



Engineering, Operations & Technology
Boeing Research & Technology

Smart Manufacturing PHM

PHM 2016 – 8th Annual Conference of the Prognostics and
Health Management Society
Denver, Colorado

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Boeing Research & technology
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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

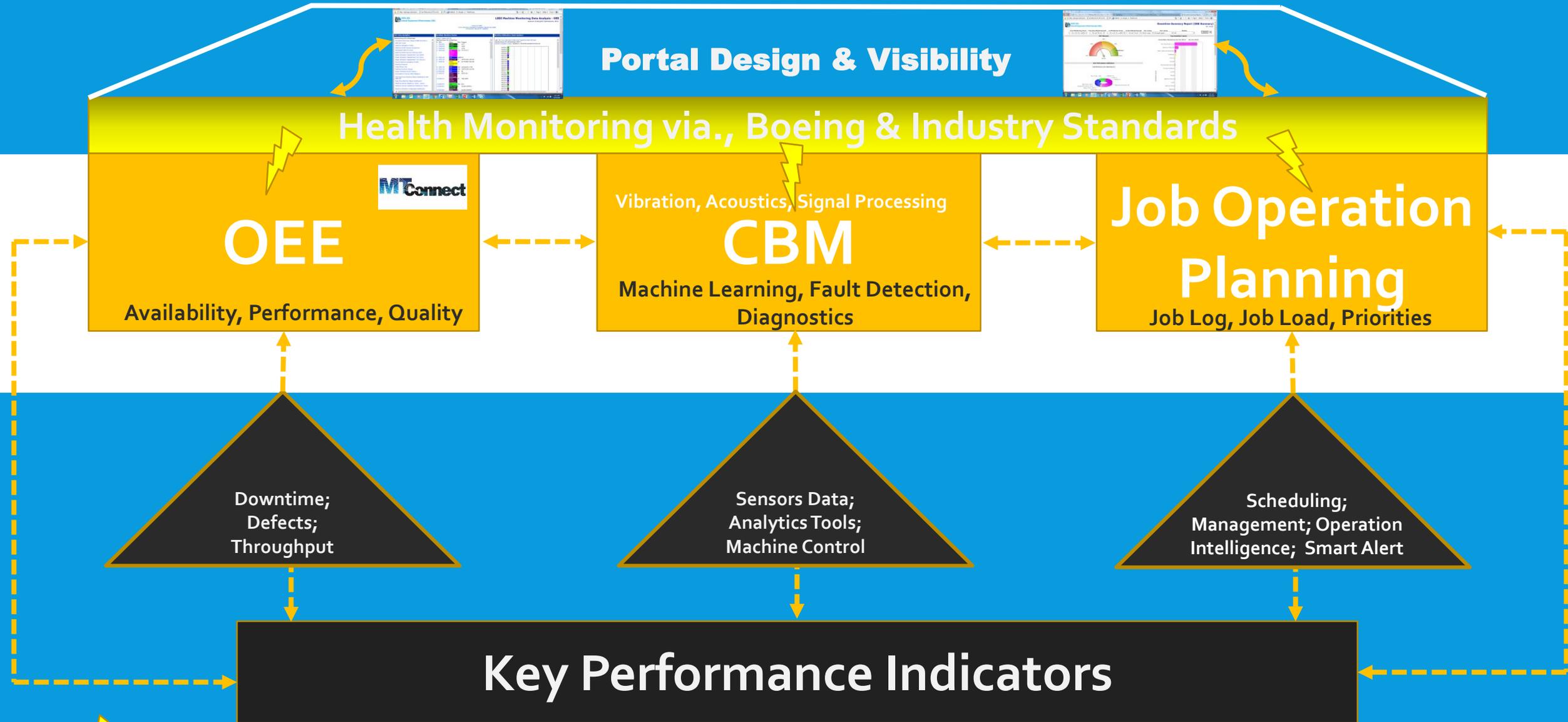
1. Hardware & Communication Module } OPC
MT-Connect
2. Data Acquisition
3. Data Analytics
4. Portal Visibility



Overall Equipment Effectiveness “OEE” Standard is being calculated across multiple Boeing Sites



MACHINE MONITORING DATA PLAN & STANDARDIZATION



 = Communication Protocol & Networking

Machine Learning at Metal Fabrication Center



Auburn, WA

- ❖ 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

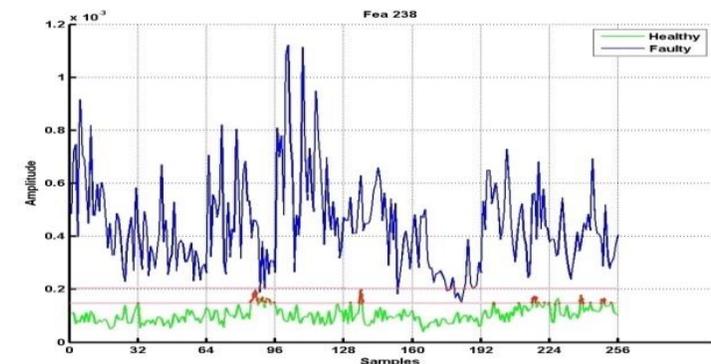


Frederickson, WA



Automated Lubrication Sensor

- ❖ Future Trend: Inline Inspection
 - Part quality
 - Calibration Verification



Raw Data vs. Expected Data

Aerospace Composites Manufacturing



Fiber Placement



Ply-Cutter

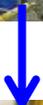


Walk-in Freezer



Temperature

Time Sensitive Material Control



Autoclave

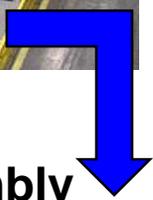


Automated Trim

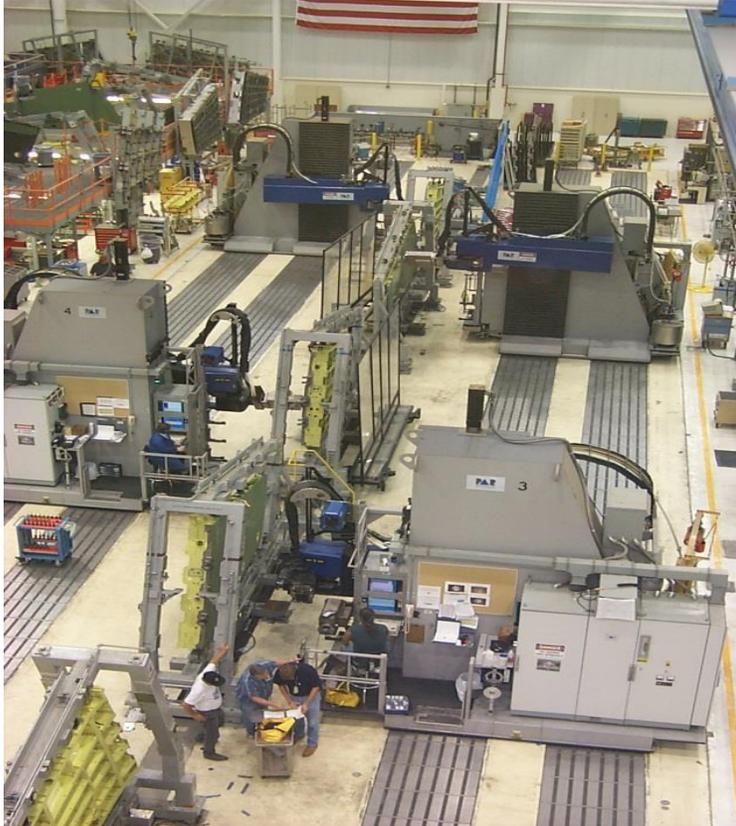


Drill System

Major Assembly



Machine Monitoring – Assembly Automation Systems



❖ Data Collections & Quality Status

- Hole or fastener data
- OEE

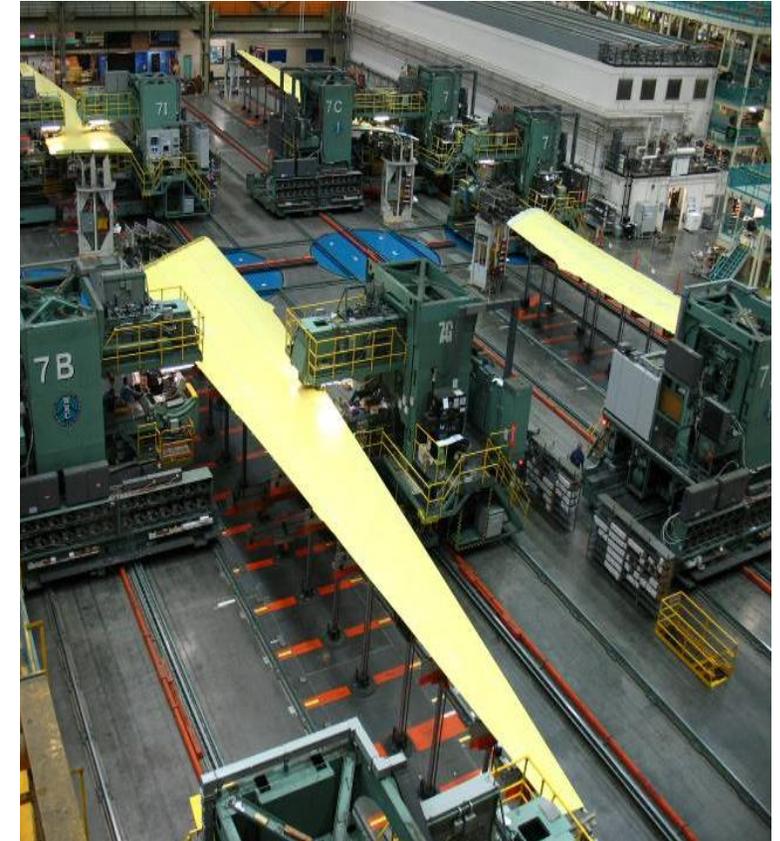
❖ Machine Health Data

- 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

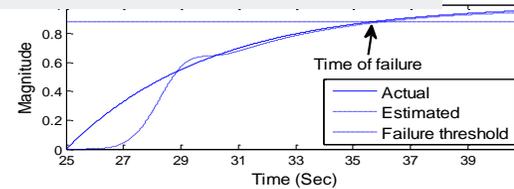
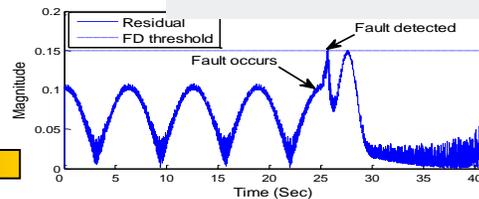


Tempered Air System



Vibration, Power Quality, Temperature, Humidity, Alignment

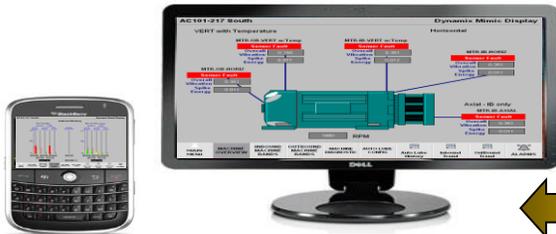
Fault detection and time to failure



Instrumented Motor



PLC and data acquisition system



User interface



On-line Power Monitoring

