Datenanalyse, Methoden und Prozesse für Ertragsmaximierung

Spreewind 2014
Overview

- History, motivation
- Infrastructure, software, processes
- Diagnostics, prognostics and CBM
- Summary
What's So Great About SCADA?

Advantages and opportunities provided by available data
How Did I Get Here?

Optimisation of Engine Reliability

Optimisation of Wind O&M
Multiple Failure Modes

Wind turbine reliability affected by a high volume and frequency of failure modes

Ref: Reliawind 2010

Ref: Gray & Watson, Wind Energy 2009
Large volumes of information available to support analysis tasks
Multiple Applications of SCADA Analytics

SCADA can be applied for a large range of tasks relating to wind turbine operations

- Production forecasting
- Yaw misalignment detection & correction
- Failure prognostics
- Outlier detection
Infrastructure, Software, Processes

Requirements for effective application of SCADA analytics
Next Level SCADA

**EFFICIENT PROBLEM IDENTIFICATION → OPTIMISATION**

Condition Monitoring, Business Intelligence, Reporting, Analytics

Centralised SCADA Database

- SCADA OEM #1
- SCADA OEM #2
- SCADA OEM #3

Multiple Information Sources
(bill of materials, service reports, CMS etc)
Software & Analytics

Software should allow the operator to quickly evaluate past, present and future operations.
Data analytics must be effectively integrated into operational processes for value generation
Practical Examples

Diagnostics, Prognostics, CBM
Failure mechanisms can be understood, modelled, quantified and monitored
Knowledge Database

<table>
<thead>
<tr>
<th>Failure Mode</th>
<th>erosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure Location</td>
<td>leading edge progressive towards periphery</td>
</tr>
<tr>
<td>Root Cause / Effect chain</td>
<td>salt, dust and sand (SiO2) in air erodes blade surface at point of momentum transfer (air flow re-direction)</td>
</tr>
<tr>
<td>Damage Promoting Operating Mode</td>
<td>high wind speed, high rotor speed</td>
</tr>
<tr>
<td>Aggravating Boundary Conditions</td>
<td>sand, salt, dust, ice in air - seasonal effect desert, semi-arid, coastal, off-shore or actic location of turbine</td>
</tr>
<tr>
<td>Damage Drivers</td>
<td>wind speed, rotor speed</td>
</tr>
<tr>
<td>State Indicators</td>
<td>power curve (power loss, particularly variable speed region) pitch curve (unusual behaviour)</td>
</tr>
<tr>
<td>Maintenance Task</td>
<td>Lifetime (20 years)</td>
</tr>
<tr>
<td>Inspection Method</td>
<td>Visual inspection of blade. Hammer test to check acoustic response Access via mobile platform or rope</td>
</tr>
</tbody>
</table>

Uptime HARVEST™ knowledge DB (example: Blade)

Structured information storage within an integrated system support continuous improvement
Outlier Detection

Fully automated and accurate outlier detection using physics-based models
Physics of Failure

Physics of Failure modelling combined with SCADA improves prognosis accuracy
Cost Minimisation

**Planned vs Unplanned Repair Costs**

Introduction of well-timed preventative maintenance reduces overall costs.
Improvement: Recommendations and Potential

**Recommendations**
- Intermediate replacement, instead of run-to-failure
- Prioritisation according to accumulated damage
- Online monitoring (SCADA, alarms)
- Failure rate tracking and adaptation of plan

*Combination of maintenance scheduling, monitoring and prognostics for minimum total cost*
Summary

- Data analytics can support a wide range of optimisation activities
- Requirements: data infrastructure, software, analytics, process integration
- Physics based methods provide transparency and are highly effective
- A combination of diagnostics, prognostics and CBM provides financial gains
- **Power of SCADA:** available, plentiful, continuous, detailed, growing
Thank you