Wind Turbine Condition Monitoring System Marketing Research

Suri Ganeriwala & Juli Hamlet

SpectraQuest Inc.
Richmond, VA

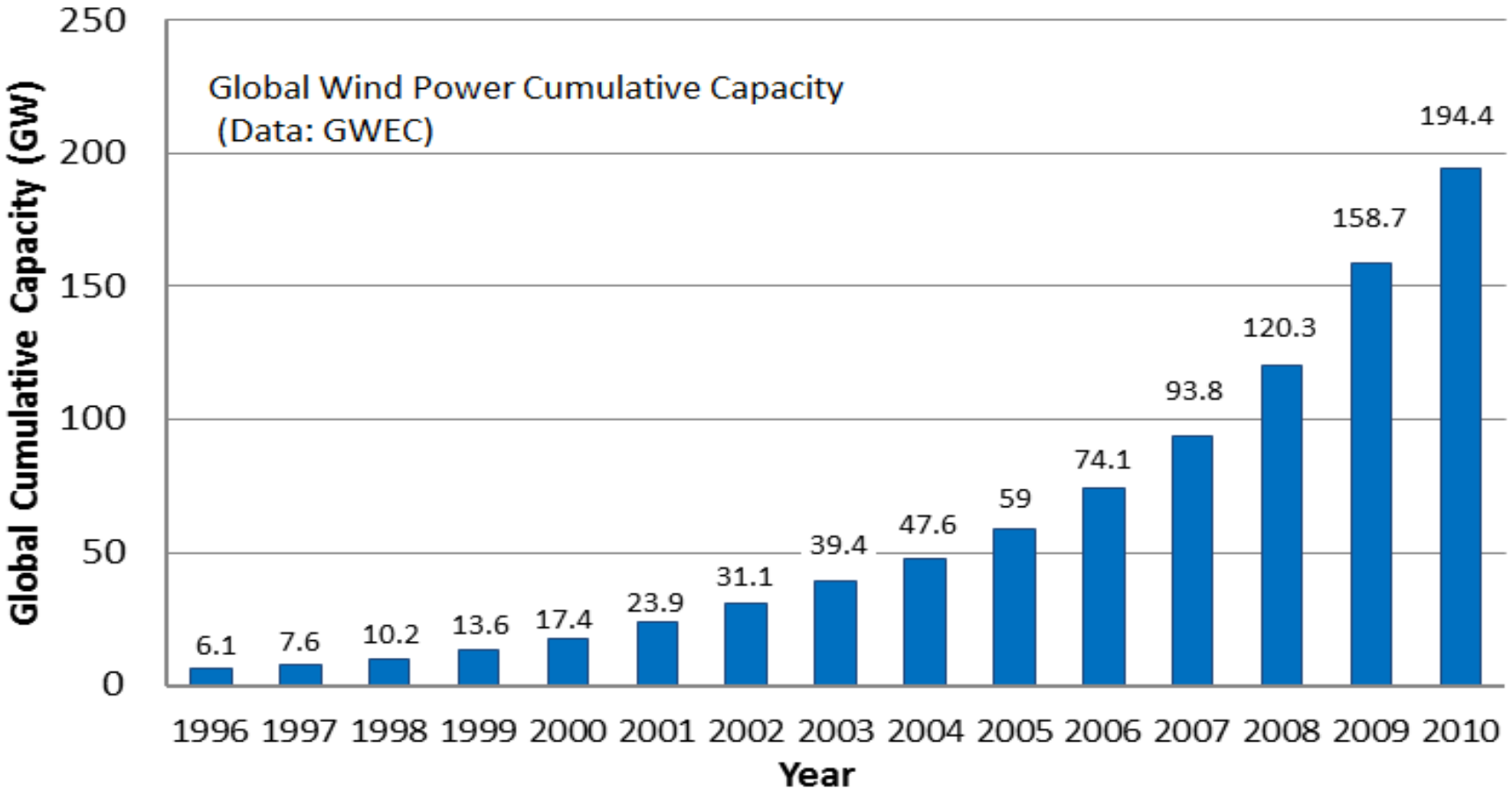
Outline:

- Introductory comments and motivation
- What is Condition monitoring
- Current Companies offering CMS
- SpectraQuest Advantage
- Marketing Research General Guidelines-our objectives

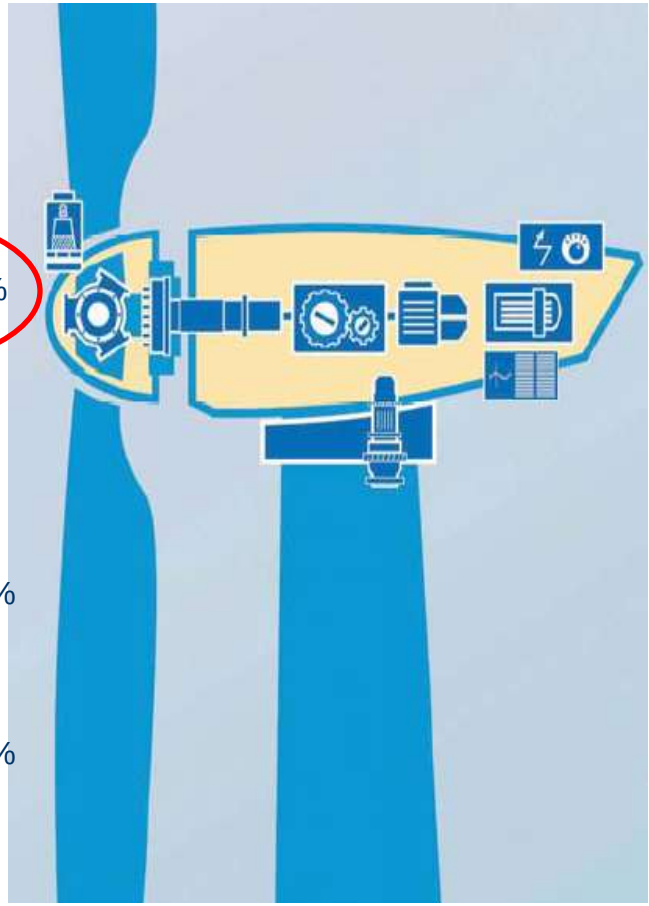
Introduction

- Generation of Energy is a prime factor for socioeconomic development
- Increasing demand of energy can not be completely fulfilled by Fossil Fuel based energy generation
- Non Conventional energy has tremendous potential as it can play a big roll in fulfilling the future energy requirement
- Development of modern technology is making the Non Conventional energy an efficient source of energy

Wind turbine production is one of the fastest growing industries



Wind Turbine Operation/Maintenance Cost



Tower 26.3 %

Rotor Blades 22.2 %

Rotor Hub 1.37 %

Main Frame 2.8 %

Main Shaft 1.91 %

Gear Box 12.91 %

Generator 3.44 %

Yaw System 1.25 %

Pitch System 2.66 %

Power Converter 5.01 %

Transformer 3.59 %

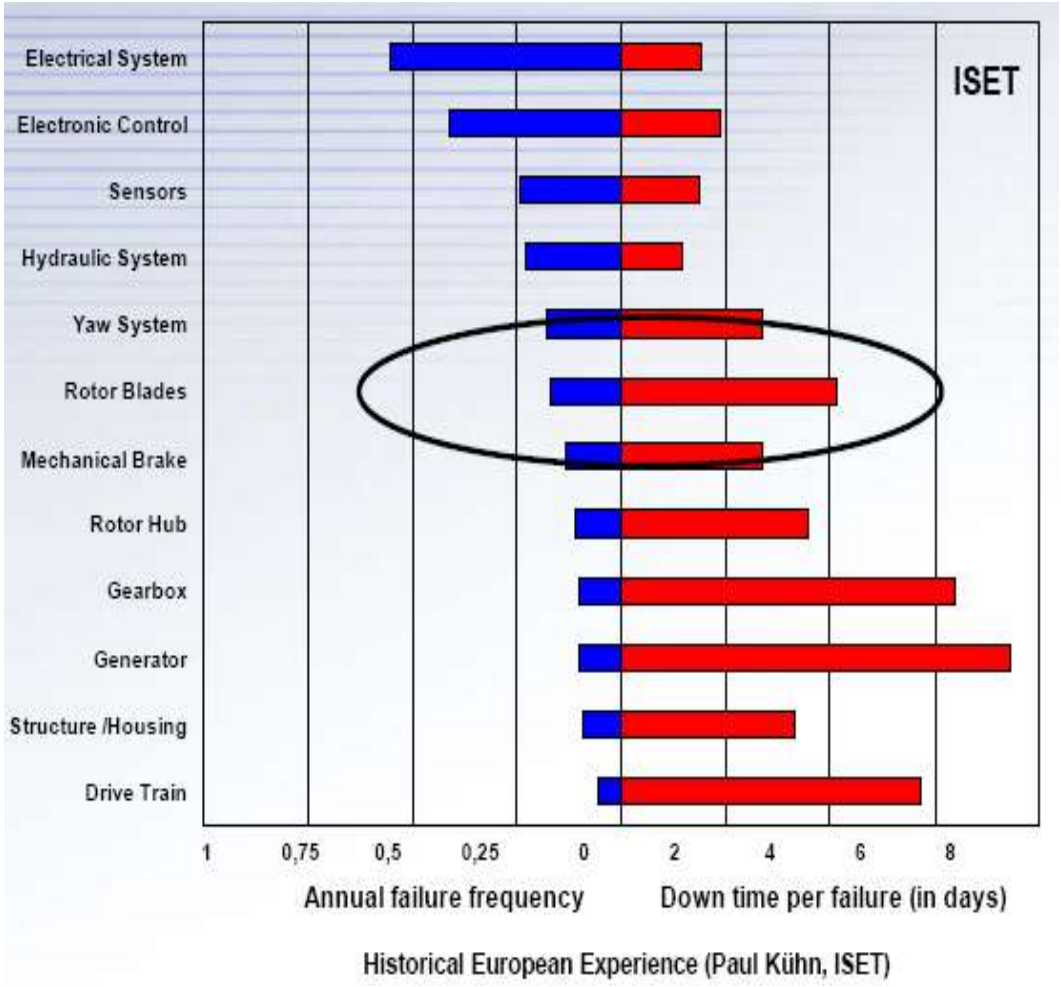
Brake System 1.32 %

Rotor Bearings 1.22 %

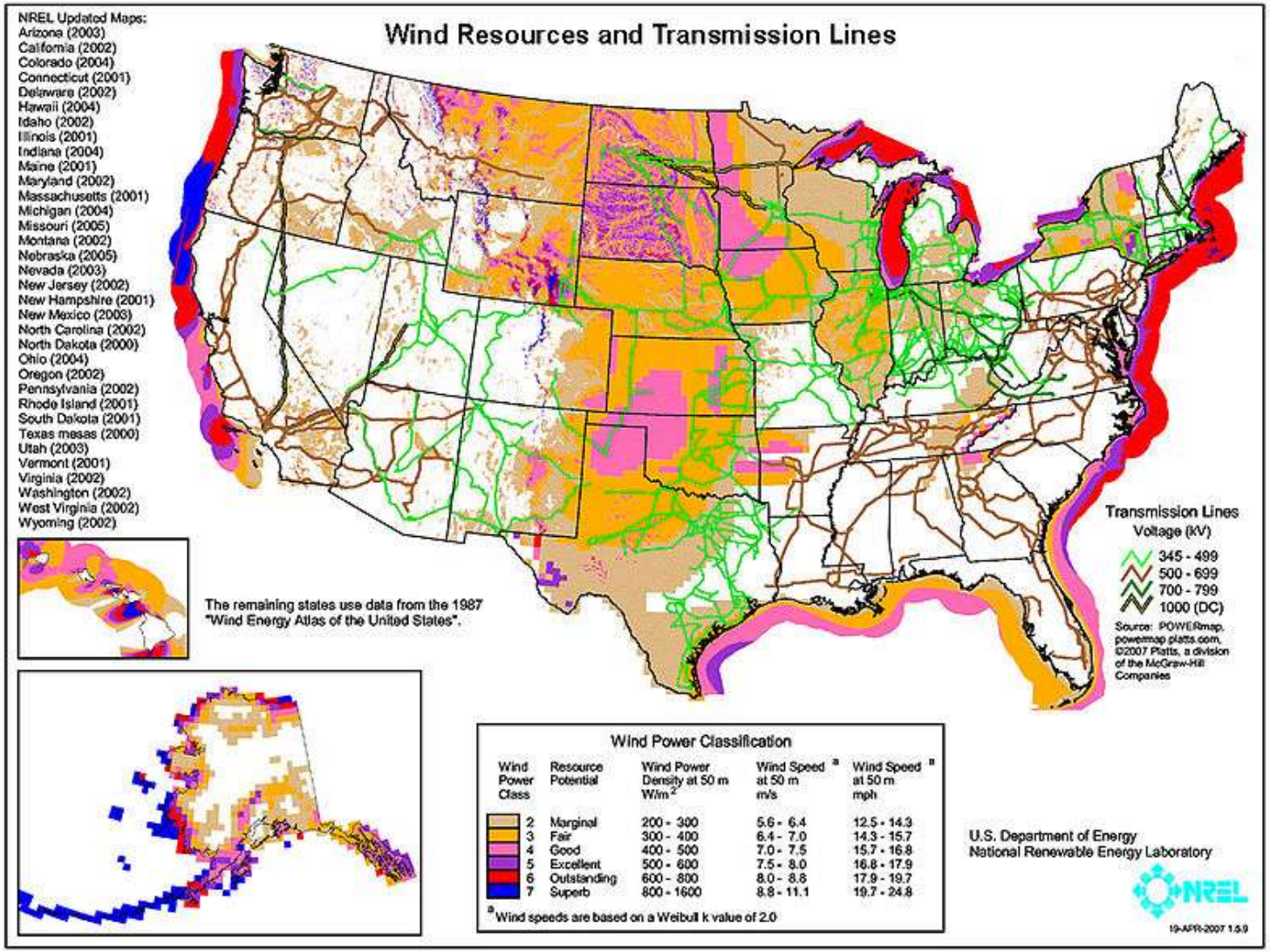
Nacelle Housing 1.35%

Wind Turbine Failure Types

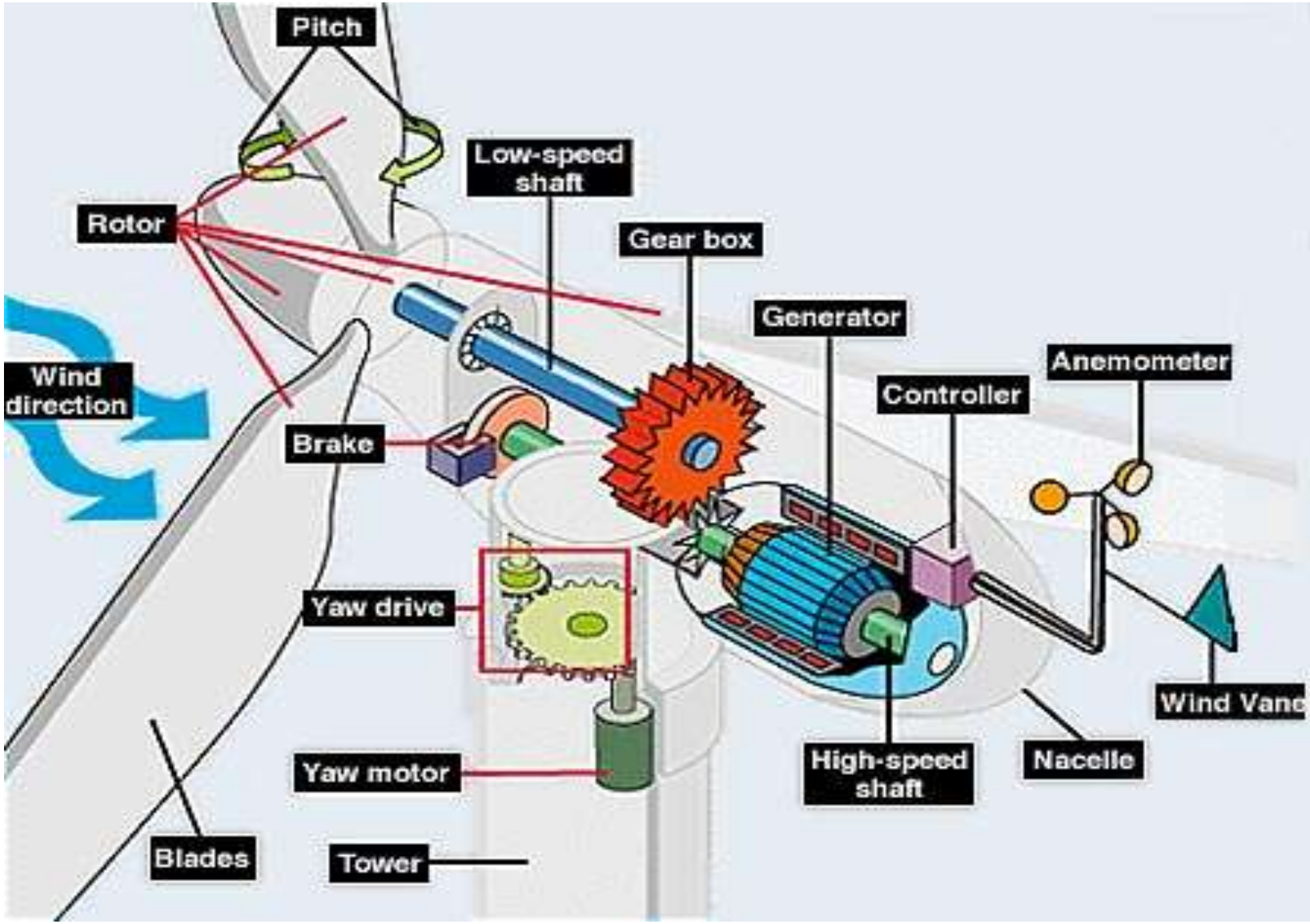
- Gearboxes and drive trains have an annual failure frequency of ~0.10, and take an average 7 days to repair
- Composite rotor blades are also a common failure type with an annual failure frequency or ~0.15
- Source: “Blade reliability initiative”, Paul Veers, Sandia National Labs



Wind Power Map in USA



INSIDE NACELLE



Why monitor machinery?

❖ Prevent catastrophic failure & significant damage ❖ Avoid loss of life, environmental harm, economic loss	***Safety***
❖ Stop unscheduled outages ❖ Optimize machine performance	***Production Assurance***
❖ Reduce repair time and spare parts inventory ❖ Lengthen maintenance cycle	***Predictive Maintenance***
❖ Reduce scrap and raw material consumption ❖ Increase product quality	***Quality Control***

Condition Monitoring:

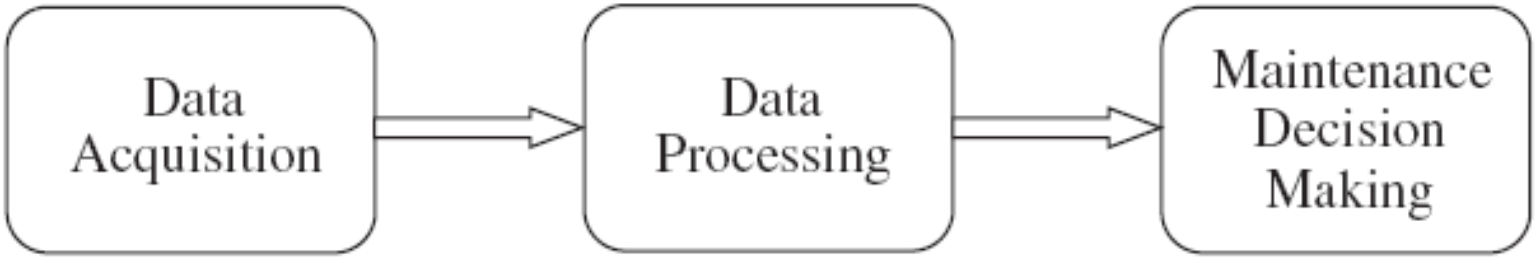
Condition Based Maintenance (CBM) promises to deliver improved maintainability and operational availability of rotating machinery while reducing life-cycle costs.

The three critical components of CBM are:

1. Fault detection
2. Diagnostics: Determining exactly what is wrong
3. Prognostics: Determining fault severity and predicting remaining life

Condition Monitoring

Three main steps: data acquisition, data processing and maintenance decision-making.

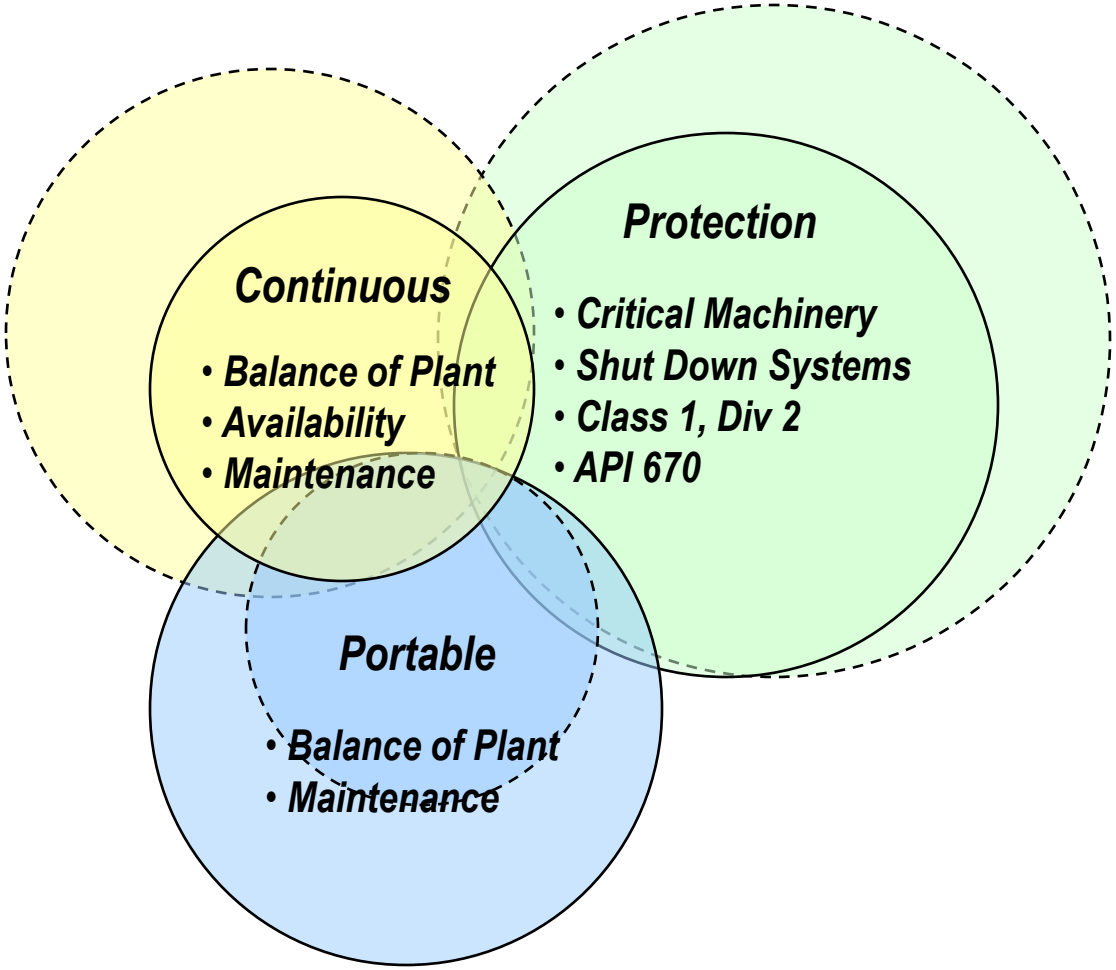


Obtain data relevant to system health

Handle and analyze the data

Recommend efficient maintenance decision

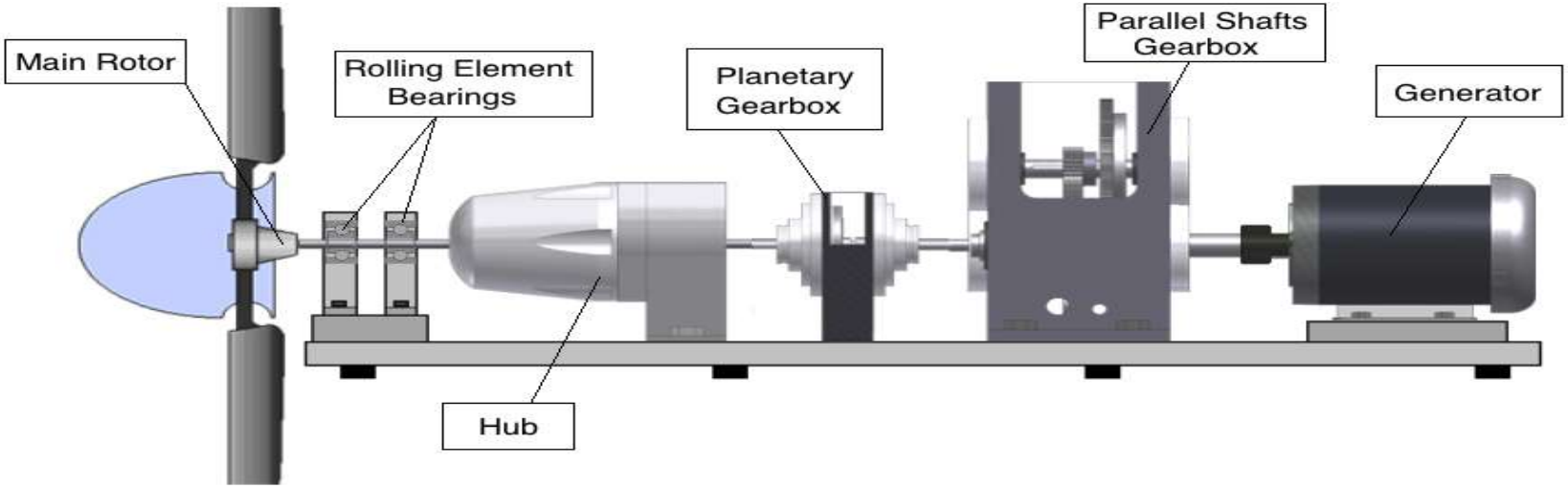
Types of Monitoring



Choose based on:

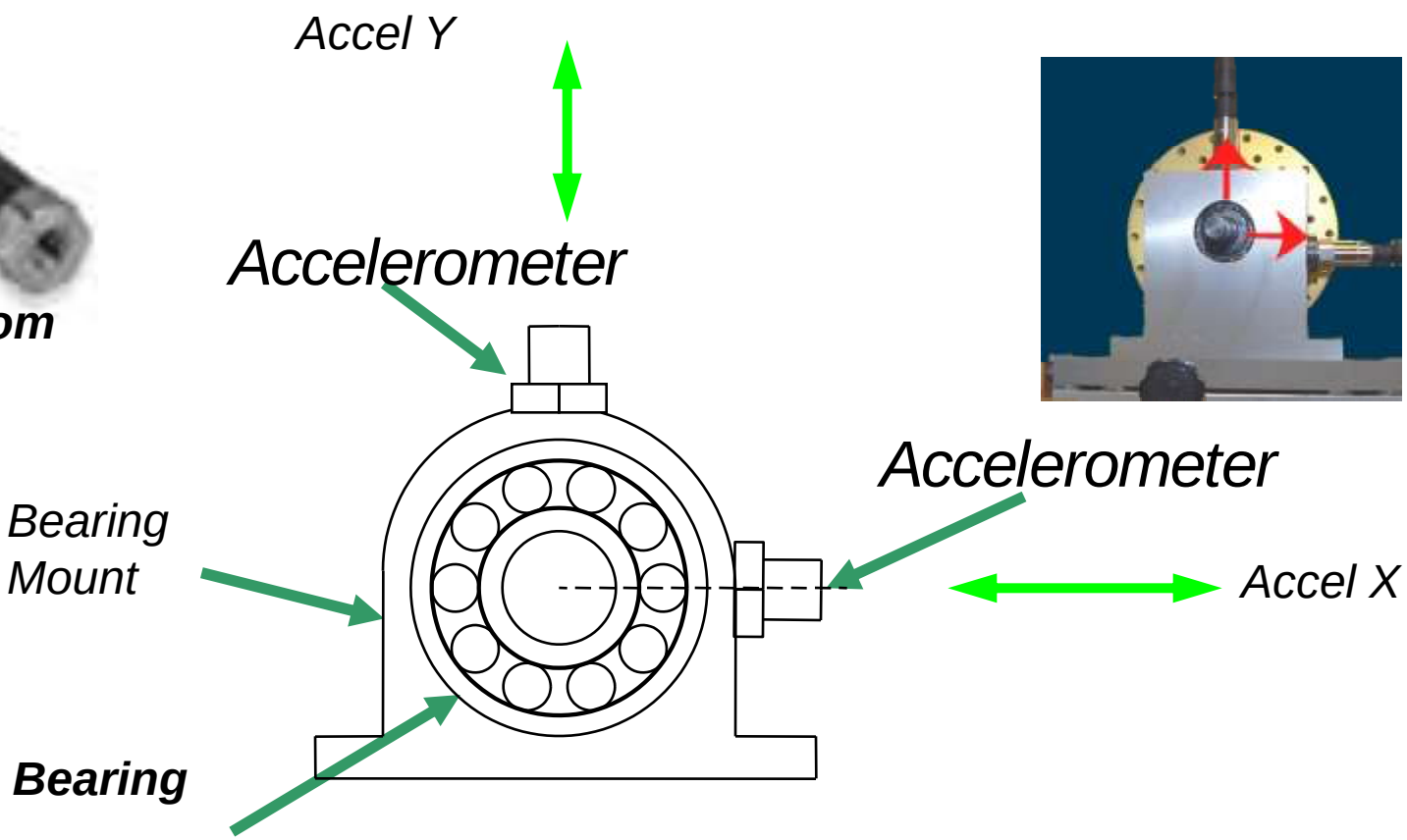
- ***Safety***
- ***Failure Modes***
- ***Equipment Criticality***

Wind Turbine Simulator



Bearing Accelerometer Placement

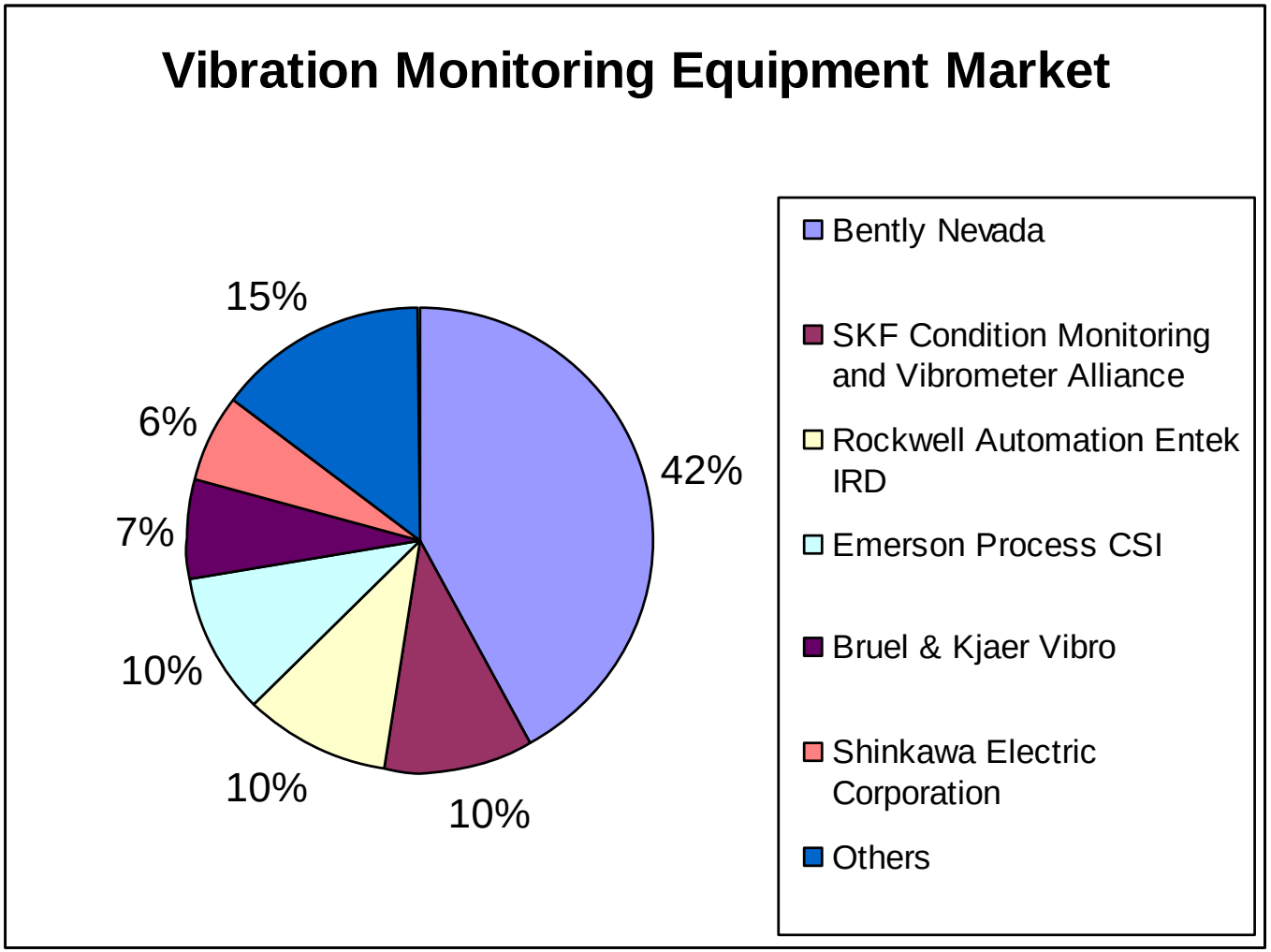
www.pcb.com



How does a bearing vibrate?

Current Companies Offering CMS

- Bently Nevada (GE)
- Commtest (GE)
- Bruel & Kjaer Vibro
- Emerson Electric / CSI
- Rockwell Automation
- SKF Condition Monitoring / SKF Reliability Systems
- 01dB
- DLI Engineering/Azima
- National Instruments
- Pruftechnik


Vibration Monitoring Equipment Market
15%
6%
7%
10%
10%
10%
42%
Bently Nevada
SKF Condition Monitoring and Vibrometer Alliance
Rockwell Automation Entek IRD
Emerson Process CSI
Bruel & Kjaer Vibro
Shinkawa Electric Corporation
Others

Vibration Monitoring Equipment

- Online
- Offline

Real-time Monitoring: *network based nodes reporting trends and alarms*	**Embedded Protection:** *machine shut-down based on key measurements*
•Distributed channels (4-100's) •Most visualization options •$15k to $60k	•High reliability •Most widely used scheme •$5k to $$25k

Handheld/Portable: *walk-around monitoring*	**Portable Diagnostics:** *boxes used for detailed test*
•2 to 4 channels •FFT display •$5k to $25k	•4 to 24 channels •Lots of analysis and display •$5k to $50k

CSI/Emersion Electric – Models 1910 & 2130

- 1910 – Spectrum Analyzer
  - 21 V input
  - 72 dB dynamic range
  - 12-bit A/D
- 2130 – Machine Health Analyzer
  - 16 bit A/D
  - 96 dB dynamic range
  - Order Tracking, Coastdown, Bearing analysis

Model 1910

Model 2130

SKF Condition Monitoring – Marlin/Microlog

- Input Voltage Range: 25 V peak AC, +/- 50 VDC
- 14 bit A/D
- 20 kHz signal bandwidth
- 80 dB dynamic range
- 60 dB of gain
- 6 MB (Flash 4 MB) memory

MARLIN *MCM* *Microlog*

CMXA50

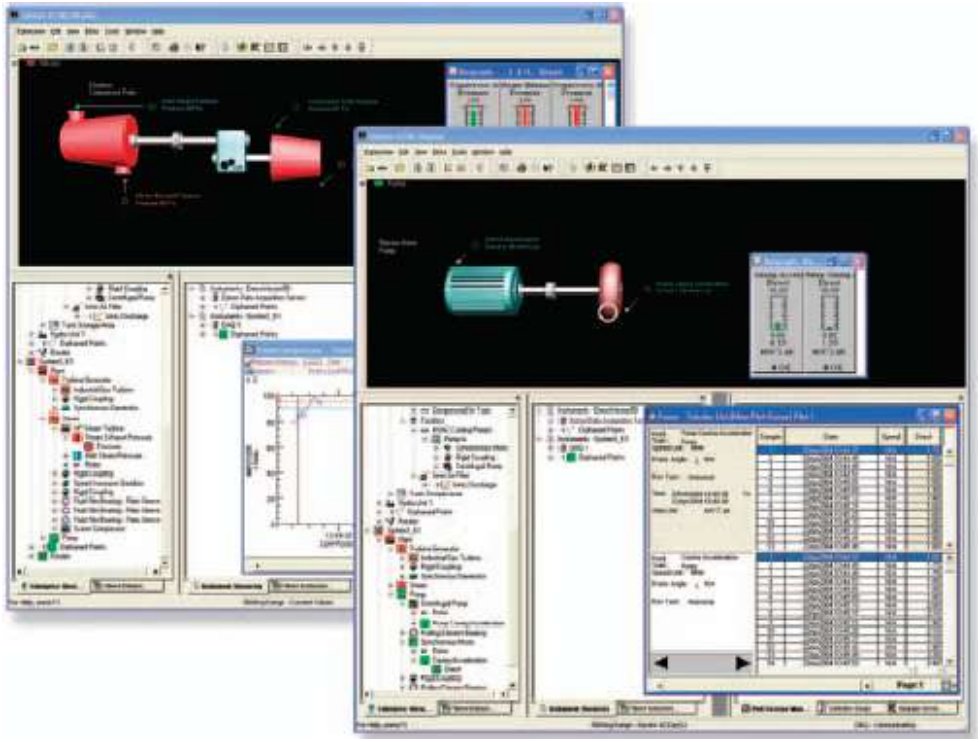
- Connectors: BNC (3) input, output, and tachometer/phase and multi-pin D connector.
- Tachometer: Minimum pulse amplitude 2 Vpp, 10% rise/fall time, minimum 0.1 ms pulse width

Bently Nevada (Part of GE) – 3500 Series

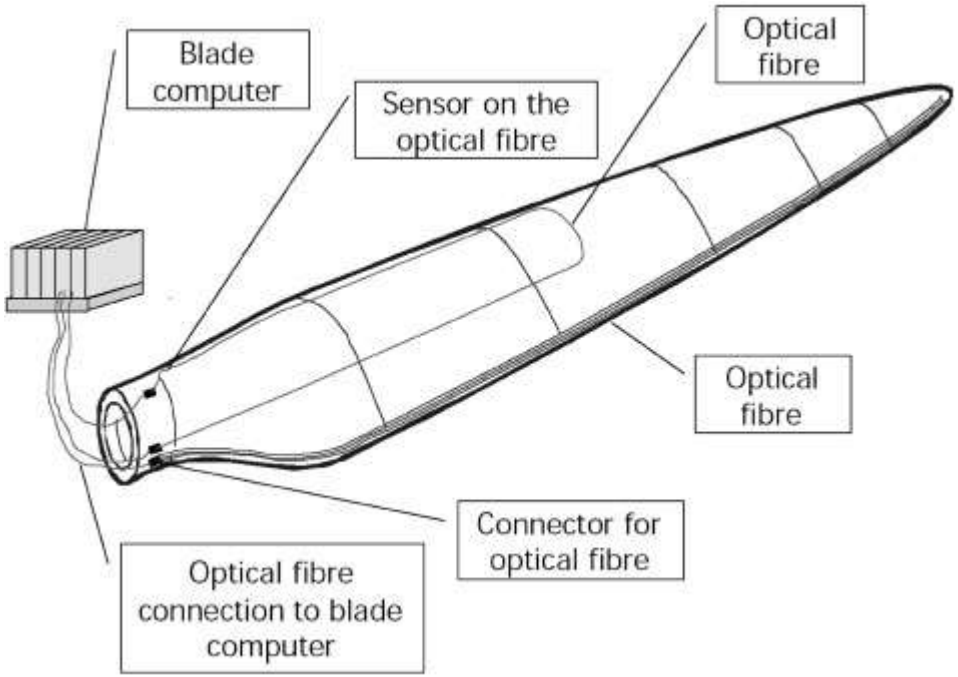
- Over 24 modules
  - Vibration
  - Dynamic Pressure
  - Temperature
  - Process Variables
- Keyphasor input module:
  - +0.8 to -21 V
  - Input range of 1 to 1,200,000 rpm
  - Signal range of 0.017 to 20 kHz

Bently Nevada (Part of GE) – System One SW

- Current version: 5.0
- Process optimization
- Alarming, trending
- Exception reporting
- Web server
- SQL connectivity
- Equipment covered:
  - Turbomachinery
  - Compressors
  - Wind Turbines
- "RulePaks" with stored diagnostics information



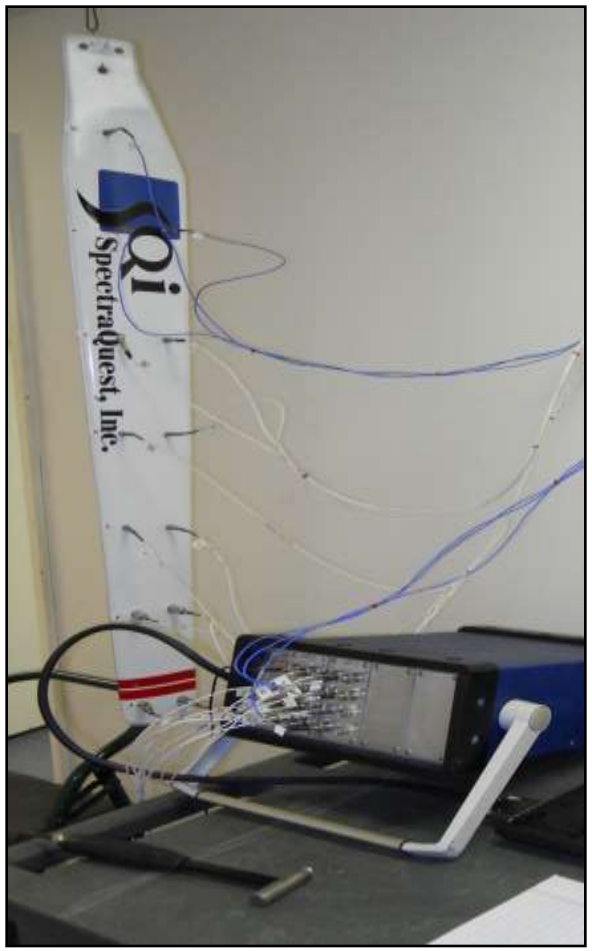
Blade Monitoring



Blade Test Setup

Thirteen accelerometers were attached to the surface of the blade.

The blade was *impacted* with an instrumented hammer at *each end* and in the *middle*.



Industry Trends

- Equipment Vendor Consolidation
  - Consolidation has resulted in the acquisition of some of the key industry players by larger entities
- Shift from Offline to Online Monitoring
  - Increasing need for Integration of Condition Monitoring systems with Plant Asset Management systems and CMMS towards monitoring of total asset health
- Demand for Vibration Consulting and Services
  - Industry downturn and pursuit of cost optimization has resulted in manpower reduction in maintenance departments of organizations.

Technology Trends

- Tight integration into PAM/CMMS using standard communications protocols
- Internet as enabler
  - Ethernet/networked vibration systems
- PC-centric vibration monitoring systems
  - More widely accepted than in other industrial applications
- Advancements in sensor technology
  - TEDS = simplified setup & increased accuracy

SpectraQuest Unique Expertise

CMS:

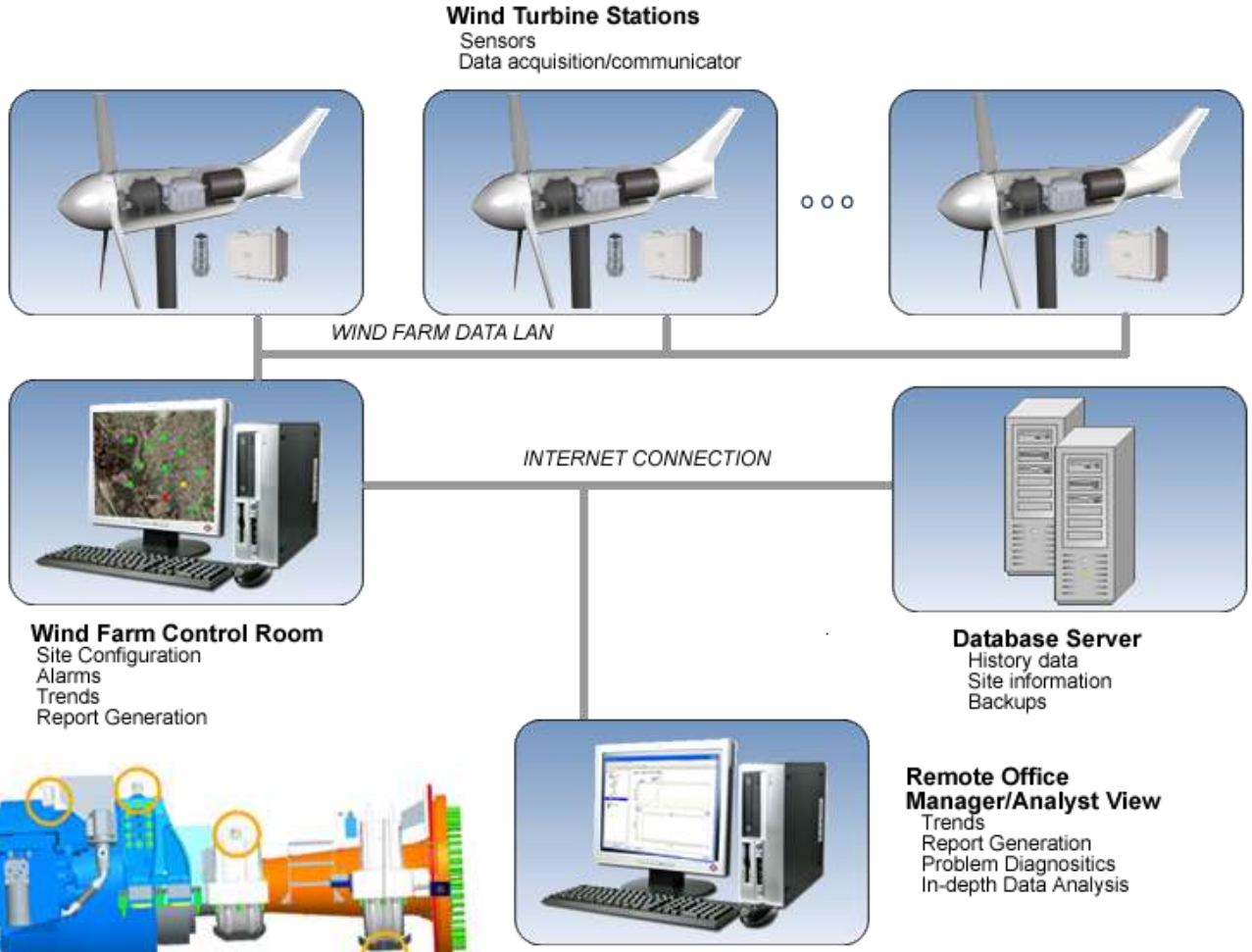
- We already have individual components of a CMS
- We have advanced signal processing algorithms to ACCURATELY diagnose and predict failure time to schedule repair
- Access to the latest technology being developed by customers using test beds supplied by SQi

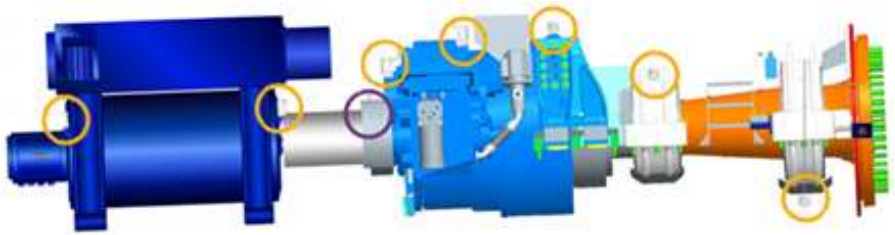
Inspection & Training:

- We will also provide a new inspection and blade monitoring system (none exist today), Training

SQi CAN offer a Total Solution

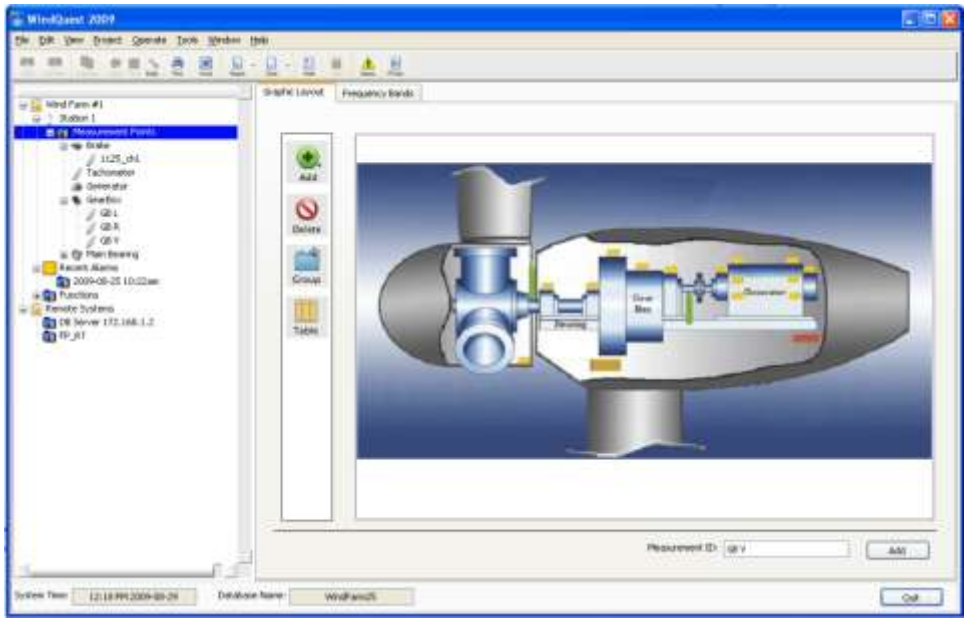
SpectraQuest Condition Monitoring System "WindQuest"





Online Monitoring and Alarming

- Location -> Machine train -> Sensor level conditions
- Color-coded Wind Turbine status
- User-customizable monitoring criteria, and alarm levels
- Click to view sensors' current values, waveforms or spectra
- User-customizable raw data storing criteria



Wind Turbine Measurement Configuration

System Structure

- On-site data acquisition/communication hardware
- Online monitoring/alarming, data archiving/trending, and reporting generation
- Advanced analysis software for analyst to perform in-depth diagnosis
- Remote monitoring and diagnostics capabilities
- Host Database server

Market Research Objectives

- Market Potential/Size
- How to enter market, are there any barriers?
- Market analyses (types of industries)
- Distribution Channels (Own sales office, Representatives, Distributors/Dealers)
- Representative Agreement, and other legal issues
- Competitors and their products
  - Pricing, sales/distribution structure, how do they market
  - Comparison of features, strengths

THANKS

SpectraQuest Inc.
8201 Hermitage Rd, Richmond, VA
www. spectraquest.com
Tell: (804) 261-3300
Fax: (804) 261-3303

suri@spectraquest.com