T73 - Exploring Sustainable Condition Monitoring
Exploring Sustainable Condition Monitoring Technologies

Logix, EtherNet/IP and the Dynamix™ 1444 Series

See how the Logix controller uses advanced equipment diagnostic add-on-instructions (AOIs) and standard Integrated Architecture® tools, to detect, identify and monitor faults in industrial equipment.

The session will illustrate how an automated solution, using common Logix controllers and Dynamix™ 1444 series monitors, can be applied to forewarn users of problems before production is impacted or to enable more efficient, cost effective maintenance strategies.
Traditional Condition Monitoring
Why isn’t it more broadly applied?

Traditional Condition Monitoring programs are typically…

- Expensive to apply
- Complex to understand
- Difficult to perceive the value

Many business that could benefit from condition monitoring do not apply it. Often this is due to the perception / reality of the requirements to apply.

A traditional condition monitoring program requires:
- **Skill sets that the business does not have**
- **Technologies that are independent of other business, operations and instrumentation systems**
- **Significant continuing labor investments that can be difficult to justify**
Traditional Condition Monitoring

What is the problem when they are applied?

Traditional Condition Monitoring programs are typically...

- Skills based
- Labor intensive
- Personality driven

...projects that are implemented and executed independently of Operations and (often) general Maintenance departments.

They often devolve into “fire fighting” tools that have little impact on operations planning, or even on routine scheduled maintenance planning.

It is not uncommon for these programs to digress, fall into disuse, or fail altogether as key personnel change, as budgets change, or as management / business focus shifts.
Sustainable Condition Monitoring
What is it?

Self Sustaining Condition Monitoring is a **philosophy** of how Condition Monitoring Systems and Programs should be **applied**…

...to help ensure that they can be **sustained** as **personnel** change, program **needs change**, and as **organizations** evolve.
Sustainable Condition Monitoring
Fault Indicators…

The core capability required of any condition monitoring program is to detect faults!

Fault Indicators are the magnitude, and sometimes phase, values of specific frequencies of vibration that are caused by mechanical or electrical faults, or process conditions.

Mechanical & electrical faults and many process conditions force vibration at specific frequencies.

It may look complex, but in most cases only a few numbers matter!
**Sustainable Condition Monitoring**

Fault Indicators are well defined...

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**Rules are the result of math... there are no secrets.**

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<table>
<thead>
<tr>
<th>Fault</th>
<th>Amplitude</th>
<th>Frequency</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Unbalance</td>
<td>Proportional to unbalance (in radial direction).</td>
<td>1 x RPM</td>
<td>Most common cause of vibration.</td>
</tr>
<tr>
<td>2 Misalignment of couplings or bearings. Bent Shaft.</td>
<td>Large in axial direction, 50% or more of radial vibration.</td>
<td>1 x RPM usual, 2 &amp; 3 x RPM sometimes.</td>
<td>Best found by appearance of large axial vibration. Use dial indicators or other method for positive diagnosis.</td>
</tr>
<tr>
<td>3 Mechanical Loosens</td>
<td>Large in radial direction. 1 x rpm usually largest peak</td>
<td>1 x RPM and sometimes multiples</td>
<td>Looseness between machine and plates or foundation and poor grouting. Look for loose pillow block bolts or cracks. Distorion of the frame or base referred to as soft foot.</td>
</tr>
<tr>
<td>6 Electrical</td>
<td>Disappears when power is turned off</td>
<td>For 27 synchr frequencies</td>
<td></td>
</tr>
</tbody>
</table>
Smart Monitors do the math!
They perform the measurement, signal processing and alarming functions necessary for each fault indicator.

Time Waveform  Spectra  Fault Indicators
Controllers apply the Logic!
Logix controllers perform the comparison and if / then logic to resolve the presence and severity of a fault.
Sustainable Condition Monitoring
Identify faults

Most machinery problems can be identified using one or more basic “if then” statements that can be easily modeled in Logic...

Unbalance

- If any 1x rpm is >.70 in/sec = WARNING
  “Unbalance Warning: Possible accelerated bearing and seals wear. Balance the machine at the next opportunity.”

- If any 1x rpm is >1.0 in/sec = DANGER
  “Severe Unbalance: Machine should not operate with this level of imbalance.”

Alignment

- If 2x rpm at Bearing 2 and Bearing 3 are both >.05 in/sec = Fault is present
  “Misalignment will accelerate bearing and coupling wear. Realign the machine at the next opportunity.”

- If 2x rpm at Bearing 2 and Bearing 3 are both >.10 in/sec = Fault may be serious
  “Severe alignment problem, potential for coupling failure and rapid bearing degradation. Realign the machine as soon as possible.”
Fault Indicators in Logix

Allows integrated detection, identification and...

**Detect**

With Dynamix, fault indicators are TAGS that are served on common I/O, via EtherNet/IP.

**Identify**

In Logix, IF-THEN Logic is applied to the (described) tag to determine the presence of the fault.

**Monitor**

Trends and limits are used to monitor the propagation and severity of the fault.
Sustainable Condition Monitoring
Automate Measurement, Detection & Presentation

Automate the Complexity
Sustainable Condition Monitoring
Present Actionable Information

Present Information in Meaningful Formats...
Sustainable Condition Monitoring
From Rockwell Automation®

Logix controllers & our Integrated Architecture® solutions

Dynamix™ 1444 Series Monitors
Introducing the Dynamix™ 1444 Series
...in a new, innovative package

A Single Main Module
+ a single main module terminal base

- Removable terminal connectors
- Both screw and spring version connectors available
- Recessed frame designed for easy gripping

Three Optional Expansion Modules
+ one common terminal base for all expansion modules.

- Integrated Buffered Output BNC connectors
- Terminal Base connections for non-sensitive wiring such as power, relays, grounds...
- Module connections for sensitive signals – fewer internal circuit connections, less noise, higher reliability
- Ethernet connections located above field wiring for easy, uncluttered access
- Connectors are angled for improved access and visibility
- Innovative DIN mount design with tension and leveling control
- Rugged, low noise, fully soldered card stack construction
Many, perhaps most, applications will require only one or more Dynamic Measurement (Main) Modules.
Dynamic Measurement Module

- 4 Dynamic Inputs
- 2 TTL Speed Inputs

Tachometer Signal Conditioner Expansion Module

- 2 Speed Inputs
- 2 TTL Speed Outputs
- 1 per Dyn. Meas. Module
- 6 Dyn. Meas. Modules per TSCX

4-20mA Output Expansion Module

- 4 Channels
- 1 per Dyn. Meas. Module

Relay Expansion Module

- 4 SPDT Relays
- 3 per Dyn. Meas. Module

Terminal Bases

- 1 Dynamic Measurement Module Base
- 1 Expansion Module Base

Dynamix 1444 Series
(just) 6 Catalog Numbers!
Dynamix 1444 Series
+ the RPC’s!

**Dynamic Measurement Module**
- 4 Dynamic Inputs
- 2 TTL Speed Inputs

**Removable Plug Connectors**
- Spring or Screw Style
- Purchased separately for each module and each base

**Tachometer Signal Conditioner Expansion Module**
- 2 Speed Inputs
- 2 TTL Speed Outputs

**4-20mA Output Expansion Module**
- 4 Channels
- 4 SPDT Relays

**Terminal Bases**
- 1 Dynamic Measurement Module Base
- 1 Expansion Module Base

**Purchased separately for each module and each base**
Dynamix™ 1444 Series
Power, Environment, Certifications & Approvals

Power
- Redundant Supplies: Integral redundant power supply inputs with supply fault detection and status available on I/O
- Supply Voltage: +24VDC (18V to 32V wide range input) – designed to accommodate battery backed systems

Environment
- Operating temperature: -25°C to +70°C
- Conformal coating: All circuit cards are conformal coated

Electrical Safety
- CE, CSA & UL

Hazardous Area
- IECex-Zone 2 & ATEX – Zone 2, cUL – Class 1 Div 2 Groups A,B,C,D

Region & Country Marks
- CE, C-Tick, Russia*, Brazil*, Korean*

Marine Certifications*
- DNV, BV, ABS, Lloyds, RINA, GL, KRS

Functional Safety*
- TUV certified to SIL 2**

* Will not be available at initial release
** When used with local, expansion module, relays
1444 Series & Integrated Architecture®
Premier Integration in Logix

- Configuration from any Logix controller
- Supported by Studio 5000® V20 & V24+
- Standard assemblies for
  - Configuration
  - Input
  - Output
Demonstrations

- Adding a module to a Studio 5000® environment
- Define the Module
  - Define the module’s “personality”
  - Specify the expansion modules that are connected
  - Select the measurements (fault indicators) to be served on I/O
- Configure the Module
  - Specify the connected sensors
  - Configure the measurements necessary to produce the fault indicators
  - Define alarms & relays
Questions?

PUBLIC INFORMATION

Thank You!