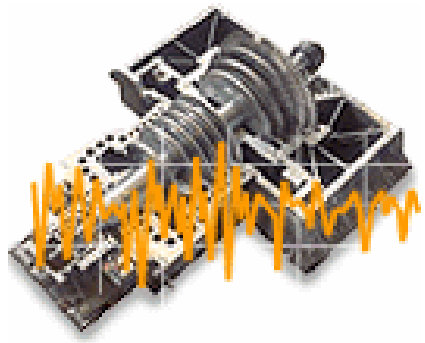
Machinery Health Monitoring and Analysis



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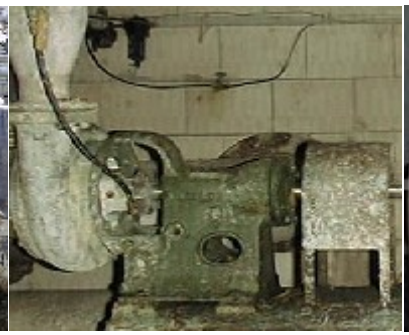
Machinery Maintenance

Mechanical equipment is the greatest source of downtime in process & utility plants


Motors


Pumps


Gearboxes


Turbines

Increases Availability and Performance at Minimized Maintenance Cost of *Mechanical Equipment*

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Machinery Condition Monitoring

“ Understanding machinery condition ensures that the right maintenance is provided at the right time”

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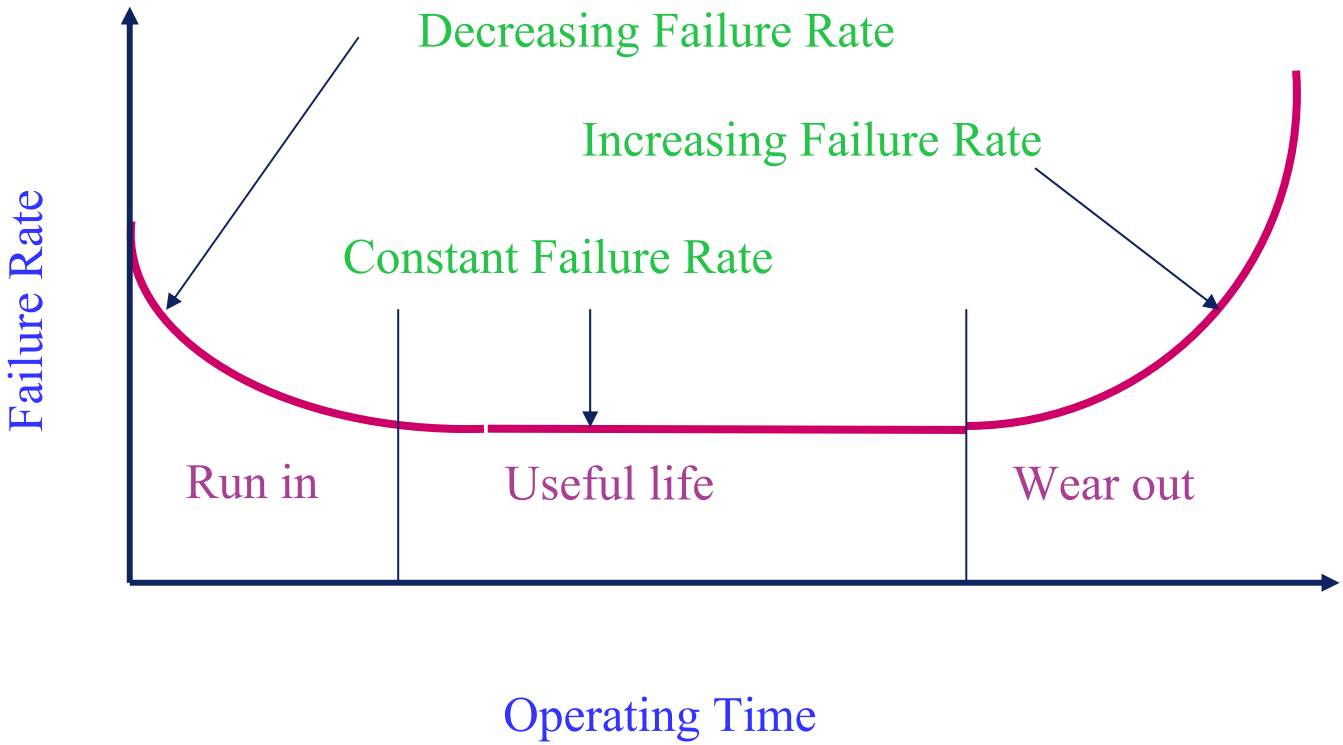
Bath Tub Curve of the Failure



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Vibration Analysis

"Of all the parameters that can be measured non-intrusively in industry today, the one containing the most information is the vibration signature."

Art Crawford

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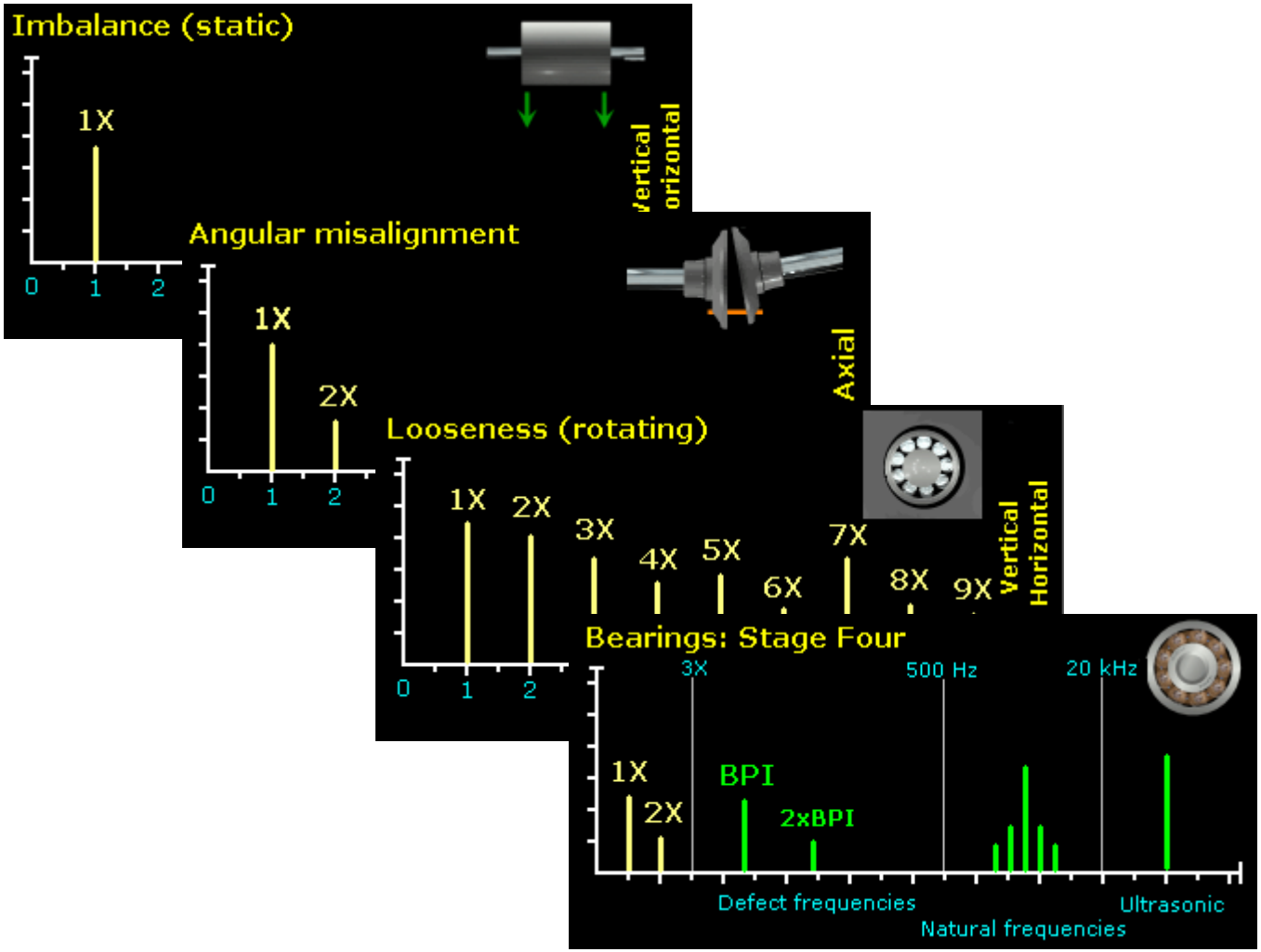
Vibration Analysis



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Diagnose Nature of Fault

Expert System

Program Documentation

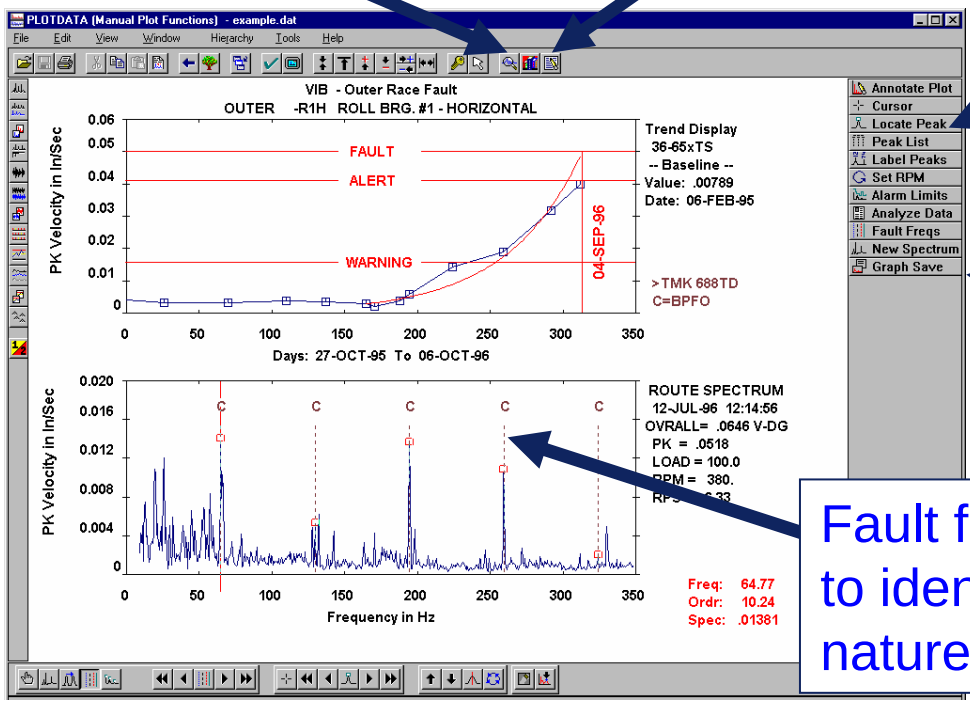
Multiple Plot Options

Multiple Analysis Options

Report Link

Fault frequencies to identify specific nature of fault

Fast Indexing



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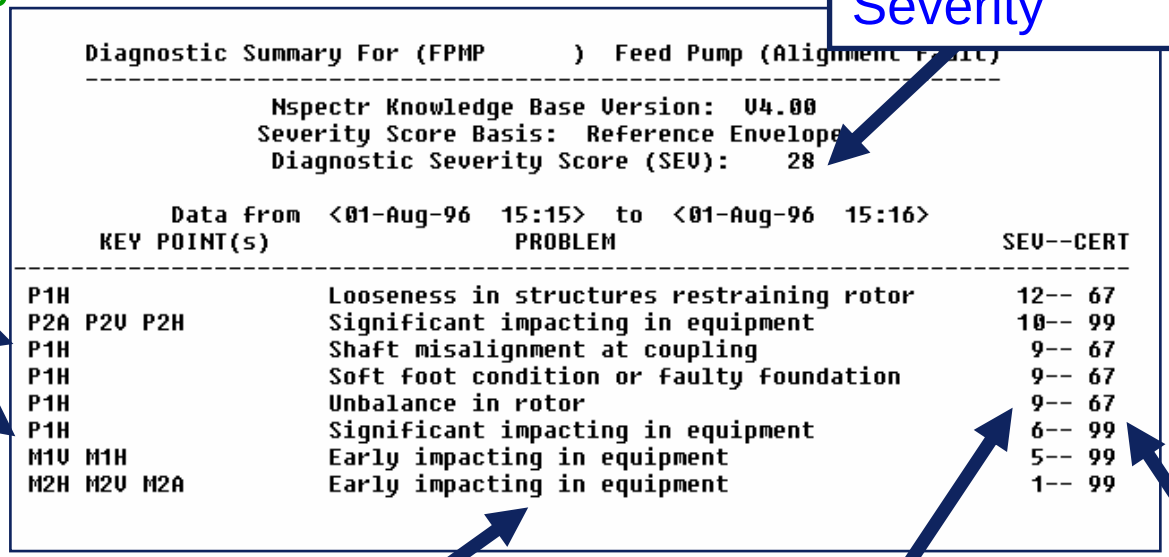
Automated Screening with Expert System

An alarm/screening report, and a first pass at analyzing machine condition



```
Diagnostic Summary For (FPMP      )  Feed Pump (Alignment Fault)
-------------------------------------------------------------

              Nspectr Knowledge Base Version:  V4.00
             Severity Score Basis:  Reference Envelope
              Diagnostic Severity Score (SEV):    28

        Data from  <01-Aug-96  15:15>  to  <01-Aug-96  15:16>
 KEY POINT(s)                  PROBLEM                          SEV--CERT
-------------------------------------------------------------------------
P1H                  Looseness in structures restraining rotor      12-- 67
P2A P2V P2H          Significant impacting in equipment             10-- 99
P1H                  Shaft misalignment at coupling                  9-- 67
P1H                  Soft foot condition or faulty foundation        9-- 67
P1H                  Unbalance in rotor                              9-- 67
P1H                  Significant impacting in equipment              6-- 99
M1V M1H              Early impacting in equipment                    5-- 99
M2H M2V M2A          Early impacting in equipment                    1-- 99
```

Calculates Overall Severity

Diagnosis Across Entire Machine Train

Multiple Diagnoses

Calculates Problem Severity

Calculates Certainty

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Software for Machinery Health Management

- Data from diverse technologies resides in one database structure
  - All personnel view the complete history for each asset
  - Technologies supported:
    - Vibration – portable and online
    - Alignment & balancing
    - Motor Diagnostics
    - Infrared Thermography
    - Lubrication analysis & Ultrasonics

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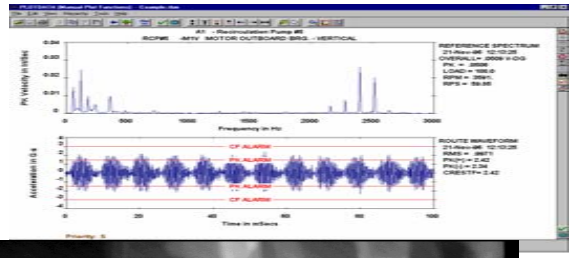
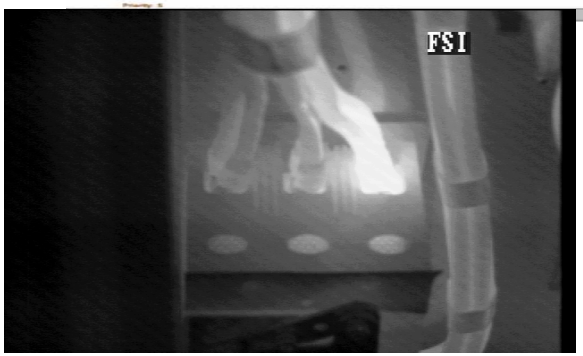
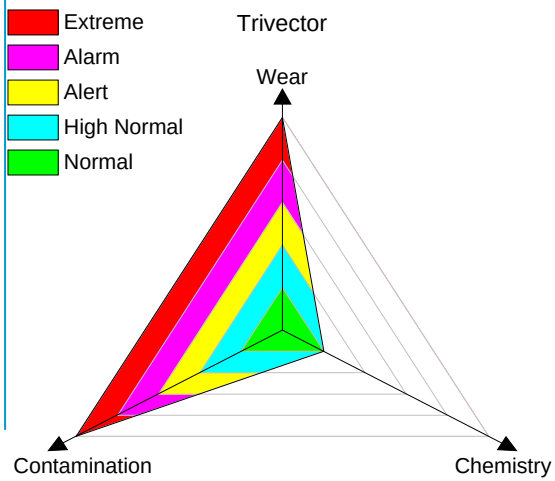
Integration







- Seven integrated technologies
- Complete asset health condition into a single database
- All diagnosis and findings under one asset in RBMview
- Why not have all of the symptoms of the equipment failure
- Know the whole story before making a recommendation

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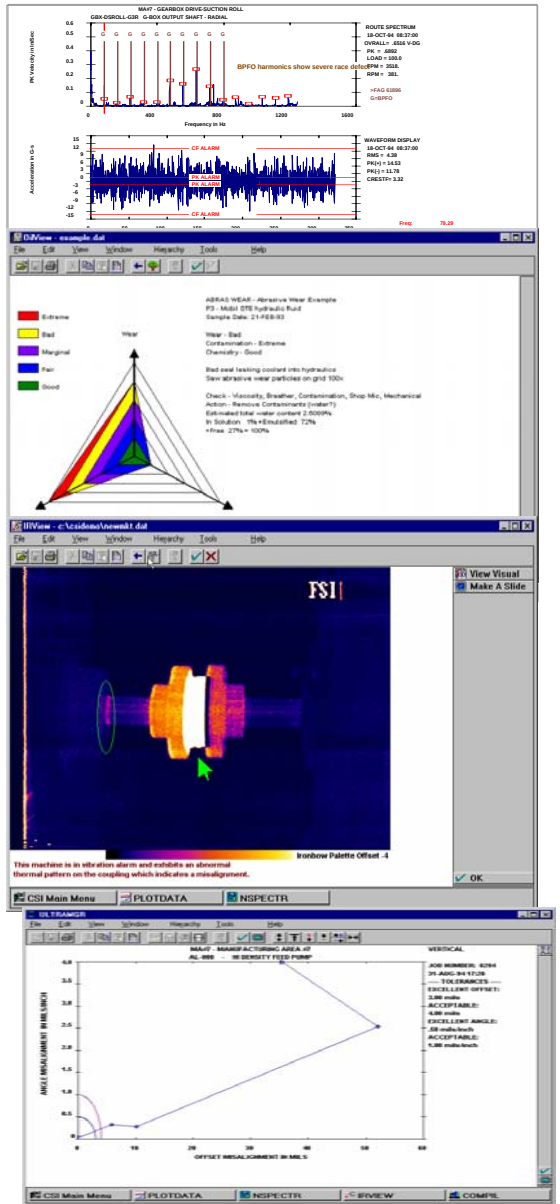
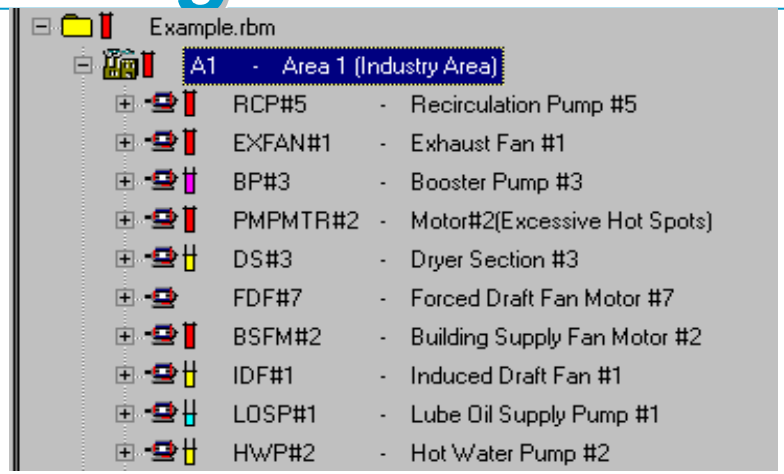
Multi-technology Analysis Tools

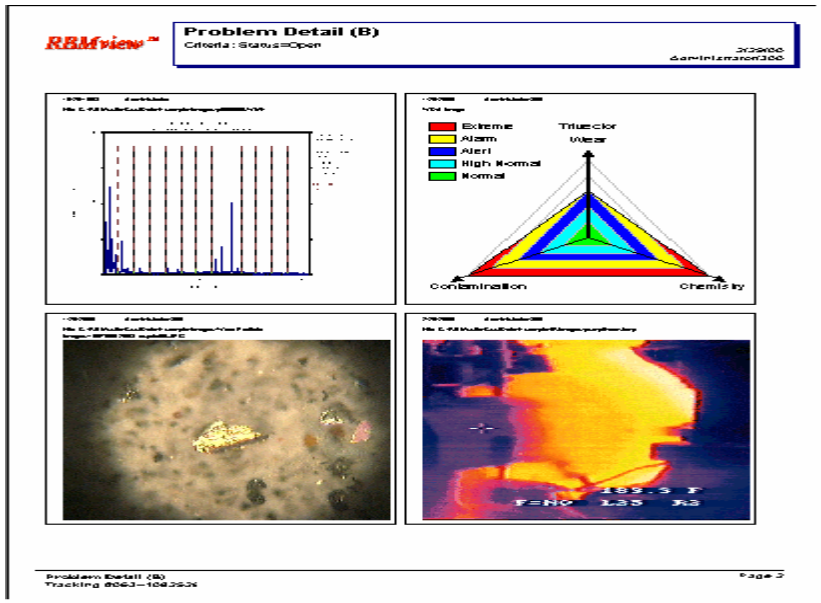
- Technology and expertise… tools for decision making
  - Vibration Analysis
    - FFT, waveform, & phase analysis
    - Automated diagnostics expertise
  - Lubrication Analysis
    - Trivector wear, chemistry, & contamination analysis
  - Electric Motor Monitoring
    - Automated rotor & stator diagnostics, using current & flux
  - Infrared Thermography
    - Palette & plot annotation tools
    - Temp profile & histogram analysis
  - Alignment & Balancing
    - Tolerance plots by the job

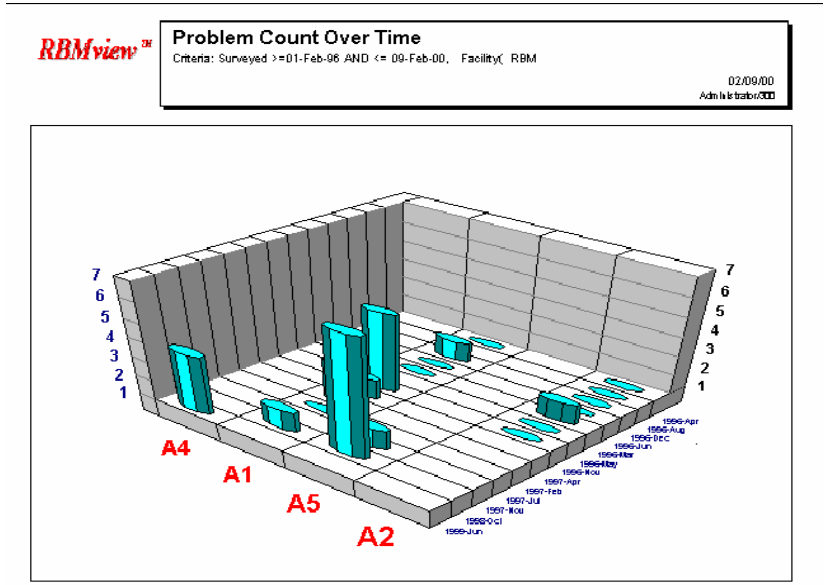


Reporting for Machinery Health Management

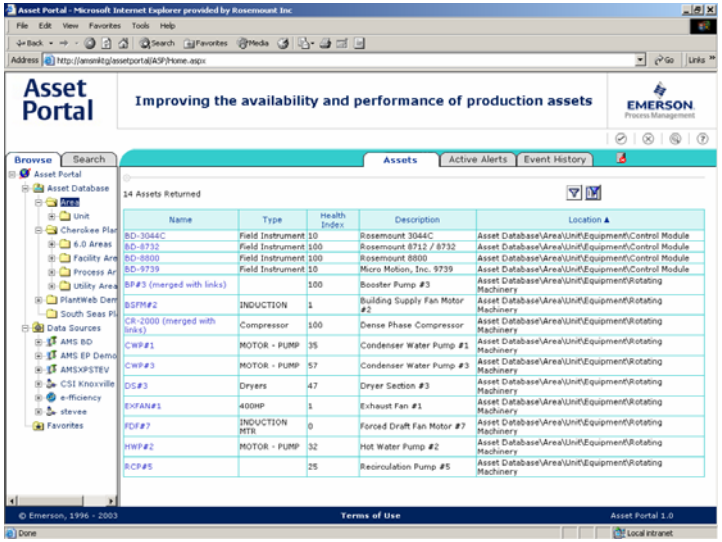
- Condition tracking and documentation
- Reporting for technician and management
- Actionable information at facility and machine level
- Multi-technology asset information repository







Application Integration and Openness



- Integration with CMMS application for automated work order generation. MAXIMO and other cmms apps.
- MIMOSA open standards alliance
- ODBC open connectivity standards
- Asset Portal Consolidates information from Machinery Health Manager, Performance Monitor, Real Time Optimizer, and Intelligent Device Manager.
  - Combines asset information from multiple plant locations
  - collects summary-level information

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Integration Conditional Monitoring (CM) with Computerized Maintenance Management System (CMMS)

- The role of **CM** is to implement a **maintenance strategy** (Predictive, Preventive or Breakdown)

- The role of **CMMS** is to manage the **execution of maintenance** (Providing tool as management of work, spares in inventory, purchasing, regulatory compliance and documentation)

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Integration Conditional Monitoring (CM) with Computerized Maintenance Management System (CMMS)

- The opportunities for new or enhanced benefits of the integration include:
  - More effective and automated implementation of maintenance strategy
  - Improved accuracy of CM analysis
  - Identification of repetitive failure for root cause analysis
  - Effective communication of machinery health throughout the enterprise

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How can these Different Systems Work Together ?

- The CM has evolved in technical wrapped around the measurement technology. In practice, CM has a well developed vocabulary and data set including these parameters:

Plant Machinery Hierarchy	Trend
Machine Priority	Spectrum
Measurement Locations	Time Waveform
Measurement Definitions	Thermographic Image
Measurement Interval	Frequency Component
Severity	Diagnosis
Alarm Status or Exception	Prognosis

How can these Different Systems Work Together ?

- The CMMS is an information intensive application, historically offering its significant benefits through gathering and distributing information about the maintenance function. CMMS has a well developed vocabulary and data set includes:

Plant Machinery Hierarchy	Parts Inventories / Costs
Work Requests / Orders	Storage Locations
Work Plans	Preventive Maintenance Actions
Work Schedules	Purchase Requests / Orders
Labor Resources / Cost	Safety Procedures

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How can these Different Systems Work Together ?

- Creating an intelligent Connection
  - It is necessary to effectively connect the shared data between these systems as the following new types of information and relationships between the systems

- Connection between the Machinery Hierarchies of the CM and CMMS
- Creation of a new CM result known as Advisory
- Creation of Work Requests based on Advisories
- A Gateway to Automate Communication between the Systems
- Tracking of Work Request within the CM System
- Display of Equipment Histories and Work Plans within the CM System

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