Equipment Predictive Analytics V1.0
Sales Material
Value of more production vs. value of maintenance saving
Value of more production vs. value of maintenance saving

OEE = Overall Equipment Effectiveness
Effectiveness is the key to profitability in the process industry. This means maximize value add by increasing production output, quality and availability while minimizing the resources input (e.g. energy and material).

But what are the hurdles why customers don’t continuously optimize?

**Resources** – most customers don’t have the needed resources to continuously monitor and analyze their processes and assets

**Competence** - some customers don’t have the necessary knowledge on site and the transparency to know where and what to optimize
Vision – A cloud based, vendor independent Asset and Process Performance Suite

User level

Services and Applications

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Process Industry Apps

- Asset and Process Performance Suite
  - Valve Monitoring
  - Drive Train Analytics
  - Pump Monitoring
  - DCS Lifecycle Portal
  - Control Performance Analytics
  - Process Event Analytics
  - Equipment Predictive Analytics
  - Batch Performance Analytics

- Available
- Pilot/MVP

MindSphere

IIoT platform (cloud)

- Data analysis asset diagnosis
- Health monitoring
- Predictive maintenance
- Specific applications for certain asset groups
- Harmonized Look and Feel
- Covers assets from multiple manufacturers
- Secure data storage
- Worldwide access to all plants and locations
- Data acquisition via field sensors and plant network

Plant level (worldwide)

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Equipment Predictive Analytics
Benefits / Value Proposition

### Increased Plant Uptime

- Avoid unplanned shut-down of your plant by predicting failures of critical equipment (based on historical data)
- Analyze behavior of equipment within process environment and find anomalies

### Higher Operation Efficiency

- Get an intuitive picture of the health of your equipment in a timely and efficient manner
- Achieve a predictive maintenance instead of time-based / reactive maintenance
- Enable remote monitoring and issue identification

### Better Decision Accuracy

- Identified correlations hidden in data for smart decisions on operation
- Consolidate knowledge, experience and data for 24/7 stable monitoring performance
- Reduce workload for limited resources on experienced engineers

### Cost reduction

- Increased reliability and effectiveness (OEE)

### Asset integrity

- All assets fully operational and optimally utilized

### Smart Data

- Intelligent linking of knowledge and data

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Practical & robust tool for predictive monitoring integrating human experience/know-how and machine analysis capability
Equipment Predictive Analytics

**Goals**

- **Increased plant uptime** through avoidance of shut-downs by pre-alerting on failures
- **Higher operation efficiency** through predictive monitoring
- **Better decision accuracy** through identification of correlations hidden in data

**Configuration and Training**

**Predictive**

**Monitoring**

Ensure Overall Equipment Effectiveness

- **Plant uptime**: Increased plant uptime through avoidance of shut-downs by pre-alerting on failures
- **Operation efficiency**: Higher operation efficiency through predictive monitoring
- **Decision accuracy**: Better decision accuracy through identification of correlations hidden in data
What is Artificial Intelligence?

1. Historical behavior  ➔ Understand the “pattern”
2. Current behavior  ➔ Apply the “pattern” and raise conclusions

Create new “pattern” based on current behavior

Artificial Intelligence
Program that can sense, reason, act, adapt

Machine Learning
Program that improves as soon as it is exposed to more data

Deep Learning
Program that learns based on multilayer neural networks
Data Availability and Analysis

Predictive Availability Monitoring

OEE

Engineering Historian Automation EPA

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EPA - System Integration with PCS 7 or third party DCS
V1 of App as an “On-premise”

Requirements on the side of the App
• PC (or VM ware) to run the App incl. environment
• Browser (Chrome) access to the App

*Firewall/DMZ may be provided separately based on customer’s security requirements
Solution and Key Techniques

Data Integration

- Process control sensor data
- Equipment real-time monitoring data
- Others

Correlation identification

Understandable/Interpretable

Experience/Know-how Integration

Robustness along life-cycle

Correlation between related sensors
Data Integration

- Process control sensor data
- Equipment real-time monitoring data
- Others

Correlation Identification

- Identify target key monitoring sensors and correlated sensors
- Define integrated “Equipment DNA”

Input:
- Historical data of certain time period (suggest ≥1 year) consisting of time series generated by sensors
  - on the equipment
  - within the related manufacturing context/process

Output:
- Target monitoring sensors
- Correlated sensors for each target monitoring sensors which are identified based on integration of data-driven results and domain knowledge.
Solution and Key Techniques

Correlation Identification ➔ Understandable/Interpretable ➔ Experience/Know-how Integration ➔ Robustness along life-cycle

Data Integration
- Process control sensor data
- Equipment real-time monitoring data
- Others

Correlation Identification
- Identify correlated points for key alarm
- Define integrated Equipment DNA

Risk Analysis

Anomaly Pre-alert
- Based on “Equipment DNA”, build Status Reference Library to alert on anomalies

Training/modeling:
- Characterizing reference “normal” conditions in the past
  - Input: Equipment DNA
    - A set of time periods for good conditions of equipment
    - Historical data for those time period
  - Output: Model of Status Reference Library

Monitoring:
- Evaluate risks with real-time status
  - Input: Model of Status Reference Library
    - Real-time data stream (suggested with certain freq.)
  - Output: Estimated risks by deviations from normal conditions and pre-alerts for high risk cases
Solution and Key Techniques

**Data Integration**
- Process control sensor data
- Equipment real-time monitoring data
- Others

**Correlation Identification**
- Identify correlated points for key alarm
- Define integrated Equipment DNA

**Risk Analysis**

**Anomaly Detection**
- Based on “Equipment DNA”, build Status Reference Library to alert on anomalies

**Interactive Machine Learning**
- Inspection for root cause analysis
- Feedback to improve model iteratively
- Adaptive for whole equipment lifecycle
Proof of concept
Advanced compressor monitoring

PI 3703 – Compressor output pressure

Algorithm detect “unhealthy behavior”
1:25 pm
Day 1

No DCS alarms
8:36 am
Day 2

1. Almost no high risk alerts
2. Series of high risk alerts
3. Only high risk alerts

Risk detected ~18 hours earlier!
1. 30th May 3pm: almost no high risk alerts

2. 1st June 6:40 pm: sporadic high risk alerts

3. 1st June 11pm: series of high risk alerts

4. 2nd June 12am: start of long series of high risk alerts

5. 2nd June after 12pm: only high risk alerts

- EPA starts alerting in the evening of 1st of June!
- Actual failure of the pump on 13th of June!
Customer Implementation Procedure

Feasibility Study (2 weeks)¹
- 1 year of history of data
- Data review and assessment
- Limited number of trained model presented as feasibility result

Project Start-up (1-2 weeks)¹
- Workshop - expectations and KPIs clarification
- Target sensors identification
- Healthy and validation periods identification

Modeling (2 - 4 weeks)¹
- Process DNA preparation
- Model training and validation
- Software and hardware deployment preparation

Site Deployment & Training (1 week)¹
- App deployment
- Analysis of first results based on live data
- Models consolidation
- User training

Evaluation & Consolidation (3 months – 6 months)¹
- Continuous models improvement
- Alerts review

Key Resources

Process/Domain Expert
- Feasibility Study
- Project Start-up
- Modeling
- Site Deployment & Training
- Evaluation & Consolidation

Data Analyst
- Feasibility Study
- Project Start-up
- Modeling
- Site Deployment & Training
- Evaluation & Consolidation

Engineers/DevOp
- Project Start-up
- Modeling
- Site Deployment & Training
- Evaluation & Consolidation

Siemens Key Resources

Customer Key Resources

Management support

Process/Domain Expert

¹ Provided periods may change based on customer’s defined scope (no. of assets)
Feasibility Study - Details

Data Acquisition
- Plant documents (P&IDs..)
- Historical Database backup
- Alarm list

Pre-modeling Workshop
- Equipment DNA definition
- Healthy periods & validation periods identification

Database Preparation
- Data integrity check
- Data clean-up
- Correlation matrix calculation

Data Modeling & training
- Modeling based on identified training periods
- Models validation

Results presentation
- Data analysis report
- EPA App demonstration
- Identify potential quick wins and actionable insights
- Next steps definition

Project execution
- …

Service and maintenance
- …
Scalable Value and EPA (on-premise) portfolio overview

Value scale

Training

Onboarding

Status Reference Library

Feasibility Study

EPA App

Infrastructure Setup

Offering structure

Short description

- User on-site training (min. 3 days) for:
  - Modelling: altering existing models & creating new models
  - Monitoring available models
  - Analysis for monitored models

- Deployment preparation (docker container preparation, documentation) and site installation (min. 5 days)

- Inhouse modeling of max. 1000 data points
- Output: 30 models (30 target sensors parallel monitoring)

- Analysis of historical data (recommended 1 year) provided by the customer. Includes data review and assessment based on customers’ defined expectations.
- Output: Results (slides/report) and trained models presented in EPA App

- Installation of EPA with real-time data connectivity. Available features:
  - Modelling: altering existing models & creating new models
  - Monitoring available models: max. 30 target sensors & 30 models
  - Analysis for monitored models

- Hardware (i.e., server / computing resource) and OS can be ordered on request for EPA installation
- Customer can also provide their own infrastructure (i.e., server / computing resource) based on the EPA configure requirement
- OS (i.e., Operation System) should be installed and licensed (if necessary)

1 One-time fee for current released version. Annual Maintenance Fee (6BG0000-0AA00-0EE0) not included. Maintenance fee covers all available updates/versions which are available for download.
Equipment Predictive Analytics
Key Takeaways

EPA improves your Overall Equipment Effectiveness (OEE).

Artificial intelligence needs data and domain experts to become smart.

Rethink the process – let’s work agile.

History is already now.

We have **answers** and **solutions**. We are here to **support YOU**.
Thank you for your Attention!

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