

Data monitoring of machines and production lines

Q1/2018



yazzoom helps you create value from your data

6

Years of Expertise

10

People

Data Science

AI – Machine Learning

Prescriptive Analytics

Optimization algorithms

Data and Process Mining

Engineering

PID control

Vision and Sensors

Physics - Mechatronics

Advanced Process Control

Scope

Consulting and Services

End to end data projects

Software products

Custom made software



Services provided by Yazzoom

- **PROCESS CONTROL** - Primary and Advanced Process Control Services to improve the production quality and efficiency
- **SOFT SENSOR DEVELOPMENT** – Development, Integration and Maintenance of Soft Sensors to improve production
- **AUTOMATIC INSPECTION AND SORTING** – Development of custom Vision, Measurement and Sorting solutions
- **PRODUCTION ANALYTICS** – Software and Services to analyse production & machine data: root cause analysis, anomaly detection,...
- **TRAINING SERVICES** – Primary and Advanced Process Control Training Courses



APC consulting



PID consulting



Soft sensor development



Inspection & sorting



Production analytics



Classroom training



Online training

Products provided by Yazzoom

- **PITOPS** - Process Identification and PID and Advanced Process Control Simulation and Optimization
- **SIMCET** - PID Tuning Real-Time Simulator for Training and Certification
- **APROMON** - PID and Advanced Control Online Control Quality Monitoring Software (CLPM)
- **PIPROMASTER** - Computer Based Training of Practical Process Control designed for the Control Room
- **YASENSE** - Software Sensor Development, Run-time and Monitoring
- **YANOMALY** – Unsupervised data mining and anomaly detection on machine data



OUR SERVICES ARE USED FOR...



Process Improvement

Process control improvements to:

- resolve quality problems
- reduce cost
- improve stability and safety



Smart Machines

Software and sensor selection for:

- inspection robots
- sorting machines
- measurement devices

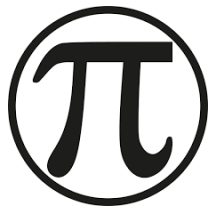


Advanced Analytics

Prescriptive Analytics for:

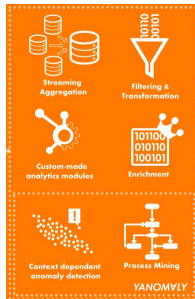
- knowledge discovery
- decision support
- root cause analysis

MONITORING PRODUCTS



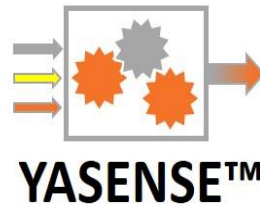
APROMON

**Control Loop
Performance
Monitoring**



YANOMALY

**Anomaly Detection &
Analytics for Machine
Data & Log Files**



**Predictive
Modeling Tool
Suite**

**All can be used for “early warning”:
separately or combined**

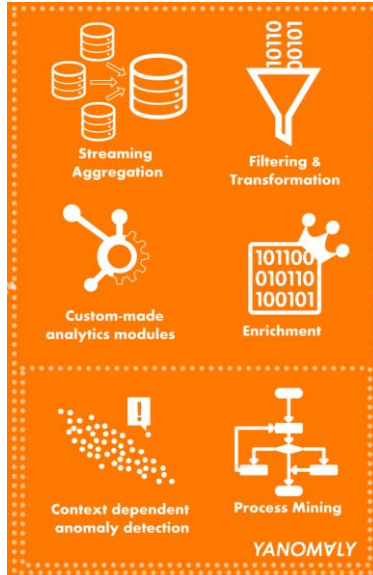
PLANNING MAINTENANCE

Several ways to “plan” maintenance (RCM2 terminology)

- Scheduled maintenance – Preventive maintenance
 - Each X weeks
 - After X running hours
- Condition based maintenance – Predictive maintenance
 - Based on dedicated local measurements, e.g. vibration (aka “condition monitoring”)
 - Based on indicators derived from available measurements using some mathematical computations, e.g. normalized energy efficiency

The focus of Yazzoom

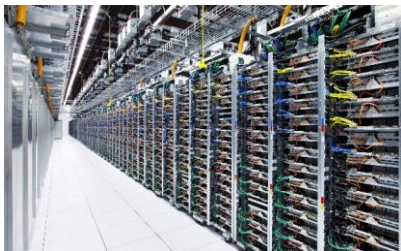
TODAY'S FOCUS POINTS



YANOMLY

**Anomaly Detection &
Analytics for Machine
Data & Log Files**

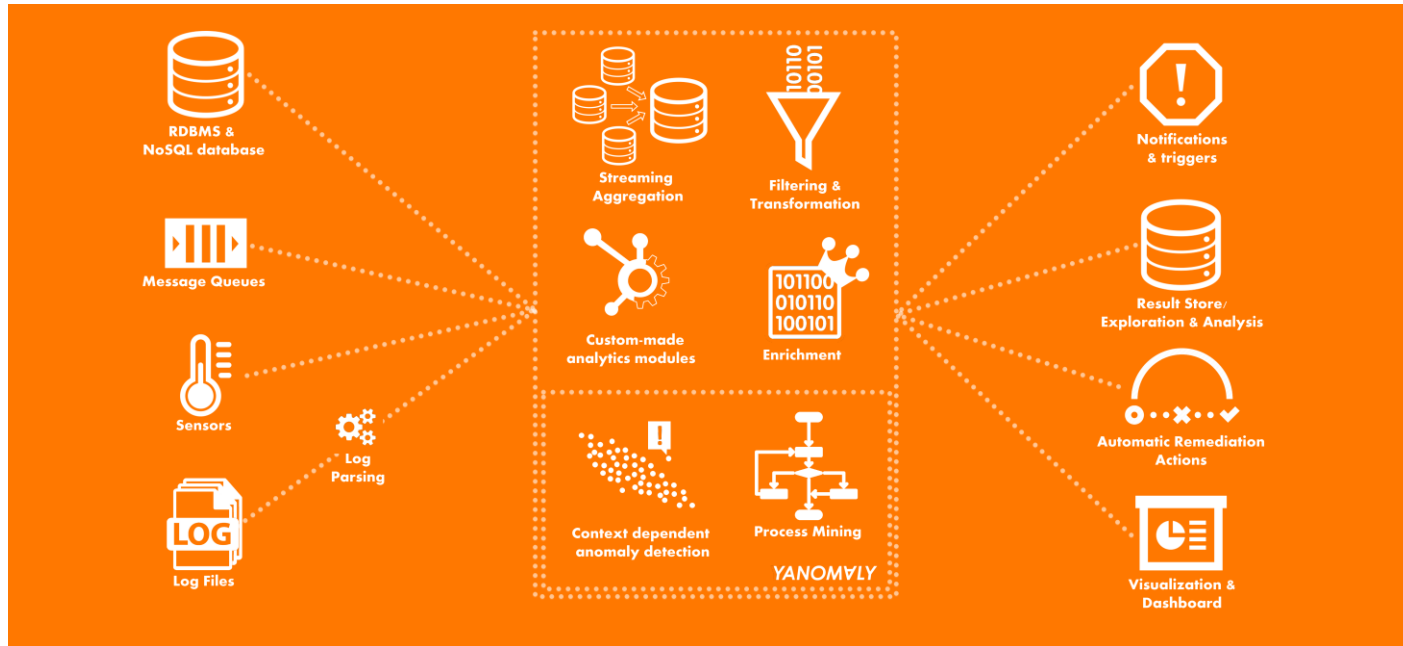
Machines, systems & devices generate Data



Sensors, process data, usage metrics,...
in databases, log files, message queues...

This Data is full of *hard to extract* **valuable** information

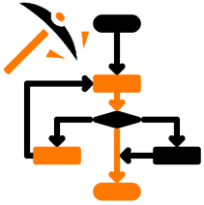
Yazzoom's solution for extracting valuable insights and actions from machine data and log files uses **advanced analytics and machine learning**.



Unique capabilities



Yazzoom has built on top of open source Big Data technologies like Logstash, Kafka, Kibana and Elastic Search a powerful reusable and extendible technological solution with some unique capabilities:



Process mining: The ability to learn from the various heterogeneous data streams statistical models that describe how the machines, devices and systems have been used and which process steps were executed by those systems.



Context dependent anomaly detection: The ability to detect in real-time anomalies or abnormal process execution in both numerical data and log files, while taking into account the context in which the system operates.

Value inside machine data:



R&D

- Learning how machine/plant/utility is used
- Higher reliability through more realistic product testing
- Better product design thanks to knowledge of real usage



Service

- Gain pre-emptive knowledge of potential problems
- More efficient investigation and troubleshooting
- Reduce the mean time to repair of your service team



Operations

- Real-time detection and even prediction of anomalies
- Avoid down-time through automatic remediation actions
- Speed up root cause analysis for faster recovery
- Fraud detection

More value from machine data:

Custom Analytics Modules developed by our multi-disciplinary team of experts for your needs and according to your specifications, for example:



- Typical product interaction pattern extraction for up and cross-selling
- Machine/Utility performance insights
- Quantify dependencies between sensor readings

YANOMVLY status

First customers from Healthcare, ICT, Process Industry and Utilities markets (most NDA)

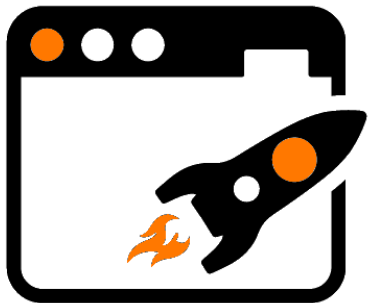


Ongoing R&D in EU ITEA3 project Reflexion

Partners in current EU project:



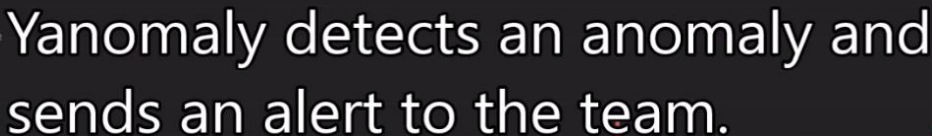
Flexible Deployment & Integration



The solution can be integrated on your company's private servers or in the cloud. We cooperate with your technical team to seamlessly integrate it in your infrastructure.

The output generated can be visualized in dashboards, trigger notifications or remediation actions to minimize or avoid further issues, or be stored for further analysis

The user can zoom & filter & click-through to the original log files



Example Univariate Numerical Anomaly Detection

This view illustrates anomaly detection on time-series data

The data points can come from sensors, or can be numerical values extracted from log files

Yazzoom has implemented several anomaly detection algorithms & ensemble method to combine results



Multivariate Numerical Anomaly Detection on CHP



2016-01-13 20:00:00 has overall anomaly score of 0.97
ISM anomaly score: 0.89 (48%)
STM_TEMP_5: 44%
STM_TEMP_6: 44%
SCD anomaly score: 0.78 (42%)
STM_MASS_FLOW_3: 32%
STM_MASS_FLOW_2: 32%

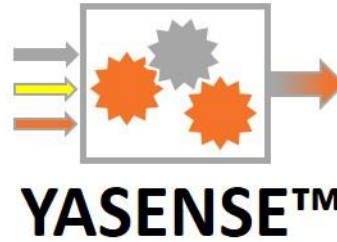
2016-01-13 20:00:00 has overall anomaly score of 0.97
ISM anomaly score: 0.89 (48%)
STM_TEMP_5: 44%
STM_TEMP_6: 44%
SCD anomaly score: 0.78 (42%)
STM_MASS_FLOW_3: 32%
STM_MASS_FLOW_2: 32%
LOVO_COMBINED anomaly score: 0.15 (8%)
GAS_INLET_PRESS_2: 30%
STM_TEMP_6: 16%
STM_TEMP_5: 9%
LOVO_GL anomaly score: 0.00 (2%)

2016-01-27 06:50:00 has overall anomaly score of 0.99
LOVO_GL anomaly score: 1.00 (39%)
LOVO_COMBINED anomaly score: 1.00 (39%)
AMBIENT_TEMP: 63%
ISM anomaly score: 0.49 (19%)
GROSS_LOAD: 68%
SCD anomaly score: 0.03 (3%)
STM_MASS_FLOW_3: 24%
STM_MASS_FLOW_2: 24%
FW_MASS_FLOW_1: 9%
GAS_INLET_FLOW_1: 5%
STM_PRESS_2: 5%

2016-01-27 07:50:00 has overall anomaly score of 0.99
ISM anomaly score: 1.00 (49%)
STM_PRESS_6: 72%
LOVO_COMBINED anomaly score: 1.00 (49%)
STM_TEMP_2: 56%
STM_PRESS_6: 22%
LOVO_GL anomaly score: 0.00 (2%)

2016-01-27 08:00:00 has overall anomaly score of 0.99
ISM anomaly score: 1.00 (49%)
STM_PRESS_6: 72%
LOVO_COMBINED anomaly score: 1.00 (49%)
STM_TEMP_2: 55%
STM_PRESS_6: 21%
LOVO_GL anomaly score: 0.00 (2%)

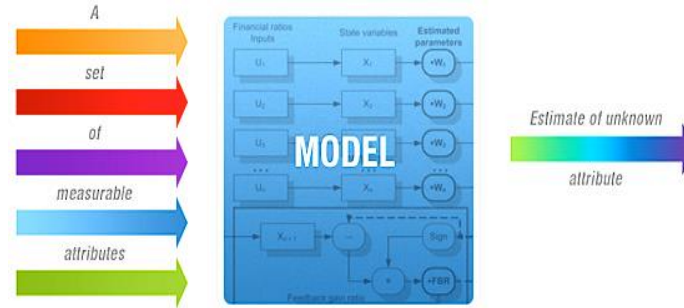
TODAY'S FOCUS POINTS



**Predictive Modeling
Tool Suite**

PREDICTIVE MODELS

- A soft sensor = virtual sensor = a computer model that estimates hard to measure variables based on available other variables



- The computer model can be “white box” (based on mathematical theory, aka first principles models, “black box” (learned from historical data using machine learning algorithms) or “grey box”.

VIRTUAL SENSORS



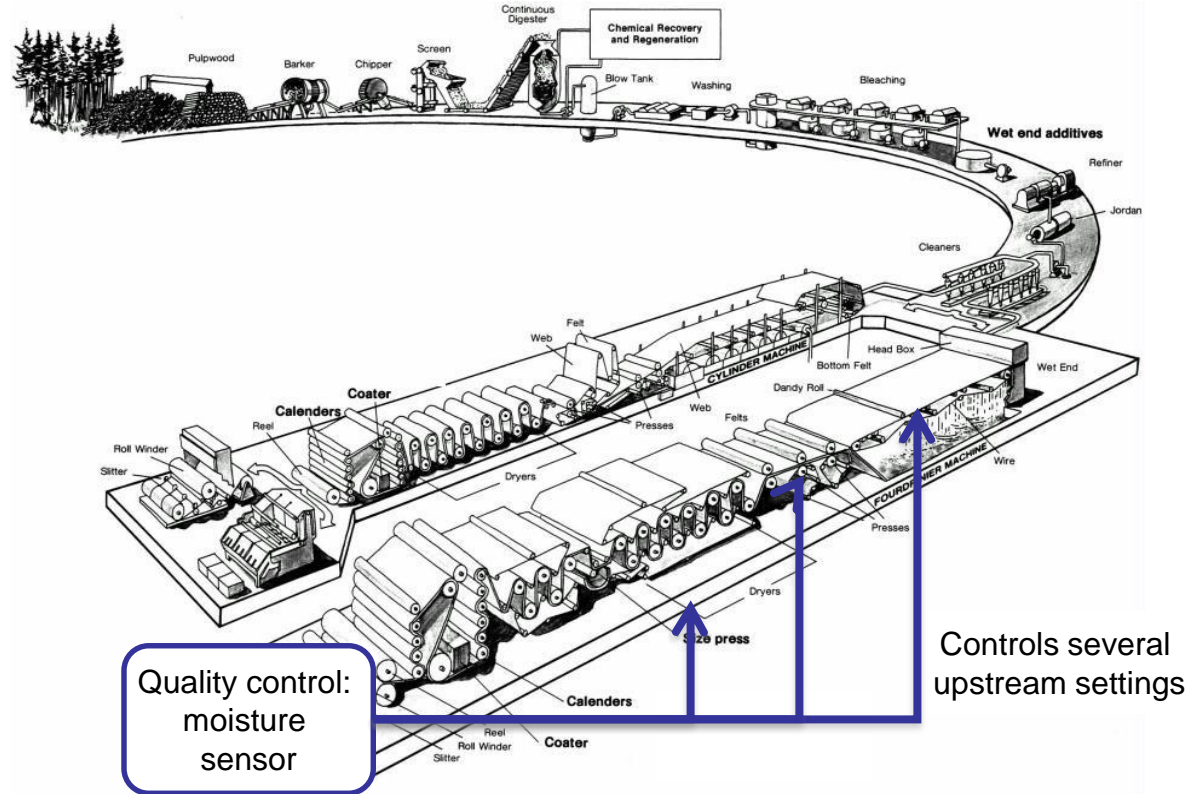
Soft sensor development

- Soft sensor development = creation of the computer model
- We have our own tool suite for soft sensor development, deployment and monitoring “YASENSE”
- Model can be
 - White box: based on physical laws expressed as mathematical equations (“first principle” models), e.g. Yasense Excel
 - Black box: learned from historical data using machine learning (AI), e.g. Yasense
 - Grey box: mix of above
- Model’s objective can be to
 - Estimate value of a continuous variable (now or predict)
 - Estimate probability of an event, e.g. failure

HOW TO BENEFIT FROM SOFT SENSORS

- Predict expensive lab measurements that take a long time to obtain
- Estimate measurements that are impossible, too dangerous or too expensive to do on-line
- Faster availability of product/process quality information
- Produce less off-quality product by giving feedback to operators or by using the prediction in automatic control
- Save on cost of lab measurements by doing them less

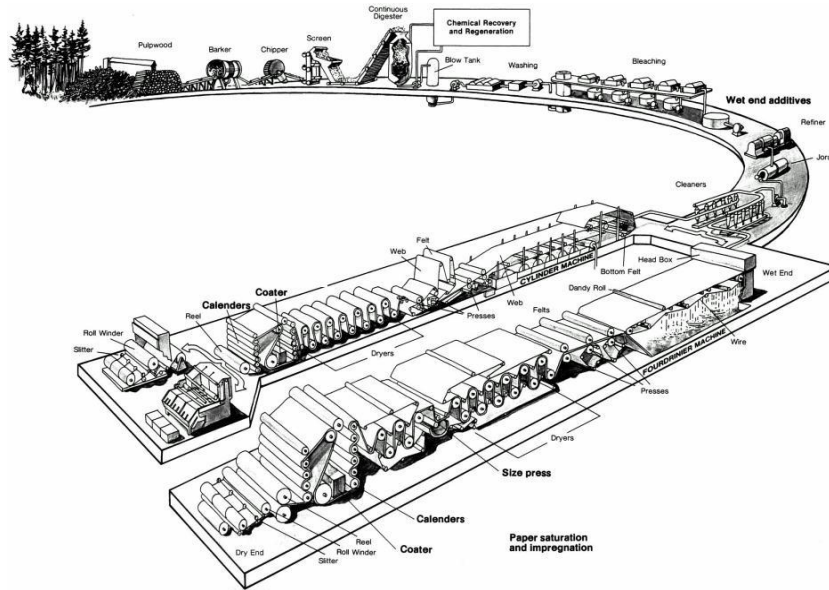
VIRTUAL SENSORS EXAMPLE: PAPER MOISTURE



VIRTUAL SENSOR FOR PAPER MOISTURE: PROBLEM STATEMENT

- Problem statement:
 - Paper moisture is one of most important product quality characteristics
 - But the on-line physical sensor is sometimes not reliable...
 - ...and the off-line lab measurement is too slow and too expensive

VIRTUAL SENSORS FOR PAPER MOISTURE: GOAL



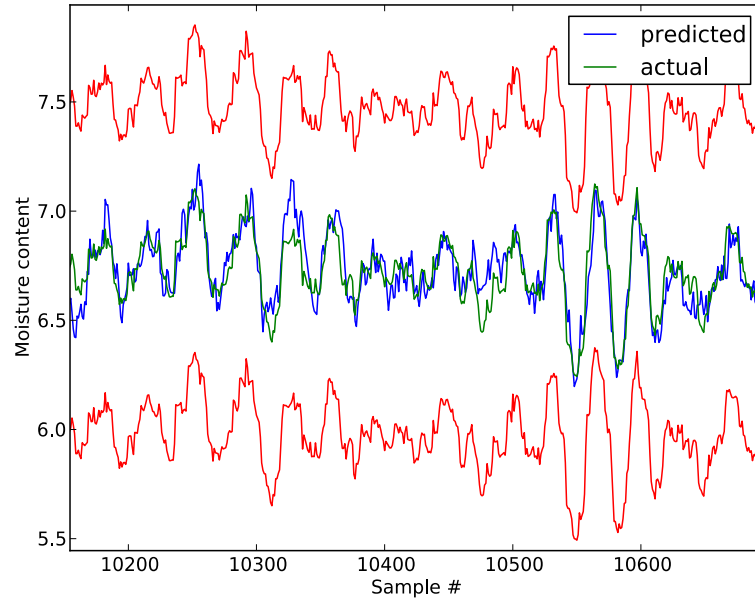
Project Goal

Replace the physical moisture sensor in the first 5 to 10 minutes after paper break in order to reduce the time that off-quality paper is produced

VIRTUAL SENSORS FOR PAPER MOISTURE: SOLUTION

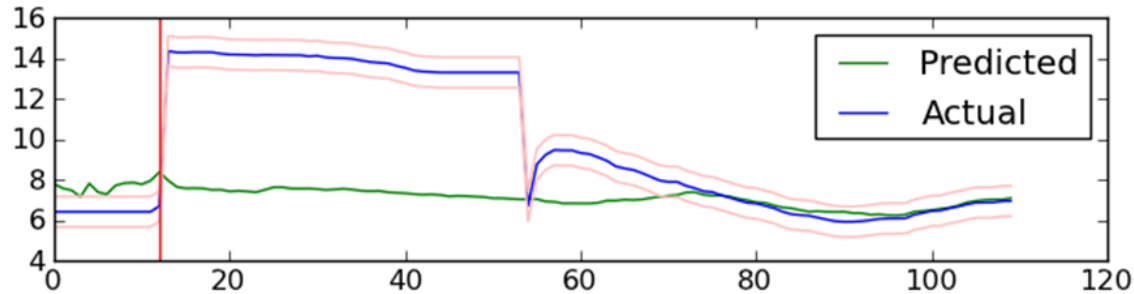
- Soft sensor predicts output of physical sensor based on upstream measurements
 - Around 120 inputs: pressures, speeds, temperatures,...
- Model building using “Machine Learning”/“Artificial Intelligence”:
 - Historical data from PI system and Product Quality database over 3 months
- Model:
 - Pre-processes the inputs to be more robust to exceptional values
 - Non-linear regression
 - Post-processing to adapt to long term variations in the process
 - Watch-dog signal to indicate reliability of predictions
- Implementation of run-time: Soft Sensor runs on a PC
 - Reads and writes to SCADA/DCS using OPC

PAPER MOISTURE PREDICTION: RESULT IN REGIME OPERATION



PAPER MOISTURE PREDICTION: RESULT AFTER BREAK

This curve shows evidence that physical sensor gives at first wrong “actual” measurement



Project realized at customer VPK - Oudegem Papier

VIRTUAL SENSOR EXAMPLE 2: DO-IT-YOURSELF VIRTUAL SENSOR WITH YASENSE EXCEL

- The classical Yazzoom YASENSE tool suite requires Yazzoom to create, deploy and maintain the model
- This is unavoidable if the model is complex or not known to experts
- In case the model is simple enough to be created (by us or by yourself) in Microsoft Excel: attractive alternative:

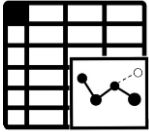
YASENSE EXCEL

YASENSE Excel

**From Excel-based white box model
to soft sensor for online prediction**



Which problem does it solve?

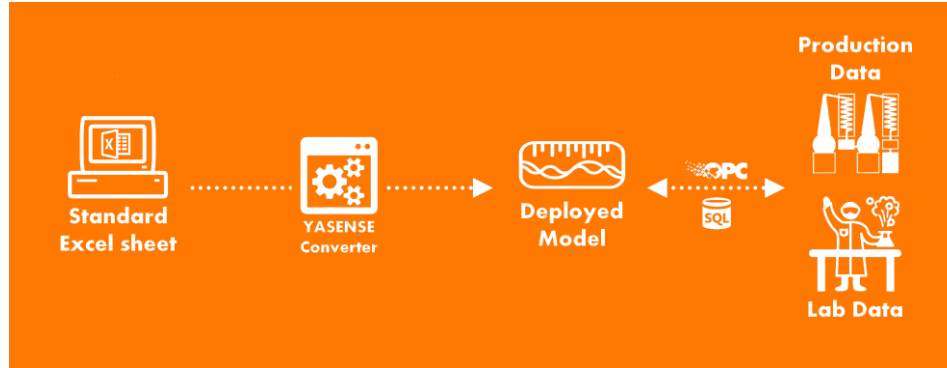


- Excel not suited to run live continuously in production
- Competitor tools require rebuilding model in proprietary IDE of PLC code

Yasense Excel converts Microsoft Excel models into live virtual sensors

Advantage: models can be built and maintained by non-programmers

In a nutshell...



The description of the soft sensor, **built in Microsoft Excel** using typical Excel functions, is **converted into a ready-to-run model** by YASENSE's Conversion Tool.

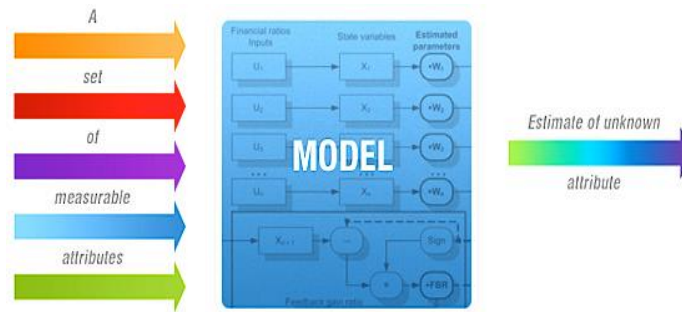


YASENSE Runtime Module is a **robust runtime platform** with advanced monitoring and watchdog capabilities that runs the model and interfaces with the PLC/DCS/SCADA of your plant or laboratory over OPC or SQL.



All this is done from YASENSE's Dashboard module, which also allows you to **monitor and control** the status of the deployed models and start or stop them.

EXAMPLE FOR CONDITION BASED MAINTENANCE



- Example:

- output = a KPI like normalized energy efficiency of pumps, mixers,...; heat exchanger efficiency etc.
- inputs = voltage, current, pressure, flow...
- model = arithmetic and logical operations written in Microsoft Excel to compute the output from the inputs

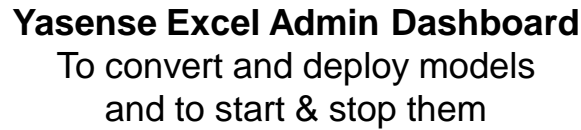
EXAMPLE: PUMP MONITORING

CONDITION MONITORING OF
A PUMP BY OBSERVING THE
PUMP EFFICIENCY



yazzoom

View of PCS7 programmer
To set up virtual sensor initially
To change inputs & outputs
This is OPTIONAL



e.g. process or quality engineer, production manager, maintenance manager etc.

YASENSE EXCEL REALIZATION IN PULP & PAPER

- Virtual sensor for paper grammage
- Virtual sensor for paper strength

Realized at customer in The Netherlands

TAKE HOME MESSAGES

- Predictive analytics can be used to
 - indicate issues with equipment and instruments (and be remedy)
 - Predict failures
- Mathematical models can be
 - learned from data using machine learning (black box model), or
 - be implemented in existing software tools like CLPM (statistics) , or
 - be created (e.g. in Excel) using your plant specific knowledge (white box model)

SUMMARY

- Yazzoom offers unique solutions for predictive and prescriptive data analytics
- Yazzoom's team unique combination of engineering and data science expertise allows us to tackle machine predictive modelling projects with high efficiency

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