Smart Manufacturing PHM

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The Boeing Company

Boeing is the world's largest aerospace company and a leading manufacturer for commercial and military products.

A top U.S. exporter, the company supports airlines and U.S. and allied government customers in 150 countries.

Boeing employs more than 160,000 people across the United States and in more than 65 countries.
Building a PHM Model for Aerospace Manufacturing

1. Hardware & Communication Module
2. Data Acquisition
3. Data Analytics
4. Portal Visibility

Overall Equipment Effectiveness “OEE” Standard is being calculated across multiple Boeing Sites
MACHINE MONITORING DATA PLAN & STANDARDIZATION

OEE
Availability, Performance, Quality

CBM
Machine Learning, Fault Detection, Diagnostics

Job Operation Planning
Job Log, Job Load, Priorities

Downtime; Defects; Throughput

Sensors Data; Analytics Tools; Machine Control

Scheduling; Management; Operation Intelligence; Smart Alert

Portal Design & Visibility

Health Monitoring via., Boeing & Industry Standards

Key Performance Indicators

= Communication Protocol & Networking
Machine Learning at Metal Fabrication Center

- **Data Collections**
  - CBM Investigations
    - Trend Analysis & Comparisons with the Past History
    - Waterfall graphs
    - Spectrum Analysis:
      - FFT, Time Domain, Frequency Domain, and Peak Rate Analysis

- **Machine Problems**
  - Spindle Faults
  - Axes Motors
  - Sub-Components Mechanical or Electrical Systems Failures

- **Future Trend: Inline Inspection**
  - Part quality
  - Calibration Verification
Aerospace Composites Manufacturing

- Fiber Placement
- Autoclave
- Ply-Cutter
- Automated Trim
- Drill System
- Walk-in Freezer
- Time Sensitive Material Control

Major Assembly
Machine Monitoring – Assembly Automation Systems

- **Data Collections & Quality Status**
  - Hole or fastener data
  - OEE

- **Machine Health Data**
  - Tool Tip & Spindle Monitoring
  - Motion System
  - Tools & Holding Fixtures
  - Mechanical Components

- **Data Analytics**
  - CBM
  - Calibration
  - Part Quality
  - Throughput

- **Non Conformance & Corrective Actions Data**
Facilities Infrastructure Health Monitoring

- Crane Mgt.
- Tempered Air System
- Instrumented Motor
- User interface
- On-line Power Monitoring
- PLC and data acquisition system

Vibration, Power Quality, Temperature, Humidity, Alignment

Fault detection and time to failure

Tempered Air Units

On-line Power Monitoring

PLC and data acquisition system

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