?
- Every type of damage has its own frequency spectrum

Expert analysis
- Freely configurable analysis with diagnostics software CMS X-tools, e.g. orbit, histogram, vector/waterfall diagram
Benefits – WinCC Analytics and Display

WinCC & Performance Monitor

• Makes it possible to show the weak points of the production and to derive suitable optimization potential.

• Flexible – Individual calculation of plant specific performance indicators within SIMATIC WinCC

• Recognizing performance indicators within the content e.g. quality per vendor

• Analyzing of the performance indicators and displaying them as bar- or Gantt – diagram or as a table also using the Web

• Viewing everything at any time – Target–group oriented analysis reports

• Expandable– Adding of performance indicators within existing plants without any loss of production
Benefits – MindSphere Analytics and Display

Customer focus: System integrators, machine manufacturers
First industry-specific applications: automotive, F&B, aerospace

Connectivity

- Optimized engineering packages for integrated configuration

Performance Management APP
Energy Management PRO APP
SIMATIC System Diagnostic APP
Alarm and Event Management APP
Shift Calendar APP

Planned for TIA Portal V15 and following TIA Portal versions

Unrestricted © Siemens 2019 All rights reserved.
Benefits

Siemens Solution is Scalable:

Machine

Production Line
Benefits

Siemens Solution is Scalable:

Entire Plant
Siemens Can Provide a Complete Solution:

Controls + Automation + HMI/SCADA
How did we do? Don’t forget to leave your feedback in the app.

Got a minute? Rate this seminar via MiA App!
After MiA, seminar slides will be available for download at:

http://www.attendmia.com/download/seminars
Questions?

John Burns
DF CP
5300 Triangle Parkway
Norcross, GA 30092-2538
Mobile: +1 (678) 575 3086
john.burns@siemens.com

Jana Kocianova
DF FA
5300 Triangle Parkway
Norcross, GA 30092-2538
Mobile: +1 (470) 809 2421
jana.kocianova@siemens.com