Machine Condition Monitoring with National Instruments Technologies

Lodovico Menozzi
Business Development - Europe
Machines Fail

http://timestranscript.canadaeast.com/gallery

http://www.virginia.edu/romac/

kes.bham.sch.uk

allworldcars.com

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Detected Faults

- Loose Mechanical Components
- Slot Frequency / EM related
- Bent Shaft
- Unbalance
- Blade Pass / Fluid Related
- Motor
- Mechanical Resonances
- Alignment
- Couplings
- Gears
- Journal (Fluid Film) Bearings
- Rolling Element Bearings
What MCM is?

- **SAFETY**: no catastrophic failures
- **PREDICTIVE MAINTENANCE**: minimizing downtime
- **PRODUCTION ASSURANCE**: greater productivity
- **QUALITY CONTROL**: improved product quality

Transportation

Industrial Machinery

Wind

Turbomachinery
Why monitor machinery?

<table>
<thead>
<tr>
<th>Safety</th>
<th>Production Assurance</th>
<th>Predictive Maintenance</th>
<th>Quality Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Prevent catastrophic failure &amp; significant damage</td>
<td>• Stop unscheduled outages</td>
<td>• Reduce repair time and spare parts inventory</td>
<td>• Reduce price and raw material consumption</td>
</tr>
<tr>
<td>• Avoid loss of life, environmental harm, economic loss</td>
<td>• Optimize machine performance</td>
<td>• Lengthen maintenance cycle</td>
<td>• Increase product quality</td>
</tr>
</tbody>
</table>

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**National Instruments**
Maintenance Strategies

Reactive
Run to Failure

Active
Preventive
Predictive
Proactive
Economics of Outages

Preventative Health Maintenance
- Preventative Scheduled Shutdown
- Preventative Unscheduled Shutdown

Predictive Maintenance Approach
- Condition-based Shutdown
- Run-to-Fail Unscheduled Shutdown

Production Level
- Time

Production Level
- Time

NATIONAL INSTRUMENTS
Predictive Maintenance can reduce preventive maintenance tasks by 15% and have an overall effect on downtime of 1-2%. If we look at the additional productivity of a maintenance staff of 30, the calculations would be as follows:

**Predictive Maintenance Return On Investment**

Reduce Maintenance Tasks 15%

Lower Downtime 1 - 2%

On a staff of 30 men - like adding 4.5 men

This equates to

3.4 men x 2080 hrs per year

x $25 per hour =

$234,000

*Courtesy of ISI (Institute for Scientific Information)*
What to Monitor

- **Vibrations Sources**
  - Bearings
  - Gearbox
  - Pumps
  - Motors
- Noise
- Displacement
- Temperatures
- Power consumption
- Rotating Speed
- ...

*Vibration applications are the most relevant for the MCM business*
Who uses Condition Monitoring?

- Rolling Mills
- Tool machines
- Ciller
- Compressors
- Power Generation
- Oil and Gas
- Marine
- Mines
- Transportation
- Aerospace
Who Uses Condition Monitoring?

Industries
- Power Generation
- Oil & Gas
- Petrochemical
- Pipelines
- Refineries
- Waste Water Treatment
- Food & Pharmaceutical
- Marine Propulsion
- Metals & Mining
- Semiconductor Manufacturing

Assets
- Industrial Gas Turbines
- Aero Gas Turbines
- Steam Turbines
- Hydro Turbines
- Wind Turbines
- Generators
- Compressors
- Blower / Fans
- Pumps
- Electric Motors
- Reciprocating Compressors
- Crushers / Pulverizers
- Pelletizers / Extruders
- Gears
- Expanders
- Heat Exchangers
- Boilers
- Vessels
- Valves
- Piping
- Instruments
- HVAC
- Transformers
- Pulp / Paper Machines
- Pulp Refiners
- Rotary Kilns
- Centrifuges
- Cooling Towers
- Turbochargers
NI SYSTEM LEVEL ARCHITECTURE
### Types of Monitoring

#### Continuous
- Moderately Critical Equipment
- Equipment Availability/Uptime
- Predictive Maintenance
- On-line/Real-time Diagnostics

#### Protection
- Operations Critical Machinery
- Machinery Shut Down
- Safety Systems

#### Portable
- Balance-of-Plant
- Maintenance
- Off-line Diagnostics
- Handheld/Walk-around systems

Selection based on:
- Safety
- Failure Modes
- Equipment Criticality
Portable and Permanent Systems

Machine Diagnostics and Condition Monitoring

Portable and deployment-ready hardware

Flexible, open analysis software

Vibration data acquisition for predictive maintenance

ni.com/soundandvibration
Hardware Platform

More than 60 modules

USB
NI CompactDAQ

USB Carrier

Wi-Fi/ENET Carrier

NI PXI

NI CompactRIO

More than 60 modules
C Series – A Next Generation Platform

CompactRIO
2004

R Series Expansion Chassis
2004

USB-92xx/94xx (USB Sleeve)
2005

USB CompactDAQ
2006

Opportunities for other buses

Wireless and Ethernet
2008

Acceptance Test

Portable

On-line
Typical Sensing Data – A real machine

Gas Turbine
- 4 Accelerometer
- 4 Bearing RTD
- 1 Gas Generator Speed
- 1 Power Turbine Speed
- 1 Fuel Flow
- 1 Ambient Temperature
- 1 Compressor Discharge Pressure
- 1 Compressor Discharge Temperature
- 1 Exhaust Gas Temperature
- 1 Power Turbine Exhaust Temperature
- 1 Power Turbine Exhaust Pressure
- 1 Air Mass Flow
- 4 Lube Oil Level Temp, Pressure, Level

Compressor
- 4 Radial Vibration Proximeter Probe
- 2 Axial Positioner
- 4 RTD
- 1 Suction Pressure
- 1 Discharge Pressure
- 1 Flow
- 1 Inlet Temperature
- 1 Discharge Temperature

Gearbox
- 8 Radial Vibration Proximeter Probe
- 2 Axial Positioner
- 6 Bearing RTD
- 1 High Speed Keyphasor
- 1 Low Speed Keyphasor
- 1 Gearbox Accelerometer
USB/Ethernet Machine Diagnostics
Portable Machinery Test and Condition Monitoring

**Standard**
- Plug-and-play USB 2.0 – 100MB Ethernet
- Alias-free, simultaneous, 24-bit A/Ds
- Time waveform, spectrum, and order analysis

NI CompactDAQ
NI USB-9234

![NI CompactDAQ](image)
CompactRIO
Machine Condition Monitoring On-Line

- On-Line Vibrations Monitoring/Analysis
- GPS/IEEE-1588 Synchronization
- Disk on Chip data Storage

Real-Time
Command Based Arch
Shared Variable
Order Analysis
Frequency Analysis
Customer Specific Analysis

Serial Port
Modbus

Reconfigurable RIO Chassis
LabVIEW FPGA

Speed
Vibration RMS
Vibration DC
Temperature
Process

DMA

Buffered Output

Speed and Vibration

9234 Accelerometer
9229 Proximity Probe
9221 Tachometer
9211 / 9217 Temperature
9264 Buffered Output
9203 4-20ma Process
Empty
Empty

Ethernet

Accelerometer
Laser Tach
Radial Prox Probes
Keyphasor
Thermocouple
Axial Prox Probe

Ethernet
Software

NI Sound and Vibration Measurement Suite
Analysis and Visualization

**Standard**
- Rise time
- Fall time
- Frequency
- Period
- Vpp
- Min
- Max
- Cycle RMS
- Duty Cycle
- FFT
- + pulse width
- - pulse width
- Amplitude
- High
- Low
- RMS
- Area
- Cycle mean
- Overshoot

**Signal Processing**
- 9 Windows
- 3 averaging modes
- 5 Digital IIR Filters
- Digital FIR Filters
- 4 interpolation modes
- Limit mask
- Derivative
- Multiple/Divide Channels
- Add/Subtract Channels
- Waveform Average
- Channel to Channel Delay

**Spectral Measurements**
- THD, SINAD, SNR, SFDR
- Specific harmonic level
- Power in band
- Adjacent channel power
- Occupied bandwidth
- Peak detection
- Zoom FFT
- Frequency Response
- Joint Time Frequency Analysis
- Super Resolution Spectral Analysis

**Modulation**
- AM, PM, FM Demodulation
- Digital Demodulation
- Frequency Drift
- Error Vector Magnitude
- Phase Error
- Magnitude Error
- Scatter/Constellation Plots

**Statistical Analysis**
- Histograms
- Standard Deviation
- Variance
- Mean, Mode, Median
Analysis Software: Sound & Vibration

- Vibration level with single and double integration
  - RMS
  - Peak (true or calculated)
  - Peak-to-peak
- Frequency Analysis
  - Baseband, Zoom, and Subset FFT
  - > 800 lines of resolution possible
- Limit Testing
- Acoustical Analysis
  - ANSI & IEC fractional octave analysis
  - Sound level with A-, B-, and C-weighting
Analysis Software: Order Tracking

- **Order Analysis**
  - User-defined magnitude and phase – 1x, 2x, 3x, … 20x, … etc.
  - Subsynchronous order tracking – 0.3x, 0.67x, etc.

- Analog and digital tachometer processing

- **Order-based spectrum analysis**

- Waterfall, Cascade, Colormap, Bode, Orbit, Polar Shaft Centerline Plots

---

**Magnitude and Phase Information**

<table>
<thead>
<tr>
<th>Order</th>
<th>Magnitude (g rms)</th>
<th>Phase (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1x</td>
<td>0.202320</td>
<td>155.5</td>
</tr>
<tr>
<td>2x</td>
<td>0.007514</td>
<td>55.2</td>
</tr>
<tr>
<td>3x</td>
<td>0.001528</td>
<td>136.4</td>
</tr>
<tr>
<td>5x</td>
<td>0.001212</td>
<td>242.0</td>
</tr>
<tr>
<td>10x</td>
<td>0.001461</td>
<td>169.1</td>
</tr>
</tbody>
</table>
The IMS Consortium
IMS Instrumentation Approach

CRITICAL ASSET

DATA ACQUISITION / SIGNAL PROCESSING

FEATURE EXTRACTION & SELECTION

FEATURE EXTRACTION & SELECTION

HEALTH VISUALIZATION

PERFORMANCE PREDICTION

HEALTH ASSESSMENT
## Watchdog Agent® Infotronics Toolbox

### Signal Processing & Feature Extraction

<table>
<thead>
<tr>
<th>Method</th>
<th>Health Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Domain Analysis</td>
<td>Logistic Regression</td>
</tr>
<tr>
<td>Frequency Domain Analysis</td>
<td>Statistical Pattern Recognition</td>
</tr>
<tr>
<td>Time-frequency Analysis</td>
<td>Feature Map Pattern Matching</td>
</tr>
<tr>
<td>Wavelet/wavelet Packet Analysis</td>
<td>Neural Network</td>
</tr>
<tr>
<td>Principle Component Analysis (PCA)</td>
<td>Gaussian Mixture Model (GMM)</td>
</tr>
</tbody>
</table>

### Performance Prediction

<table>
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<tr>
<th>Method</th>
<th>Health Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autoregressive Moving Average (ARMA)</td>
<td>Support Vector Machine (SVM)</td>
</tr>
<tr>
<td>Elman Recurrent Neural Network</td>
<td>Feature Map Pattern Matching</td>
</tr>
<tr>
<td>Fuzzy Logic</td>
<td>Bayesian Belief Network (BBN)</td>
</tr>
<tr>
<td>Match Matrix</td>
<td>Hidden Markov Model (HMM)</td>
</tr>
</tbody>
</table>
Information Delivery and Visualization

Results of Smart Prognostics Tools for Asset Health Information

Confidence Value for performance degradation assessment (CV ~ 0-1)

Health Radar Chart for multiple components degradation monitoring

Health Map for potential issues and pattern classification

Risk Radar Chart to prioritize maintenance decision
Modeling of the Prognostic Modules

Meaningful Data from each Operating Condition n

PM for Operating Condition n

Signal Processing & Feature Extraction

Feature Selection/Reduction

Health Assessment
Fault Diagnosis
Performance Prediction

Confidence Value for performance degradation assessment (CV ~ 0-1)

Health Radar Chart for multiple components degradation monitoring

Health Map for potential issues and pattern classification

Trend Prediction for proactive maintenance
1. Signal Processing & Feature Extraction

**Stationary**

- Raw Vibrations
- Time-synchronous Average
- FFT + Envelope

**Non-Stationary**

- Raw Vibrations
- Wavelets

<table>
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<td>Time Domain Analysis</td>
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<td>Wavelet/Wavelet Packet Analysis</td>
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<tr>
<td>Principal Component Analysis (PCA)</td>
</tr>
</tbody>
</table>

**CWT of time synchronous signal for gearbox with broken tooth (File 105)**

**Raw Vibrations**

**Time (for 1 revolution)**
2. Health Assessment

Normal Behavior in Operating Condition 1

Recent Behavior in Operating Condition 1

Raw Vibration in each Operating Condition

Normal Behavior

Most Recent Behavior

Feature Space

Confidence Value (CV)

Normal Behavior in Operating Condition 1

Recent Behavior in Operating Condition 1

Raw Vibration in each Operating Condition

Normal Behavior

Most Recent Behavior

Feature Space

Confidence Value (CV)

Logistic Regression
Statistical Pattern Recognition
Feature Map Pattern Matching (Self-organizing Map)
Neural Network
Gaussian Mixture Model (GMM)
Normal Behavior in Operating Condition 1

Recent Behavior in Operating Condition 1

Gearbox Health Map

One Health Map trained for EACH operating condition!

Normal Gearbox

Recent Behavior Gear 1 Broken Tooth

### Health Diagnosis

- Support Vector Machine (SVM)
- Feature Map Pattern Matching (SOM)
- Bayesian Belief Network (BBN)
- Hidden Markov Model (HMM)
- Evidence-based Holo-Coefficients
3b. Health Diagnosis – Option 2

Normal Behavior in Operating Condition 1

Recent Behavior in Operating Condition 1

e.g.: Chipped-tooth problem in first gear. Higher risk in high speed regimes.

Specialized Multi-regime Diagnostic Tool: Evidence-based Holo-Coefficient Diagnostics
PHM Analytics for Wind Turbines (1)

Select Wind Farm:
Phoenix, AZ - Zone 1

WIND FARM INFO:
- Rated Capacity: 450 kWh
- Actual Capacity: 378 kWh

CURRENT CONDITIONS:
- Ambient Temperature
- Humidity (%)
- Wind Speed

Equipment Health

Equipment Risk

[Diagram showing wind farm with turbines T1 to T8, highlighting T4 with symbols for online, offline, and low health value]

[Graphs showing health and risk levels for each turbine]

[Logo: NATIONAL INSTRUMENTS]
PHM Analytics for Wind Turbines (2)

Select Wind Farm: Phoenix, AZ - Zone 1
Select Wind Turbine: Turbine 4 - T4

WIND TURBINE INFO:
- Health Index: 0.4
- Timestamp: October 26, 2009 5:20 PM

CURRENT CONDITIONS:
- Ambient Temperature
- Humidity (%)
- Wind Speed

Wind Turbine Efficiency

Wind Turbine CV History

Component Health
- Gearbox
- Generator
- Bearings
- Blades
- Yaw
- Pitch

Component Risk
- Gearbox
- Generator
- Bearings
- Blades
- Yaw
- Pitch

National Instruments
PHM Analytics for Wind Turbines (3)

Select Wind Farm: Phoenix, AZ - Zone 1
Select Wind Turbine: Turbine 4 - T4
Select Component: Gearbox

GEARBOX INFO:
Health Index
Timestamp: October 26, 2009 5:20 PM

Holo-Coefficient Diagnosis

<table>
<thead>
<tr>
<th>Index</th>
<th>Fault</th>
<th>Detected?</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chipped Tooth</td>
<td>YES</td>
<td>HIGH</td>
</tr>
<tr>
<td>2</td>
<td>Crack in gear</td>
<td>YES</td>
<td>LOW</td>
</tr>
<tr>
<td>3</td>
<td>Imbalance</td>
<td>NO</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Backlash</td>
<td>NO</td>
<td>-</td>
</tr>
</tbody>
</table>

Fault Info
Timestamp: October 26, 2009 5:20 PM

Multi-regime Health Assessment, Diagnostics And Prognostics

Radar Chart
Watchdog Agent® in LabVIEW

Signal Analysis
- Transforms
- Wavelet Analysis
- Time Frequency
- Advanced IIR

Performance Assessment
- Logistic Regression
- SPR
- SOM
- Particle Filter

Performance Prediction
- Time Series Analysis
- Match Matrix
- Fuzzy Logic
- Neural Network

Health Diagnosis
- Hierarchical Clustering
- Bayesian Networks
- SVM
- SOM
MCM CASE STUDIES
Online Wind Farm Condition Monitoring System with Centralized Data Collection

Industry:
Energy/Power

Products:
NI 9423, NI CompactDAQ, USB-9233, NI 9205, cDAQ-9172, NI 9474, LabVIEW

The Challenge:
Developing a diagnostic network to automatically track the status of wind turbines with centralized access so that users can take advantage of the captured signals for off-line analysis.

The Solution:
Using NI LabVIEW to develop an application that can perform data acquisition and database management and provide Web access to applications and performing data acquisition with NI CompactDAQ to easily condition and capture different signals on a single device.

Embedded Measurement System for Remote Monitoring of Wind Turbines

Industry:
Energy/Power

Products:
Reconfigurable Chassis, Real-Time Module, NI 9853, NI 9239 BNC, Real-Time Controllers, NI 9237, NI 9401, LabVIEW

The Challenge:
Replacing existing remote monitoring systems with new monitoring systems that are time synchronized for performing measurements at a higher sample rate and with higher accuracy. The system will be installed on remote wind turbines and cannot be replaced or repaired easily.

The Solution:
Developing a flexible NI LabVIEW software application based on the NI CompactRIO platform that not only acquires measurements, but also filters analog and digital signals, applies a timestamp, temporarily stores data to prevent data loss, and transmits data to a database server.

Wind Turbine Assembly Diagnostics

Industry:
Energy/Power

Products:
USB-9233, LabVIEW

The Challenge:
Developing a system in accordance with ACCIONA quality standards for the dynamic characterization of wind turbines during the postassembly testing stage that is powerful, reliable, and flexible in terms of installation and use as well as within budget.

The Solution:
Integrating IEPE industrial accelerometers using NI USB-9233 modules for data acquisition distributed among different positions along the nacelle of a wind turbine and connected through a USB hub to an industrial PC, from which we can manage the test and its results.

Wind Turbine Structural and Blade Test/Monitoring

Host Computer

(TCP/IP)

Standard Ethernet

NI CompactRIO

Fiber Optic Cable

EtherCAT

Automatic Synchronization

NI 9144 Deterministic Ethernet Chassis

NI PXI

Copper/Fiber Converter

NI

National Renewable Energy Laboratory

Innovation for Our Energy Future
Steam & Gas Turbine Monitoring System

Industry:
Energy/Power

Products:
CompactRIO, LabVIEW, Real-Time Module, FPGA Module

The Challenge:
The growing demand for electricity has resulted in an increased demand for efficiency and availability, achievable with continuous monitoring of parameters related to machines installed, through remote and real-time data acquisition systems allowing predictive maintenance and fast recovery in case of failure.

The Solution:
Rapidly development of a remote machine monitoring systems able to acquire and log all the relevant gas/steam turbine parameters.

DIAGEN, remote diagnostics system for large electric power generators

Industry:
Energy/Power

Products:
CompactRIO, Real-Time Module, FPGA Module, LabVIEW

The Challenge
With this application you want to make an integrated hardware and diagnostic software for remote monitoring of electric generators of high power (20-750 MVA) constructed by Ansaldo Energia SpA (Genoa).

The Solution:
The solution adopted was to create a real-time monitoring system based on NI CompactRIO platform can therefore safely perform in a real-time data acquisition and a post-processing of the same effectively.

Oil Well Fracture Pump Monitoring and Analysis using LabVIEW and NI RIO Technology

Industry:
Oil and Gas

Products:
FPGA Module, LabVIEW, Single-Board RIO, LabVIEW Real-Time Module, CompactRIO

The Challenge:
Building an advanced monitoring system that can survive being mounted directly to an oil well servicing pump in a rugged environment while performing advanced analysis on sensor data.

The Solution:
Using NI CompactRIO and NI Single-Board RIO hardware along with NI LabVIEW software to design a pump monitoring system that monitors the operating parameters of a reciprocating pump used in well servicing applications.

Automated Final Turbine Test

Industry:
Energy/Power, Machines/Mechanics

Products:
SCXI-1130, SCXI-1127, PXI-4070, NI TestStand, PXI-6143, LabVIEW, PXI/CompactPCI

The Challenge:
Automating the final manufacturing tests of wind turbine control systems to increase test coverage, decrease test time, and address the rapidly growing production volume.

The Solution:
Using NI TestStand and LabVIEW with NI PXI instruments and SCXI signal conditioning to develop a standard automated test system for kk-electronics that can be adapted to global production sites.


NI PXI Test System
Online Monitoring of Nuclear Reactors Using NI CompactRIO

Industry:
Machines/Mechanics

Products:
Real-Time Module, CompactRIO, FPGA Module, NI 9234, LabVIEW

The Challenge:
Developing an online monitoring (OLM) solution for boiling water reactors, which contain machinery in hazardous and difficult-to-access areas.

The Solution:
Using an integrated, embedded NI CompactRIO system to develop the EWV-1 and OLM-32 hardware to provide live, wireless monitoring of plant assets in conjunction with AMS’ monitoring software.

Monitoring Compressor Performance Using NI Data Acquisition Boards

**Industry:**
Manufacturing

**Products:**
PCI-6023E, LabVIEW

**The Challenge:**
Designing a gas compressor data acquisition system capable of synchronizing samples from multiple sensors to the rotational position of the pistons’ crankshaft and performing measurements from field mounted meters and thermocouples.

**The Solution:**
Combining high-speed data acquisition and signal conditioning to precisely measure of compressor performance, using a FieldPoint network to acquire data from the thermocouples, pressure meters, and flow meters located throughout the gas loop and LabVIEW to process the data, calculate performance results, log data, and generate reports.

Facility Online Machine Condition Monitoring System

Industry:
Process Industry

Products:
PXI-8108, PXI-1042Q, PXI-4472B, CSC-3059 (a customized version of 4472B)

Application:
China Steel standardized their machine condition monitoring (MCM) system based on PXI and PXI-4472B. Each of China Steel’s production lines has a total of 300 to 500 accelerometers installed and they needed a reliable distributed software architecture for data acquisition, analysis, alarm & reporting. All system software is designed in LabVIEW and is to be duplicated for a total of 23 production lines. Software design consulting was a critical piece to winning the related hardware opportunities and has helped us close sales for 32 PXIs to date (over $510K hardware sales made so far).

TURN KEY PRODUCTS
• Integration
  Consultants, Integrators and Channel Partners

• Solution
  Systems that solve industry- or application-specific needs

• Product
  Complementary software and hardware

• Technology
  Key Suppliers (Intel, Microsoft...)

“Customer success, Financial success, Product adoption”
NOISE & VIBRATION ANALYZER

Industry:
Acoustic&Vibration

Products:
Sound and Vibration, LabVIEW, Dynamic Signal Analyzer

The Challenge:
Development of turn-key, computer based, open architecture Acquisition and Analysis Systems for Sound & Vibration, Electroacoustic Analysis, Dynamic Data Acquisition Systems,

The Solution:
realizazion of “Custom System” meeting fully compatibility with standard technologies today available on the market, taking care of business investment.
Both R&D and Production Line applications (i.e. Q.C.) are covered..

http://www.wintek-it.com/
CoDiS On line monitoring and diagnostic system

**CoDiS – Computerized Diagnostic System**

On line permanent monitoring diagnostic system

http://www.veski.hr/en/proizvodi/codismon/
Bearing Monitoring

FAG ProCheck - simple, intelligent, reliable

- Custom analysis algorithm on FPGA
- Real-Time System for managing analysis and communication
- Host application For Control & asset management

http://www.fis-services.com/site/en
vibDaq Solutions for TurboMachinery

Challenge
- Develop a portable vibration diagnostics tool for turbo machinery applications
- Needs flexibility, scalability, graphics, and advanced signal processing

NI Tools
- LabVIEW, PXI, DSA, Order Analysis, USB DAQ

Solution
- Leveraging off the shelf technologies Vibedaq now has a strong competitive posture in the portable machine diagnostics applications market

www.vibDaq.com
www.calbay.com
FLEXSTAND LOGGER

REAL-TIME LOGGING SYSTEM FOR GREEN ENGINEERING

FlexStand is a comprehensive logging and analyzing software solution. It is ideal for the development of Wind Turbine systems and related renewable energy projects.

The FlexStand software collects sensor data and provides a real-time analysis of the data. It allows users to monitor and control the performance of the system in real-time.

www.flexstand.eu
www.cim.as
NI as a Machine Monitoring Supplier

- Sound and Vibration is a strategic business segment
- Extensive software investments at NI
- Specific hardware and software products
- Leveraging over 15 years in Sound and Vibration applications
- Leveraging over 20 years in instrumentation control software
- Leveraging over 30 years in computer based instrumentation
- Domain expertise employees and partners
- Cost Competitive, leveraging economies of scale
- Financially Strong, World-Wide Support
Summary

• Machine Monitoring
  – Saves time and money
  – Improves operational reliability
  – Improves data re-use for service and design

• National Instruments provides
  – Machine Monitoring Solutions
    • Sound and Vibration Assistant, Partners
  – OEM Components for Equipment Manufacturers
  – Measurement technology partner
  – Economies of scale
Questions?

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www.ni.com/mcm