Machine Health for the Machine Maker

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Ed Spence is the Founder and Managing Director of The Machine Instrumentation Group, a collaborative network of CBM product and service providers helping machine makers develop their own CBM instrumentation.

From 2008 to 2018, Ed was the Marketing Manager for Analog Devices MEMS Sensor Technology Group, where he defined the accelerometer roadmap for Condition Monitoring.
Enabling IIoT Technologies

Chip Scale Sensors
MEMS accelerometers enable higher levels of integration, smaller form factors and digital interface

Predictive Analytics
Data engineering approaches improve diagnostic accuracy and add predictive insights

Wireless Networks
Lower deployment costs for on-line continuous monitoring

Data dashboards
Cloud/Web server based data visualization, distribution and analysis

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Condition Monitoring Today...

- Predominantly manual by 3rd party service providers or plant maintenance
- Low cost way to monitoring Balance-of-Plant
The Transformational Semiconductor Industry...

- Low power, low cost radios
- Chip antennas
- Micro-power controllers and processors

MEMS Accelerometer noise decreasing with resonant frequencies increasing

Solid State Accelerometers

Evolution of Bluetooth bit rates

21kHz

30kHz

45kHz

<5kHz

Solid State Accelerometers
The Digital Condition Monitoring Sensor...

Chip sensors enable highly integrated ‘smart sensors’

SOLID STATE ACCELEROMETERS

DIGITIZATION & EMBEDDED PROCESSING

DIGITAL INDUSTRIAL INTERFACE

SCADA
PLC
Machine Controller
The OEM /Machine Maker Opportunity...

CBM value capture

• Embedded CBM sensors
• Digital interface to local controller
• Customized health indicators
• Automate ‘tribal knowledge’
• Service based revenue
OEM Incentives to Provide Prognostics / Monitoring

- Value proposition – condition monitoring services
- Workforce changes
  - Senior/Experienced users continue to retire
- Leaner maintenance
  - No time to become HW specific experts, busy running the plant
- Technology has evolved enabling cost effective solutions
  - Sensing / communications / embedded solutions / etc
- Smart Phone Culture
  - People are becoming used to having access to information
- Expanding the universe of equipment monitored
- Expanded fault coverage
Expanding the Application of CBM

CBM 1.0
On-Line Systems
Critical plant

CBM 2.0
Route based
Expands coverage to BoP

CBM 3.0
Wireless networks
Continuous monitoring for BoP
Expands coverage to new applications

CBM 4.0
Embedded sensors
Pre-instrumented OEM equipment
Expanding CBM coverage to new equipment
Adapting CBM to Specialized Equipment

- Fixed frequency rotation
- Monitoring and diagnostic techniques well understood
- Common library of known faults

Motor-Pump Train

- Unique motion signatures and fault modes
- Diagnostics are visual
- Fault knowledge is ‘tribal’
- Many hardware configurations

Control Valve & Actuator
A General Process for Machine CBM Development...

*New health indicators can often be developed directly from available operational control data. An analytics pilot study can be performed before adding any new instrumentation...
Lessons Learned so Far and Future Work...
(from an Emerson Fisher – TMIG Case Study, The Reliability Conference, Las Vegas, April 2018)

- Acquiring and evaluating new measurands requires new sensors
- Exploring techniques for expanded health monitoring is multi-faceted
  - Leverage and manage the convergence of new technologies
- Accelerating Time-to-Market
  - Force multiplier using contractors vs developing everything in-house
- Capturing domain knowledge
  - SME informed health indicators
  - Holy grail: automated CBM

Expand Sensor Deployment
Collect More Field Data
Embed Next Generation Sensor Technologies
Improved Data Analytics – Machine Health Indicators
Prognostics Dashboard
Thank you!

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