Condition monitoring of onshore wind turbines: independent thinking

Bruce Valpy, June 2011

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Market analysis & business development
- **Supply chain development**
- **Economic impact assessment**
- **Support to industrialisation**

Technical innovation & engineering analysis
- **Support to investment in technology**
- **R&D programme management**
- **Design and engineering services**

Project implementation
- **FIT project development (UK only)**
- **SCADA & condition monitoring**
- **O&M technical support**

Technical education

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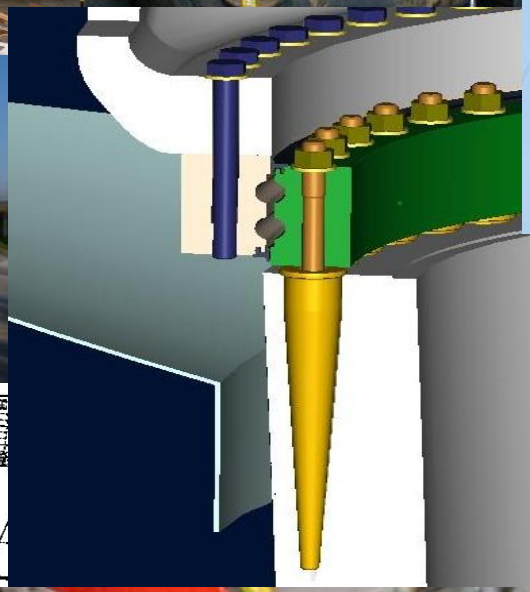
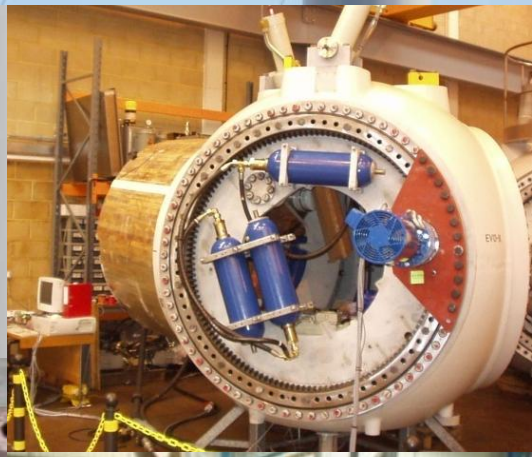
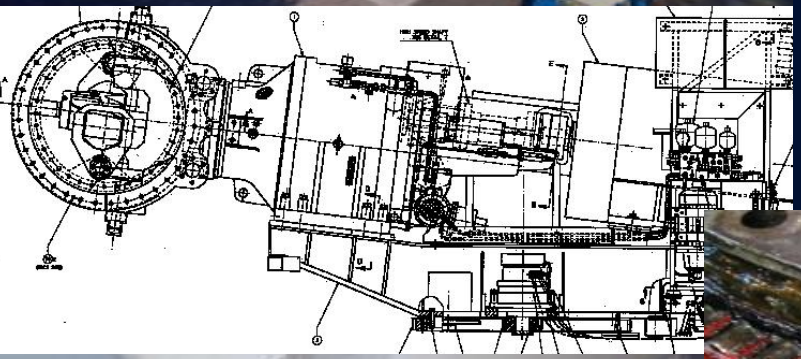
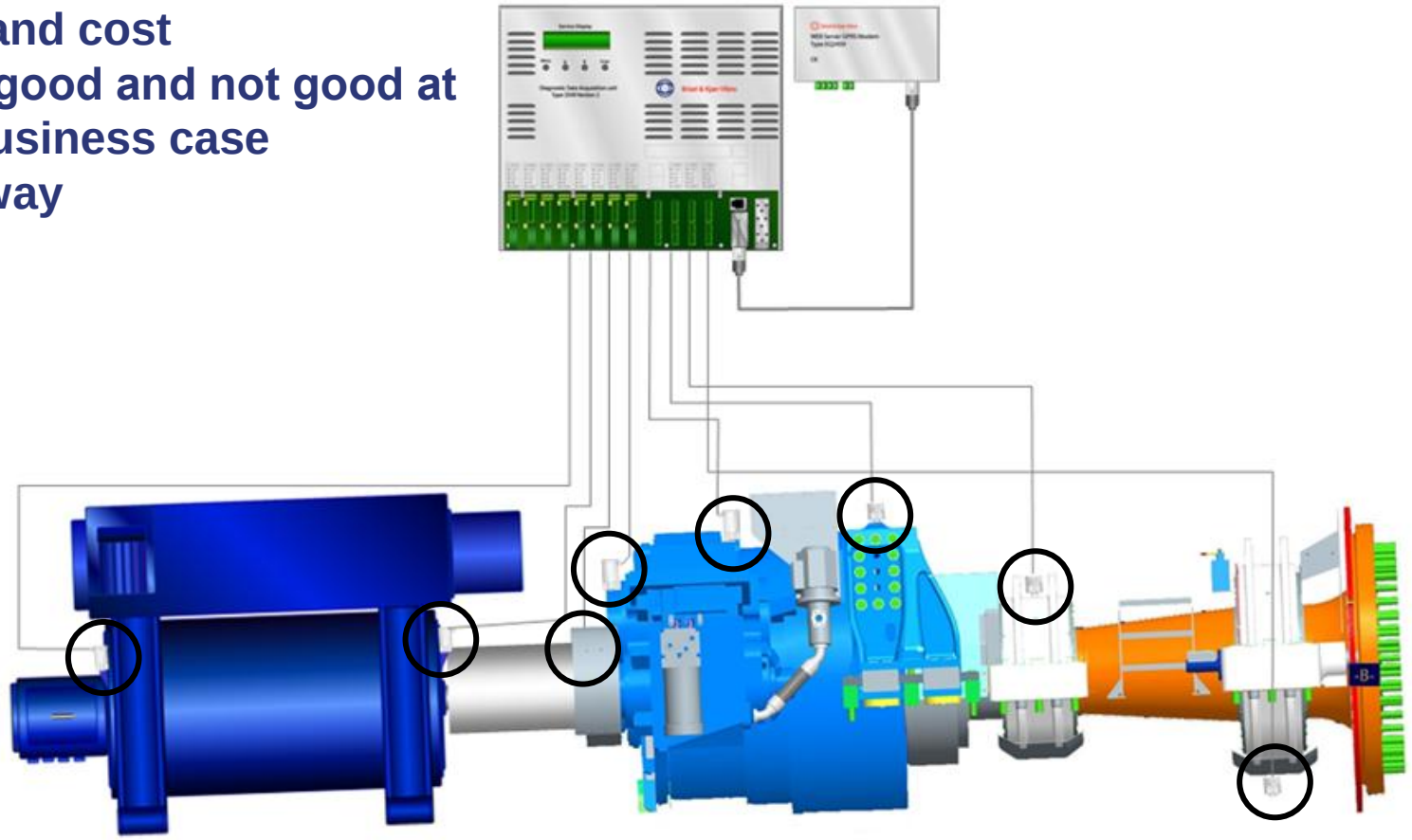






Scope

- Recent trends
- Market situation
- Purpose and cost
- What it's good and not good at
- Typical business case
- Another way
- The ideal



Condition monitoring: recent trends

1. Market for condition monitoring systems has not grown as fast as anticipated 5 years ago
2. All large wind turbine manufacturers are offering independent 'add on' systems, especially on multi-MW turbines

Vestas SINOVEL GE Energy GOLDWIND

ENERCON ENERGY FOR THE WORLD Gamesa SUZLON POWERING A GREENER TOMORROW SIEMENS

3. WTMs and others bringing experience from other sectors

DOOSAN MITSUBISHI POWER SYSTEMS e·on

4. Technical trend towards:
   - Use of more types of sensor
   - Monitoring more components
   - Analysing data from many turbines, centrally
   - Use of more wind turbine design understanding

Condition monitoring: market situation

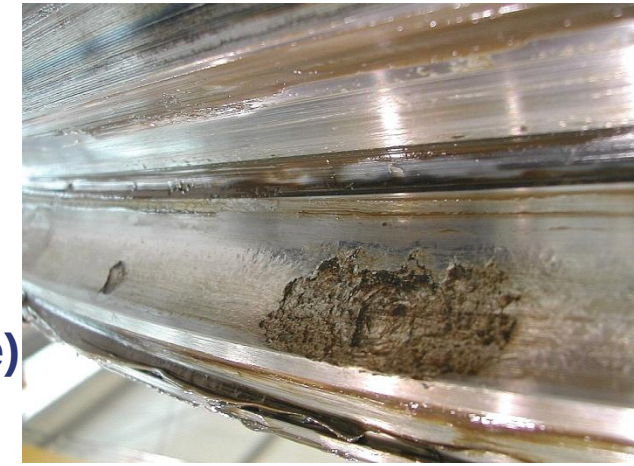
Company	System	Temperature	Humidity	Pressure	Acoustic emission	Cleanliness (oil)	Electrical	Strain	Accelerometer	Displacement	Tachometer	Video	Rotor	Drivetrain	Tower
Areva/01db-Metravib Drivetrain	*OneProD*	✓			✓			✓	✓					✓	
Bently Nevada (GE)	*WT-CMS Adapt.wind*					✓		✓	✓					✓	
Beran Instruments	*PlantProtech*				✓			✓	✓				✓		✓
Brüel & Kjær Vibro	*WTAS - Type 3651*	✓		✓	✓			✓	✓				✓	✓	✓
Eickhoff	*E-GOMS*				✓			✓	✓					✓	
Emerson Process Management	*epro MMS*	✓						✓						✓	
FAG	*FAG WiPro*	✓			✓			✓	✓				✓	✓	✓
Gamesa	*SMP-8C*							✓	✓					✓	
Global Maintenance Technologies	*E-Sentry System*	✓	✓	✓				✓						✓	
Gram & Juhl	*TCM®*							✓	✓		✓		✓	✓	✓
Holroyd Instruments	*AE Systems*			✓					✓					✓	
IGUS ITS	*BLADEcontrol®*							✓					✓		
Insensys	*RMS*						✓		✓				✓		
Prüfteknik Condition Monitoring	*VibroWeb XP*	✓			✓			✓	✓					✓	
Rovsing Dynamics	*Winergy CDS*				✓			✓		✓				✓	
Siemens Wind Power AS	*FLENDER CM*						✓			✓			✓	✓	✓
SKF	*WindCon*			✓	✓								✓	✓	
Vatron	*DriveMon Wind*	✓				✓								✓	
WindSL	*WT-HUMS*	✓		✓	✓			✓		✓				✓	✓
µ-SEN	*Ω-Guard®*			✓						✓				✓	

(excludes single-sensor type systems based on acceleraometers AE, US, oil cleanliness sensing; also analytics only suppliers)

Condition monitoring: purpose & cost

Use

- Fault detection = finding problem (after failure = needs repair)
- Diagnostic = finding cause of problem
- Prognostic = predicting future failure



To

- Enable service crew to address problem:
  - Before failure
    (ie. minimising maintenance cost & lost revenue)
  - At planned time (eg low wind)
  - On their first visit
- Understand root cause of problem (may feed back to design)
- Minimise engineer input looking at data from multiple sites

Cost

- WT controller & service crew: nothing extra
- CMS: €5-10k + €1-2k/yr

Condition monitoring: what it's good & not good at

✓ **Bearing damage**
- Detect and prognose
- Gearbox (especially HS stage), main bearing, generator bearings

✓ **Gear tooth damage**
- Detect and prognose

✓ **Abnormal operation**
- Gross yaw and pitch system defects

✗ **Adding up fatigue life from day 1 & predicting date of failure (and are unlikely ever to do so)**

✗ **Diagnosing root cause (yet)**

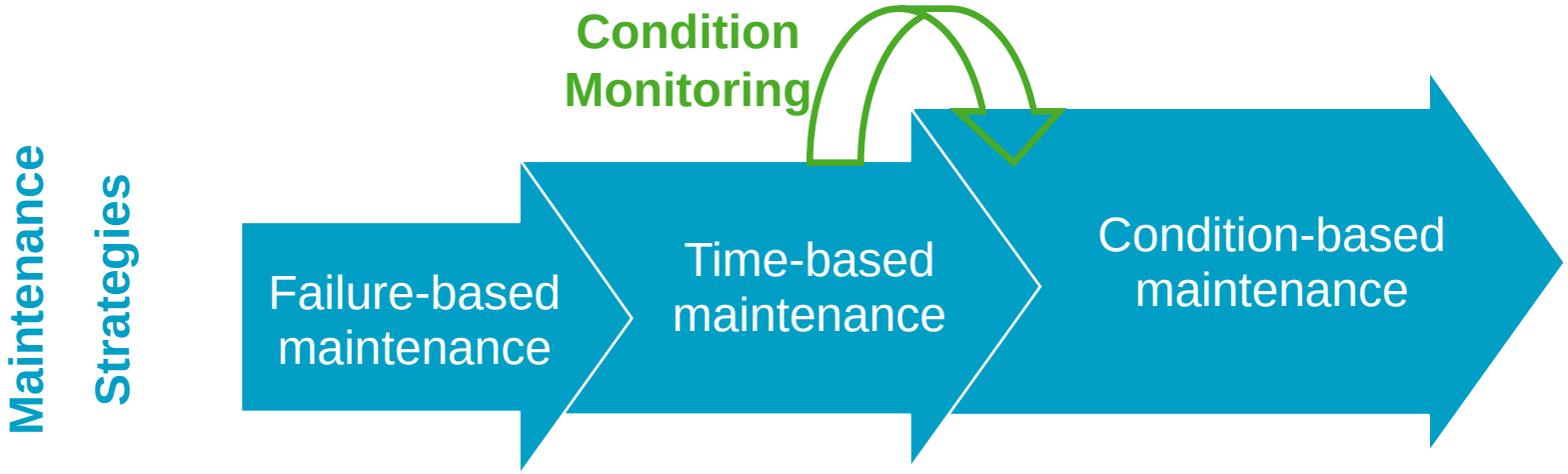
Condition monitoring: typical business case

- Pay €X + €Y/year
- Avoid lost revenue of €Z
- Avoid large component replacement cost of €A
  - eg set of bearings instead of complete gearbox
  - 1 service van instead of 4 vans and a crane etc.

- CMS supplier examples always look great
  - Detect the problem
  - Generic reliability data often ‘old’ and generic

- Customers are enjoying benefits
- Payback average 2-8 years (looks best for larger turbines & offshore)

Condition Monitoring: another way



- **Think differently: combine with condition-based maintenance = focus on the components that need it**
- **Challenge: Needs more technology understanding = input from WTM or ?**

Condition monitoring: the ideal

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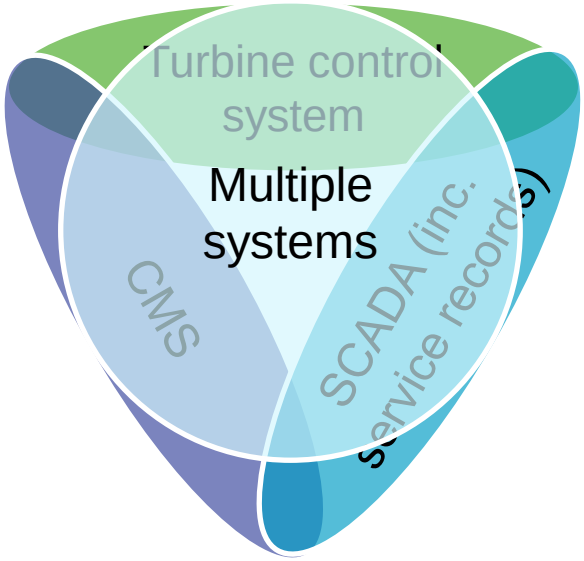

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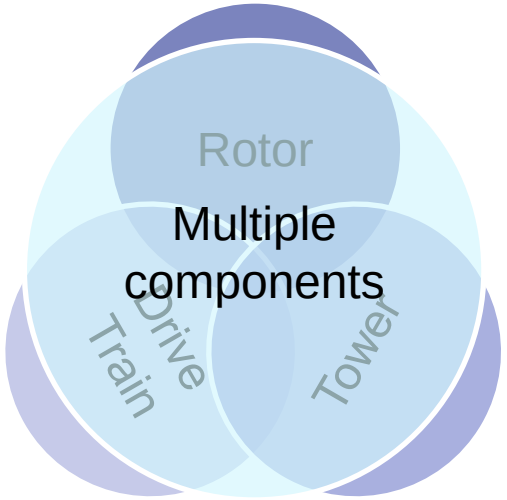

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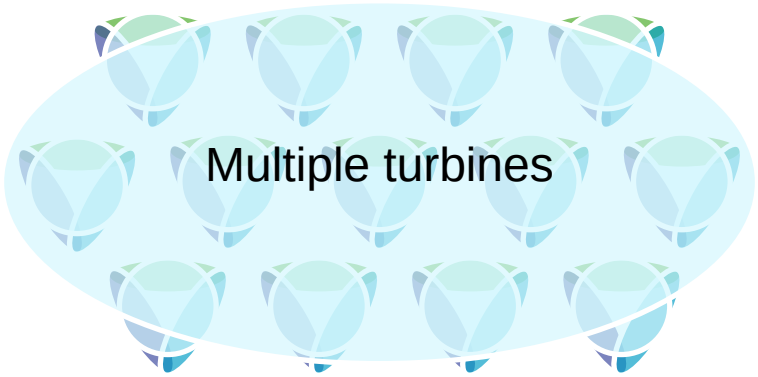

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