Smarter Analytics Leadership Summit
Big Data. Real Solutions. Big Results.

Improving Operational and Financial Results through Predictive Maintenance
Introductions

Jerry Kurtz  
Vice President - Industrial Sector  
Business Analytics and Optimization

Paul Hoy, CPIM  
Global Industrial Sector Executive  
IBM Business Analytics

Lester McHargue  
Business Solutions - Industrial Sector  
Business Analytics and Optimization

John Ward  
Global Industrial Sector Solutions Leader  
IBM Predictive Analytics
IBM Signature Solutions bring together analytic industry expertise, reusable assets and delivery skills to address high-value client initiatives.

A portfolio of outcome-based analytics solutions that address the most pressing industry and functional challenges by bringing together the breadth and depth of IBM’s intellectual capital, software, infrastructure, research and consulting services to deliver breakaway results.

**Tackle**
**High-value initiatives**
Address industry imperatives and critical processes

**Deliver**
**Proven outcomes**
Built on a rich portfolio of analytics capabilities and IBM innovations implemented at clients worldwide

**Accelerate**
**Time-to-value**
Faster return on investment with short-term projects that support the long-term roadmap
Predictive Asset Optimization — optimizes performance and improves quality by integrating IBM’s industry, services, software and research expertise

**New Signature Solution: Predictive Asset Optimization**

- Monitor, maintain and optimize assets for better availability, utilization and performance
- Predict asset failure to optimize quality and supply chain processes

*Combined with user-friendly, industry dashboards, accelerators and methods*

---

**Customer Next Best Action**

**Anti-fraud, Waste & Abuse**

**CFO Performance Insight**

---

**Predictive Asset Optimization**

---

© 2012 IBM Corporation
Asset-intensive companies need help to solve complex operational and process issues

**Asset Performance**
- Lack of visibility into asset health
- High costs of unscheduled maintenance
- Inability to accurately forecast asset downtime and costs

**Process Integration**
- Difficulty separating the “signals” from the “noise”
- Lack of visibility of predictors across organizational silos
- Inability to leverage analytical insights for asset optimization
Predictive Asset Optimization integrates Analytics Capabilities with Enterprise Asset Management (EAM)

Business analytics can provide insights and actionable events to improve operational efficiencies, extend asset life and reduce costs.

- Asset maintenance history
- Condition monitoring and historical meter readings
- Inventory and purchasing transactions
- Labor, craft, skills, certifications and calendars
- Safety and regulatory Requirements

- Optimized maintenance windows to reduce operating expense
- Efficient assignment of labor resources
- Minimize parts inventory
- Improved reliability and uptime of assets
IBM delivers business value with extraordinary differentiation in analytics skills, products, innovation and marketplace experience

Smarter Analytics Signature Solutions bring together these capabilities

“...whole is greater than the sum of its parts.”
Why choose IBM’s Signature Solution: Predictive Asset Optimization?

Industry Expertise

- Predictive models for a number of specific industry use cases

Big Data, Predictive & Advanced Analytics

- An enhanced advanced analytics methodology, tailored to the needs of the predictive asset/maintenance space

Accelerators

- Pre-configured dashboard/visualization templates
- Pre-integrated software tools, with connectors to a variety of asset management solutions

Talent

- A resource pool of highly talented advanced analytics SMES and Industry experts with Predictive Asset Optimization experience
Trends in Predictive Maintenance

Paul Hoy, CPIM
Global Industrial Sector Executive
IBM Business Analytics
Analytic solutions enable optimization of asset performance

3x
Organizations that lead in analytics outperform those that are just beginning to adopt analytics by 3 times

83%
83 percent of CIOs cited analytics as the primary path to competitiveness

Asset Performance
- Improve quality and reduce failures and outages
- Optimize service and support

Process Integration
- Optimize operations and maintenance
- Enhance manufacturing and product quality

Source: IBM CIO Study, “The Essential CIO”
Answering the questions associated with better asset and process performance

How can I perform in depth root cause failure analysis on my process and equipment?

How can I detect warranty issues sooner?

How can I optimize my maintenance plan?

What is the life expectancy of an asset’s component or part?

How can I predict an impending equipment failure and the cause?

How do I achieve optimal equipment efficiency and availability?

How can I create highest quality products?

How can I reduce process variability?

How can I ensure supply is aligned with demand?
Predictive Maintenance Use Case – Key Examples

Predictive Maintenance for Assets

• Predictive Production Line Continuity
  • Utilize predictive analytics to identify when internally used production machinery, equipment, and assets are likely to fail or need service, and perform preventive maintenance in order to maximize production uptime and minimize disruptive, costly unscheduled downtime.

• Predictive Optimization of assets in the Field
  • Utilize predictive analytics to identify when equipment in the field is likely to fail or need maintenance in order to maximize uptime/in-service time for equipment sold to customers or used to deliver service.

Predictive Quality and Warranty Performance

• Utilize predictive analytics to identify when goods and equipment sold to customers is likely to fail in order to identify root cause for problem correction, and to proactively address issues to reduce warranty cost and improve customer satisfaction.
Predictive Asset Optimization analyzes data from multiple sources and provides recommended actions, enabling informed decisions.
Predictive Asset Optimization Architecture

- **End User Reports, Dashboards, Drill Downs**

- **Statistical Analytics** (SPSS Modeler)

- **Decision Management** (SPSS DM)

- **Business Analytics** (COGNOS BI)

- **Analytic Datastore**
  - (Pre-built data schema for storing quality, machine and prod data, configuration)

- **Industrial Enterprise Services Bus**
  - (Message Broker)

- **Telematics, Manufacturing Execution Systems, Legacy Databases, Distributed Control Systems**

- **High volume streaming data** (InfoSphere Streams)

- **EAM System**
  - (Tivoli Maximo Tririga or other)
Predictive Asset Optimization generates business value

**Business Use Case**

**Predict Asset Failure/Extend Life**
- Determine failure based on usage and wear characteristics
- Utilize individual component and/or environmental information
- Identify conditions that lead to high failure

**Predict Part Quality**
- Detect anomalies within process
- Compare parts against master
- Conduct in-depth root cause analysis

**Business Value**
- Optimize Enterprise Asset Management maintenance, inventory and resource schedules
- Increase return on assets
- Estimate and extend component life
- Improve customer service
- Improve quality and reduce recalls
- Reduce time to identify issues
## Deriving Value From Predictive Asset Optimization

<table>
<thead>
<tr>
<th>Key Metric</th>
<th>Business Benefit</th>
<th>How Advanced Analytics Enables Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximize Revenue</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competitive Advantage</td>
<td>Products and Services</td>
<td>New Products and Services. Up Sell Opportunities, Higher product quality</td>
</tr>
<tr>
<td></td>
<td>High Availability</td>
<td>Better Asset Utilization, More Production Cycles</td>
</tr>
<tr>
<td></td>
<td>Lower Start Up Costs</td>
<td>Fewer Reworks, Fewer Installation Repairs</td>
</tr>
<tr>
<td><strong>Cost Savings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased Reliability</td>
<td>Less Un Planned Downtime</td>
<td>Fewer Failures, Faster Problem Identification, Better process throughput</td>
</tr>
<tr>
<td></td>
<td>Better Productivity</td>
<td>Issues Cost Avoidance, Faster Root Cause, Higher equipment utilization</td>
</tr>
<tr>
<td></td>
<td>Better Quality</td>
<td>Proactive Monitoring, Predictable Performance, Identification of factors likely to result in diminished quality</td>
</tr>
<tr>
<td><strong>O &amp; M Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased Efficiency</td>
<td>Non Production Costs</td>
<td>Fewer Failures, Fewer Emergencies, Less need for excess MRO inventory</td>
</tr>
<tr>
<td></td>
<td>Shorter Maintenance</td>
<td>Predictive Maintenance, Better Planning</td>
</tr>
<tr>
<td></td>
<td>Lower Warranty Costs</td>
<td>Fewer Part Failures, Shorten Issue Resolution</td>
</tr>
<tr>
<td><strong>Customer Experience</strong></td>
<td>Proactive Management</td>
<td>Fewer Surprises, Proactive Communication</td>
</tr>
<tr>
<td>Increased Satisfaction</td>
<td>Individual Experience</td>
<td>More Focused Communication, Holistic View</td>
</tr>
<tr>
<td></td>
<td>Better Collaboration</td>
<td>Information Integration Across Industry, Better Insight Across Silos</td>
</tr>
</tbody>
</table>
Customer Case Studies

John Ward
Global Industrial Sector
Solutions Leader
IBM Predictive Analytics
Predictive Quality and Warranty Performance
BMW
Case Study Overview: BMW

Customer Overview
- German manufacturer of quality vehicles for worldwide markets
- Manufacturing plants in Germany and elsewhere
- Service / Warranty agencies worldwide

Business Challenges
- Needed to gain deeper insights into the causes and combinations of circumstances which led to warranty issues in each geography
- Needed to increase customer satisfaction through increased product quality and reduced warranty issues

Solution Implemented
- Implemented a data mining capability to gain actionable insights across a wide range of warranty issues
- Fed back issue findings into product design process for improvements and modified service patterns where these were demonstrated to have contributed to warranty issues

Proven Business Value
- Reduced warranty cases from 1.1 to 0.85 per vehicle
- 5% reduction in warranty cases
- Annual savings of €30m approx.
Predictive Quality: IBM Predictive Asset Optimization (PAO) is used in the BMW light-alloy foundry for the production process to better understand and eliminate problems quickly.

Reduced scrap rate by 80% in 12 weeks
Predictive Maintenance: Reduce warranty claims for new cars by analyzing historical information and vehicle data using IBM Predictive Asset Optimization (PAO).

Reduced warranty costs by 5%, Repeat repairs by 50%
Predictive Optimization of Assets in the Field
A Large Construction Equipment Manufacturer
A condition monitoring system that will:
- Combine multiple data sources associated with a piece of equipment
- Apply predictive analytics to highlight possible problems
- Utilize interpretive expertise to confirm the problem and identify a solution

Predictive Asset Optimization for Heavy Equipment

- Machine Data
  - Wired or Wireless
- Events / Trends / Payloads
- Work Orders
- Inspections and Fluid Samples

View 5 CM Elements and make Maintenance and Repair Recommendations

Condition Monitoring Elements
1. Machine Data
2. Fluid Analysis
3. Inspections
4. Site Conditions
5. Repair History

Off-board Analytics To Detect Slower Moving Problems

Recommendations Fed into Maintenance & Repair (M&R) Process

Analysts Validate Recommendation Effectiveness
# Typical PAO Heavy Equipment Use Cases

<table>
<thead>
<tr>
<th>Priority</th>
<th>Model Description</th>
<th>Business Value</th>
<th>Modeling Techniques</th>
<th>Data Sources</th>
<th>Business Questions Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Predict Major Component Failures</td>
<td>Machine health score used to predict impending failures</td>
<td>Classification Models</td>
<td>Repair History (Dealer Source TBD), Fluid Analysis, VIMS, Events, Other</td>
<td>Are there indications that a major component failure is likely to occur in the immediate future?</td>
</tr>
<tr>
<td>2</td>
<td>Predict Component Life Based on Specific Machine History</td>
<td>Understand impacts of individual low level failures, estimate component life</td>
<td>Regression Models</td>
<td>Repair History (Dealer Source TBD), Events</td>
<td>How do low level failures cumulatively affect the life span of components? What are the site specific effects?</td>
</tr>
<tr>
<td>3</td>
<td>Identify Failures that Often Occur Together</td>
<td>Based on history, identify machines that have a high probability of experiencing similar failures</td>
<td>Association Models</td>
<td>Warranty Data, Repair History</td>
<td>What kinds of failures are likely to occur together (e.g., failure x happens n hours after failure y, failure x is usually followed by y and z, failure x happens every n hours, when failure x happened, condition y is usually present)?</td>
</tr>
<tr>
<td>4</td>
<td>Detect Anomalies within the Fleet</td>
<td>Detect groups of machines experiencing anomalous behavior</td>
<td>Clustering Models</td>
<td>(Trends, Fluid, Events) or Other Electronic Data Source</td>
<td>What machines are behaving differently from the others in the fleet or at a site?</td>
</tr>
<tr>
<td>5</td>
<td>Utilize Statistical Process Control</td>
<td>Detect statistically rare conditions that bear further investigation</td>
<td>Runs Chart, Range Chart</td>
<td>Trends or Other Electronic Data Source</td>
<td>What are the rules by which observed changes in electronic data will trigger alerts?</td>
</tr>
<tr>
<td>6</td>
<td>Predict Component Life Based on Population</td>
<td>Extend component life, better MARC analysis</td>
<td>Weibull Analysis</td>
<td>Warranty Data, Repair History</td>
<td>How can component life history data be used to make decisions about PM or PCR intervals,</td>
</tr>
</tbody>
</table>
Predictive Maintenance Demonstration
Predictive Asset Optimization
Large / Capital Equipment Manufacturers
Capital Equipment Manufacturers

Manufacturers need to be able to identify potential component failure as well as machine health of in-service equipment by identifying early signs of potential downtime and enterprise component issues.

➢ **The Opportunity**
  • Difficulty in separating the signal from the noise to detect enterprise component problems
  • Unscheduled maintenance and downtime are critical issues costing the end customers from Hundreds of Thousands to Millions of Dollars per hour
  • Most relationships with the user community if reactive in nature. Quality issues are often identified at the site.

➢ **Business Case**
  • Early identification and mitigation of enterprise component and quality issues
  • Provide insight to the health and probability of failure for in service equipment maximizing uptime
  • Establish a proactive relationship with the user community to increase asset availability, reduce costs, and create new product and service offerings
  • Better maintenance planning
  • Identification of new product and proactive services.

➢ **What Makes it Smarter**

This system uses a variety of Advanced Analytical techniques to monitor Time-Series Machine Data, Site Conditions and Service History to predict component well as system failure

Structured Data
• Process Data
• Alarm Data
• Manufacturing Data

Unstructured Content
• Work Orders
• Technical Support
• Warranty Claims
The methodology include six phases:
- Business Understanding
- Data Understanding
- Data Preparation
- Modeling
- Evaluation
- Deployment

The first phase, “Business Understanding,” is critical for successfully turning qualitative and quantitative data into valuable insights that lead to value-added actions.

Phases 2 through 5 can occur in any order and almost always include multiple iterations back to the Business Understanding stage.

The methodology by itself, however, does not guarantee success with advanced analytics.

Success requires deep expertise and experience in evaluating and using a wide range of advanced analytical techniques.

A large equipment manufacturer saved $1 million in just two weeks by using predictive maintenance to proactively identify problems and take action before failure occurred. By minimizing downtime and repair costs across all its manufacturing operations, the manufacturer achieved a 1400% return on investment in just four months.
## Capital Equipment Manufacturers - Creating Client Value Through Integrated Operations

<table>
<thead>
<tr>
<th>Visibility</th>
<th>Prediction</th>
<th>Collaboration</th>
<th>Optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production and Performance Reporting</td>
<td>Technical Support And Engineering</td>
<td>Maintenance and Service</td>
<td>Warranty and Quality</td>
</tr>
<tr>
<td>Turnaround Optimization</td>
<td>Predictive Modeling &amp; Maintenance Planning</td>
<td>Maintenance Service Optimization</td>
<td>Warranty Analytics</td>
</tr>
<tr>
<td>Consumables Inventory Planning</td>
<td>Early Event Warning</td>
<td>Enterprise Asset Management</td>
<td>Advanced Analytics and Discovery</td>
</tr>
<tr>
<td>Downtime Optimization</td>
<td>Data Mining for Anomaly Detection</td>
<td>Enterprise Document Management</td>
<td>Knowledge Management</td>
</tr>
<tr>
<td>Downtime Reports</td>
<td>Standards</td>
<td>Maintenance Reports</td>
<td>Trade Publications</td>
</tr>
<tr>
<td>Call Logs</td>
<td>Service Records</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Business Solutions
- Production and Performance Reporting
- Technical Support and Engineering
- Maintenance and Service
- Warranty and Quality
- Collaborative Decision Making

### Unstructured Content
- Downtime Reports
- Standards
- Maintenance Reports
- Trade Publications
- Manuals
- Call Logs
- Service Records

### Real-time Data Capturing and Actuation
- DCS, PLCs Historians
- RFID & Remote Sensing
- MES Application & Facility Monitor
- Engineering Equip & Process Doc

### Physical Assets
- Physical Assets
- DCS, PLCs Historians
- RFID & Remote Sensing
- MES Application & Facility Monitor
- Engineering Equip & Process Doc
US Capital Equipment Manufacturers: A Matrix/Horizontal Approach To Analytic Value

**Maintenance**
- Reduce Downtime
- Better Collaboration
- Efficiency
- Asset Utilization

**Production / Process**
- Better Efficiency
- Higher Quality
- Predictive Performance
- Holistic View

**Field / Plant Service**
- Product Design
- New Products
- New Services
- Proactive
- Consistent Standards

**Technical Support / Engineering**
- Incident Avoidance
- Case Reduction
- Case Resolution
- Efficiency
- Root Cause

**Warranty**
- Fewer Claims
- Part Cost
- Supplier Recovery
- Reserves

---

**Revenue Growth:** Availability, Asset Utilization, New Products, New Services, Proactive

**Cost Savings:** Reduced Downtime, Higher Quality, Better Efficiency, Root Cause Analysis

**O&M Costs:** Enterprise View, Fewer Emergencies, Value Based Decisions, Warranty Costs

**Customer Satisfaction:** More Availability, Better Collaboration, Proactive Communication

Integration of Analytics Across Functional Areas Yields the Best Results
Value of Integrated Analytics

- Faster Alarm Detection
- Earlier Failure Prediction
- Proactive Improvements
- Enterprise Analytics
- Dependencies

Better Optimization
Better Asset Utilization
Process Optimization
Customer Impact Analysis
Value Based Decisions

- Faster Alarm Detection
- Earlier Failure Prediction
- Proactive Improvements
- Enterprise Analytics
- Dependencies

Better Optimization
Better Asset Utilization
Process Optimization
Customer Impact Analysis

- Faster Alarm Detection
- Early Failure Prediction
- Proactive Improvements
- Enterprise Analytics
- Dependencies

Enterprise Analytics + Next Best Action
B better Optimization
Better Asset Utilization
Process Optimization
Customer Impact Analysis

- Alarm Detection
- Early Failure Prediction
- Reactive Improvements

- Real Time Process
- Enterprise Production
- Maintenance & Supply and Demand
- Finance

Value

Capability
## Some Example Results

<table>
<thead>
<tr>
<th>Use Case</th>
<th>PAO Approach</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide Early Detection of factors impacting availability</td>
<td>Combine operational, environmental, and maintenance information to identify causal factors</td>
<td>Identification of the leading factors impacting up time</td>
</tr>
<tr>
<td>Provide Early Detection of Enterprise Wide component failures, impacting warranty, and asset availability.</td>
<td>Integrate process, technical support, and warranty information to identify enterprise wide patterns in component failures</td>
<td>10 to 13 month early detection</td>
</tr>
<tr>
<td>Provide Early detection of trends that impact quality and performance</td>
<td>Integrate process, technical support, and maintenance information to identify multivariate patterns that lead to poor results</td>
<td>Identification of primary and secondary causal factors</td>
</tr>
<tr>
<td>Provide an indication to the health of in-service equipment, and the probability of failure between maintenance windows</td>
<td>Integrate process, environmental, operational, maintenance, and engineering support information for a complete picture to health of an asset.</td>
<td>80% to 90%+ accuracy in predicting equipment downtime.</td>
</tr>
<tr>
<td>Enable proactive customer management through better understanding of individual equipment issues</td>
<td>Integrate process, technical support, maintenance, and warranty information to provide individualized products and services</td>
<td>Identification and proactive delivery of products and services. Direct and through dealers</td>
</tr>
</tbody>
</table>
Predictive Asset Optimization
Implementation Methodology
Predictive Maintenance Value

Financial Impact
- Improved revenue growth
  - Revenue Growth
  - Improved cost position
    - Operating Margin
- Improved working capital position
  - Capital Efficiency
    - Improved efficiency of capital outlays
      - Reduced Risk
        - Risk Mitigation
- Improved cost position
  - Maintenance

Value Drivers
- Production
  - Higher Productivity
  - Renewal Cost
  - Increased Up Time
  - Maintenance cost

Key Performance Indicators
- Tons per Hour
- % improvement / ton
- Component Rebuild Cost
- Component Life
- % scheduled
- Mean Time Between Stops
- Mean Time to Repair
- Labor resources
- Parts consumption
- Number of Spares
- TCO Per Spare
- Dedicated Shop space
- Average Spare Parts / Components Inventory
- % field repairs
- Average inventory value, major components
- % improvement / Hour
- % improvement / Hour
- MTBS
- MTTR
- Maintenance Ratio
- Parts Ratio

Shareholder Value

© 2012 IBM Corporation
Predictive Asset Optimization’s pre-integrated solution offers flexibility to meet your company’s needs.

Flexible Deployment

OPTION 1: BUSINESS VALUE ACCELERATOR
- Assess Requirements 2-3 Weeks
- Develop Business Case 2-3 Weeks
- Define Solution Roadmap 1-2 Weeks

OPTION 2: SOLUTION PROOF-OF-CONCEPT or PROOF-OF-VALUE
- Define and Implement Pilot 6-8 Weeks
- Evaluate Pilot 1-4 Weeks

OPTION 3: SOLUTION IMPLEMENTATION
- Define Use Cases
- Establish Solution Components
- Conduct Solution Impact Assessment
- Design, Build and Deploy

Flexible Purchases

Options
- Pre-configured individual products and services, or as
- GBS hosted solution

Start Here
Strategy Workshop
IBM Proven Methodology: A Parallel Approach

IBM's approach is tailored to deliver immediate value via a Proof of Value (POV) application as well as provide short and long-term strategic development for initiative planning and capabilities development.
How to learn more

➢ For additional information including whitepapers and demos, please visit:

➢ IBM.com Predictive Maintenance

➢ Smarter Predictive Analytics:

➢ Smarter Analytics Signature Solutions