Health Monitoring of Wind Turbines



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GOALS

- •Detect Wind Turbine Health
- •Perform Maintenance only When Needed
 - Condition Based Maintenance
- •Reduce Costs and Downtime
- •Predict Remaining Useful Life

MOTIVATION (not a new idea)

Space Flight

- NASA Spacecraft Telemetry
- Astronaut Health Monitoring



Vehicle Health Monitoring

- Navy Ship systems monitoring
- DOD Joint Strike Fighter



Aircraft Structural Health Monitoring

- Scheduled structural inspection
- Critical interior parts can cost \$80,000 just to inspect



Cessna Citation

Hawker 800

Active Corrosion Detection



Pipe Integrity

LAVINED

Corrosion Isolation on High * Temperature SS Vessels

Tank Car Liner Integrity



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Wind Turbine Bearings

- SKF WindCon 3.0 (www.skf.com)
 - Vibration monitoring for online condition monitoring
 - automatic lubrication



- 1 Pump unit 2 Progressive feeder
- 3 Progressive feeder with piston detector
- 4 Progressive feeder with 2/2 direction valve and piston detector
- 5 Lubricant collector
- 6 Lubrication pinion
- 7 WindCon online condition monitoring system
- 8 Remote monitoring visualization / parameterization

Diagnostics

Wind Turbine Gear Box - Operational Noise







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TECHNOLOGIES FOR STRUCTURAL HEALTH MONITORING

Acoustic Emission (Passive)

- Physical Acoustics Corporation (MISTRAS is parent company)
 - Growing cracks emit PINGS
 - Detect with acoustic sensors
 - Filter to isolate crack pings
 - Artificial Intelligence to predict crack growth and remaining useful life as it happens





Active Ultrasonic

- Acellent Corporation
 - Emit acoustic pulses that travel through structure
 - Detect baseline healthy structure
 - Continually monitor and compare to detect damage



CURRENT WORK

Crack Detection in Metals

- Acoustic emission and active ultrasonic
- Static pull of cracked test article to failure



Crack Length Prediction



Active Damage Detection



Baseline (no damage)

With damage

Artificial Intelligence to automate wave analysis with multiple sensors



Damage Detection in Composites

- Acoustic emission and active ultrasonic
- Material is more complex
 - Fiber breakage
 - Epoxy matrix failure
 - Delamination



- AI tools for signal processing
- Determining failure location and severity

Ongoing Composite Testing



Bearing and Shaft Wear

- Acoustic Emission sensors and vibration sensors on bearing housing
- Bearing shaft test rig Accelerated degradation
 - High temperature
 - High humidity



Future Tasks

- Investigate integrating sensors into the blade structure
- Identify appropriate sensors for in-service monitoring
- Develop system reliability model
- Develop diagnostic and prognostic tools