Simulation & Predictive Maintenance Application

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Key Takeaways

• Listening and Pivoting

• Collaboration

• Flexibility
SIMULATION & PREDICTIVE MAINTENANCE

SAFRAN APPROACH
2015 Q1. First Artificial Neural Network (ANN) to solve Structural Health Monitoring SHM problem

2016 Q1. Assessment of random noise effect in SHM EWSHM-2016 – Congress Bilbao (Spain)

2017 Q2. ANN approach to predictive analysis of rotary industrial machines

2018 Q1. Marketing development & Customer seeking

Today
First bench-markings with potential customers and collaborators

2017 – Congress Bilbao (Spain)

Hydraulic Press
Hydro-electric generator
Variable Frequency Generator (VFG)
Automotive tire vulcanizing furnace applications
IT, OT and ET

Smart Predictive Maintenance requires for three different Technologies: IT, OT and ET.

1. Information Technology to analyze historical Big Data.

2. Operation Technology to obtain data in streaming from real process.

3. Engineering Technology to identify physical behaviors and simulate run-to-failure data.
Due to traditional Maintenance Cycles, run-to-failure data are normally missing from collected Data Base.

2. Run-to-failure data are necessary for Smart Prediction.

3. Digital Twins simulate anomalies to generate these data.

4. Digital Twins follow Physical Responses.
• **Digital Twins are applicable to** any level of taxonomy.

• **The whole corporation can be connected by** using Simulated Process.

• **Digital Transformation is mandatory for any company for future developments.**
INDUSTRIAL PROCESS APPLICATION

Hydraulic Press
Application – Hydraulic Press

Methodology

1. Preliminary analysis:
   • Monitor for collecting calibration data.

2. Simulation model:
   • Create Parametric Virtual Model with Simulink.
   • Correlate with calibration data.
   • Generate anomalies (Data Base).

3. Neural Network supervised training:
   • ANN generation/training with Deep Learning Toolbox.

4. Implementation of the predictive model:
   • Synchronize active monitoring and predictive maintenance model.
   • Develop interface for friendly user experience with GUI Layout Toolbox.
Application – Hydraulic Press

1. Model of the hydraulic press
   • Hydraulic double acting cylinder
   • 4 ways - 2 positions valve
   • Pump
   • Safety valve

2. Control
   • Controlled by a variable time signal, piloting the main valve.

3. Monitoring
**Application – Hydraulic Press**

**Simulink - 1D Virtual Model**

- **Electric mod**
- **Hydraulic mod**
- **Mechanical mod**
Application – Hydraulic Press

1. Anomalies simulation
   • Parametric model → scenarios (anomalies progressive growth or abrupt).

2. Anomalies list
   • Decrease of Pump rotation speed.
   • Delay of the control valve.
   • Pressure of the safety valve.
   • Valves leakages.
   • Bypass between up and down circuits.
   • Hydraulic lines leakages.

3. Sensitivity analysis of anomalies
   • Sensor impact.

4. Damage Qualification
   • Determine damage boundaries for alerts.

+ 2500 scenarios!!
Application – Hydraulic Press

1. **Data base**
   • **NN Dataset & Training** is developing by switching Input-Output.

2. **ANN Generation**
   • Build the ANN architecture with Deep Learning Toolbox.

3. **Training**
   • Adjust relative neural parameters to reach desired values.

4. **Validation**
   • Iterative process using physical inputs to validate ANN and Virtual Model.
Application – Hydraulic Press

GUI Layout Toolbox
SAFRAN SIMULATION APPLICATIONS
Application – Work Load Distribution

Concession Prediction

Prediction

Concession Work Flow

Employee Flow

Concession Queue

Corporation

Industrial Process

Components

Workload Distribution
Application – Tire Vulcanizing Furnace
Application – Electric Generator
LESSONS LEARNT
Lessons learnt

• Listening customers to pivot from SHM to Simulation & Predictive Maintenance.

• Finding collaboration to keep growing knowledge and portfolio.

• Adapt processes to be flexible for customer demands.