Equipment Reliability and Condition Monitoring

August 10, 2006

SCIENTECH

ER/CM Presentation Coverage

- **Background and Terminology**
- **ER Success Elements**
- **Key Areas of ER Initiatives**
- **Scientech's Involvement with ER & CM**

Industry Trends

- Plant Life Extension (to 60 years)
- Capacity Factors greater than 95%
- Zero Tolerance for Unanticipated Equipment Failures
- Shorter Outages
- Lower Maintenance Costs
- Schedule work greater than 26 weeks out
- Staff Reductions
- Do More with Less

Equipment Reliability & Condition Monitoring

- Not just Nuclear related initiatives
- Applies to Fossil Industry as well
- Applicable to all production industries
- Key elements to asset optimization efforts
- Focus on equipment and processes

ER & CM Drivers

- Sustained operational performance
- Improved availability
- Positive financial performance
- Increasing production effectiveness
- Minimizing unplanned and unexpected maintenance
- INPO AP-913 and NEI 940 Guidelines

Equipment Reliability Focus Items

- Delivering corporate value
- Breaking down departmental barriers
- Leveraging best practices across the enterprise
- Delivering predictable and sustained production
- Understanding past failures and successes
- Rigorous analysis & evaluation to define strategies
- Continuous Improvement

ER Definition

- **Equipment reliability –** a process that represents the integration and coordination of a broad range of equipment reliability activities into one process for plant personnel to evaluate important station equipment, develop and implement long-term equipment health plans, monitor equipment performance, and make continuing adjustments to preventive maintenance tasks and frequencies based on equipment operating experience. This process includes activities normally associated with such programs as reliability-centered maintenance (RCM), preventive maintenance (periodic, predictive, and planned), Maintenance Rule, surveillance and testing, and equipment performance monitoring. **INPO Definition*

Terminology – Definitions

- **Condition Monitoring (CM) –** The process of data and information collection incorporating alarming features in support of identifying anomalies and determining the health of equipment.

- **Condition Based Maintenance (CBM) –** The process of performing equipment maintenance based upon degrading performance and/or change in acceptable condition of the equipment item rather than on a reactive (failure) condition or preventive (time-based) condition; Doing required maintenance at the right time.

Equipment Reliability Defined

INPO View[1]

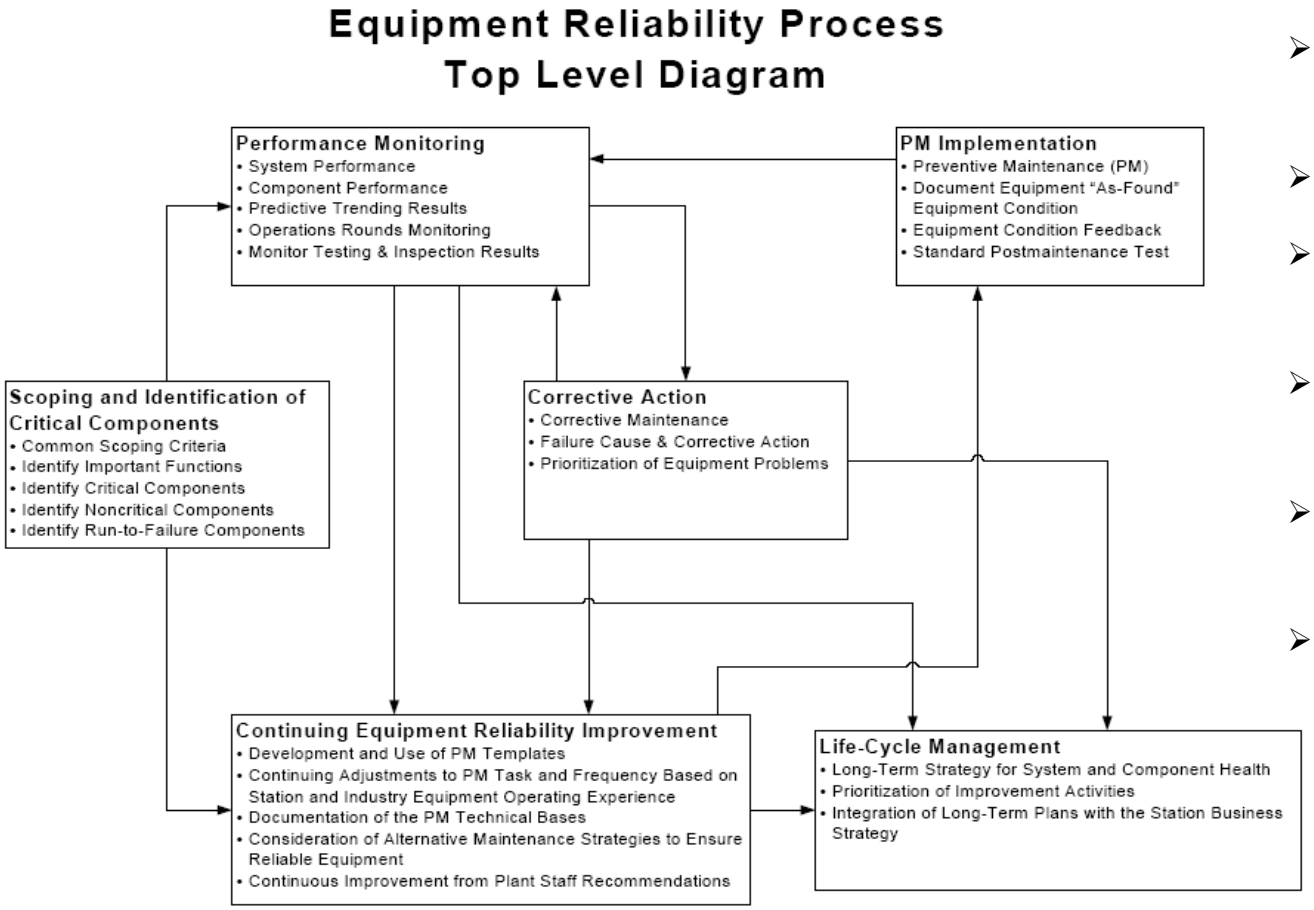
- ER encompasses and binds existing functions and programs into a single process.
- The ER Process integrates plant activities like Performance Monitoring and Corrective Action, Preventive Maintenance, Long-Term Planning and others.
- The integrated ER Process focuses the efforts of the organization on the theme of – reliability of plant equipment.

ER intended to support top level objectives

- Improve plant capacity (capacity and capacity factor), reliability, and availability
- Achieve maximum plant useful life

[1] *From EPRI Destinations /D2004*

INPO View of Equipment Reliability



- **Performance Monitoring**
- **PM Implementation**
- **Scoping & Identification**
- **Continuing ER Improvement**
- **Life-Cycle Management**
- **Corrective Action**

The Complexity of Equipment Reliability

- Higher expectations on everyone
- Less or decreasing manpower
- Intolerance for unanticipated equipment failures
- Need for immediate data acquisition
- Need to predict degradation as early as possible
- Many sources of component & system information
- Many databases to access
- Need for real-time performance indicators

Complexity to Manageability

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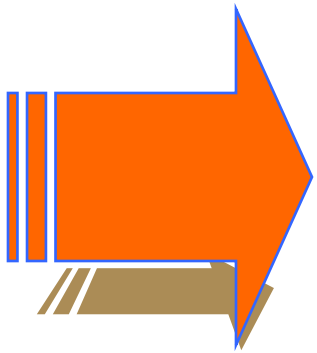


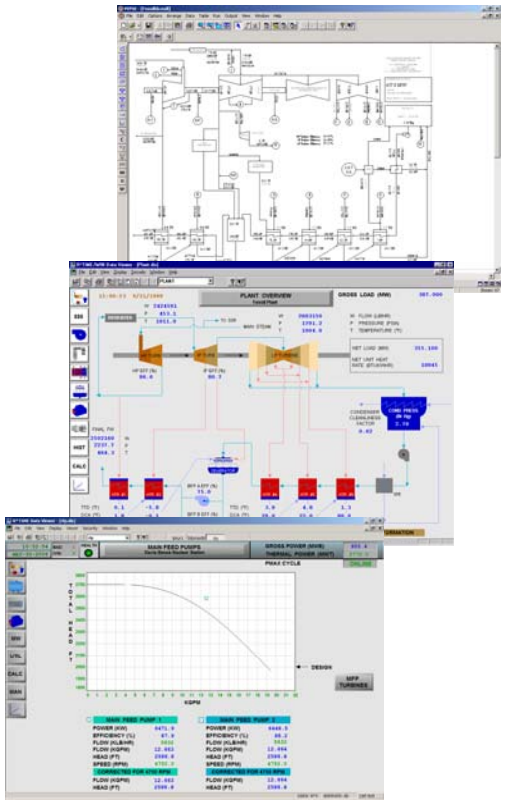
- **Optimized Processes**
- **Automated Tools**
- **Application Integration**

Key Areas of ER/CM Initiatives

- Culture Change
- Process Improvements
- Optimized Maintenance Practices
- **Effective Equipment Condition Monitoring**
- **Supportive Tools and Applications**
- **Real-Time Communications**

Effective Equipment Condition Monitoring

- Types:
  - Performance
  - Condition
  - Predictive
  - Real-time / Periodic, On-line / Off-line
- Expectations:
  - Identify condition changes
  - Provide early warnings
  - Clarify fault development
  - Provide diagnostic assessment
  - Direction to problem mitigation



Successful Equipment Condition Monitoring

- Able to detect the indicators and inducers of degradation
- Able to provide diagnostic knowledge of the degradation condition
- Able to detect degradation rate of change at early enough stage to predict risk and manage corrective measures
- Able to provide insight to mitigate the developing problem

Supportive Tools and Applications

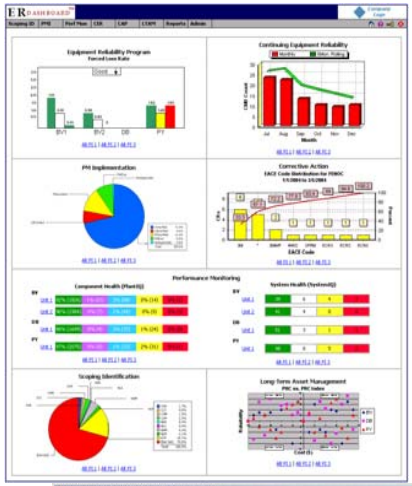
- Types:
  - Real-time / On-line / Off-line
  - Information vs. Data presentation
  - Process coordination
  - Analytical, diagnostic, prognostic
- Expectations:
  - Adds value
  - Improves efficiency
  - Easy to use
  - Provides notifications
  - Turns data into information - information into knowledge

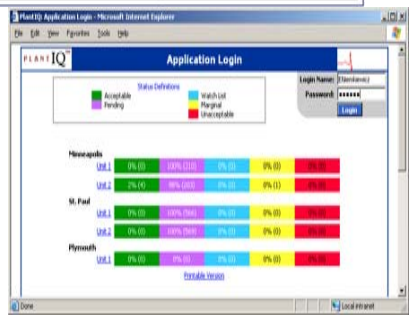
Value of Implemented Tools/Applications

- Increases knowledge and information dissemination capabilities
- Facilitates standardization
- When integrated, improves efficiencies and overall effectiveness of efforts
- Improves process optimization
- Typically produces very positive ROI

Real-Time Communications

- Focus:
  - Live status updates
  - Linked information
  - Commonality of information
  - Timely notifications
  - Easy accessibility
- Types:
  - Web-applications
  - Dashboards
  - Integrated on-line reports
  - HTML reporting/messaging





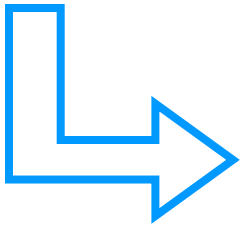
Benefits of Real-Time Communications

- Improves analytical & diagnostic process capabilities
- Enhances information & knowledge processing
- Provides timely insight
- Facilitates management of expectations
- Supports efficient risk assessment decision abilities

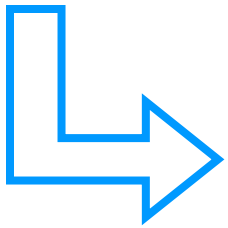
Information Integration

- **To facilitate real-time communications information integration is essential.**

Integrated Applications

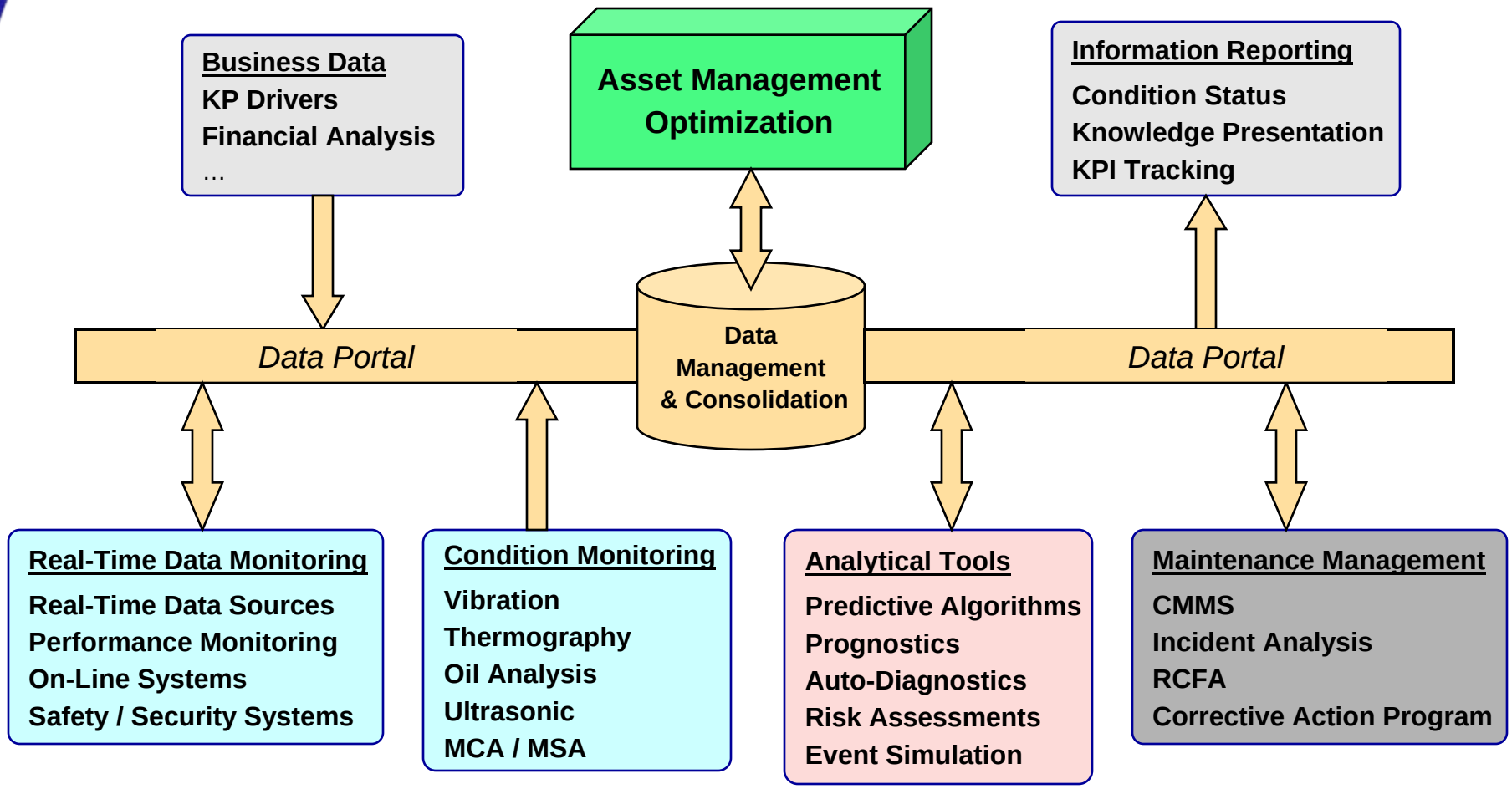


Integrated Information



Integrated Knowledge

Approach to Information Management



Key Equipment Reliability Solution Tools

- **Efficient data historian** - **R*TIME**
- **Performance monitoring** - **PMAX**
- **Condition monitoring w diagnostics** - **CMAX**
- **Advanced pattern/predictive recognition** - **PdP/SSA**
- **Plant performance assessment** - **PEPSE**
- **RCM analysis & process** - **RCM Workstation**
- **Risk Assessment and Modeling** - **Safety-Monitor**
- **Status reporting** - **IKS~PlantIQ**
- **KPI & Financial tracking** - **IKS~Dashboard**
- **Integrated On-Line & Off-line condition monitoring / PdM systems & applications**
- **Utilized Computerized Maintenance Management System**

Total Condition Assessment

Thermal Performance Monitoring

+

Condition Monitoring w Diagnostics

+

Predictive Pattern Recognition

+

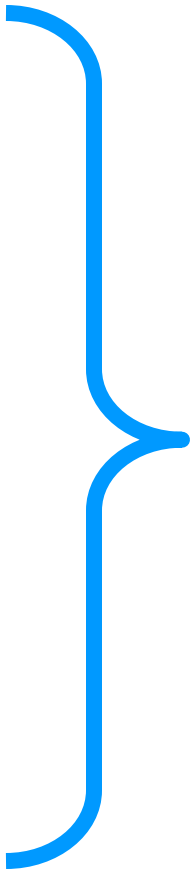
Plant Performance Assessment

+

Risk Assessment

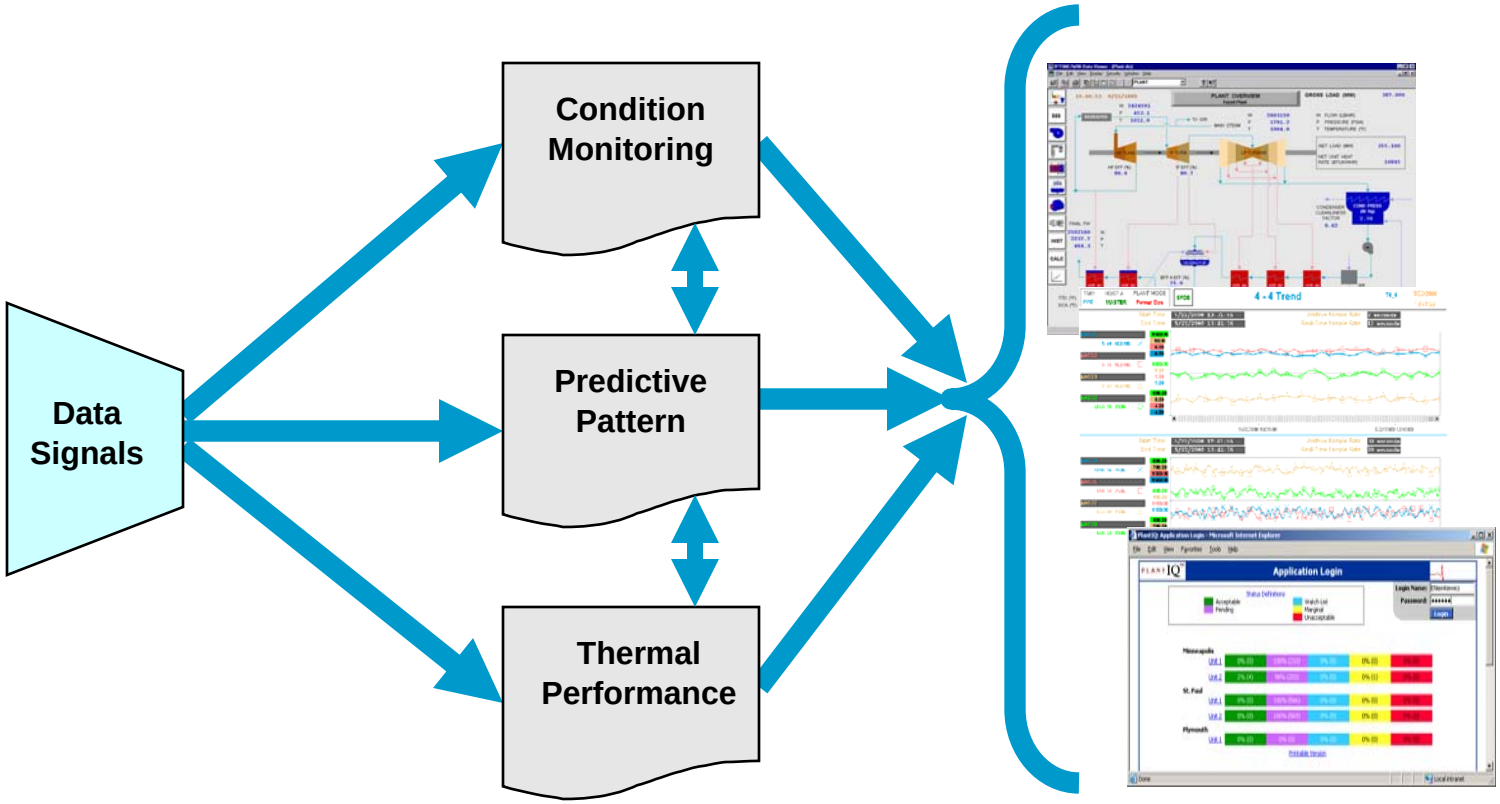
+

PdM Technologies

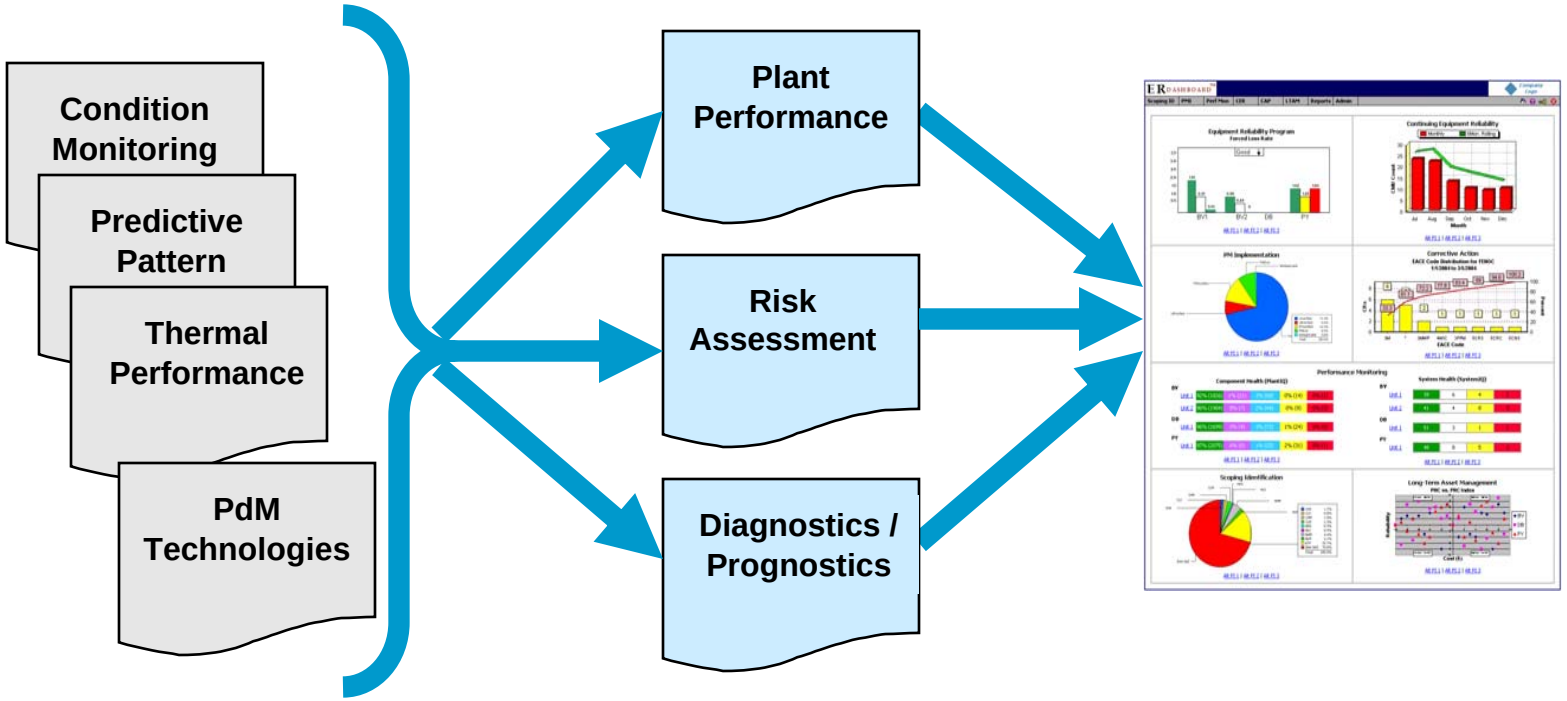


Total Condition Assessment

Real-Time Integration



Real-Time Integration



New Developments

Thermal Performance Monitoring

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* **Condition Monitoring** **w Diagnostics**

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* **Predictive Pattern Recognition**

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Plant Performance Assessment

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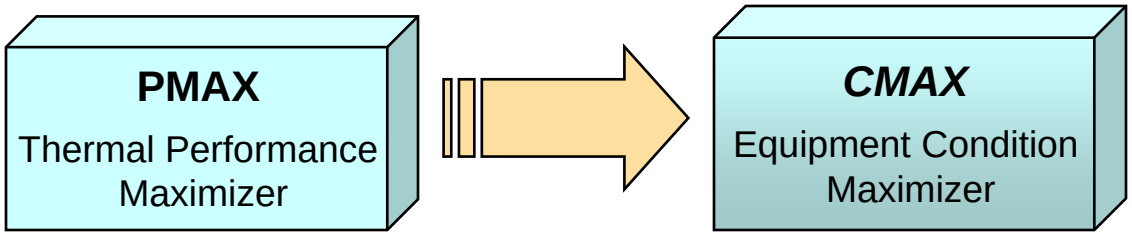
Risk Assessment

+

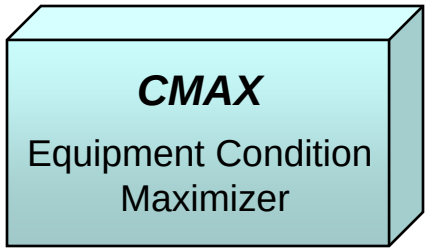
PdM Technologies

CMAX = Condition Maximizer



- Focus on systems and equipment components
- Utilizes same input medium, data processing, calc engine, alarming features, Viewer, and imbedded reporting tools
- Calc rules based upon system functions & dynamic performance
- Takes advantage of the IVM and What-If capabilities
- Integrates with PMAX, PEPSE, and PdP information for more thorough condition assessment information

CMAX Attributes



Maximizes and collaborates on-line monitoring systems

Utilizes same modeling structure as PMAX

Utilizes Advanced Pattern Recognition and Predictive Algorithms

Primary inputs include:

- Process data
- Vibrations & Dynamics data
- PdM technology results information
- Performance information

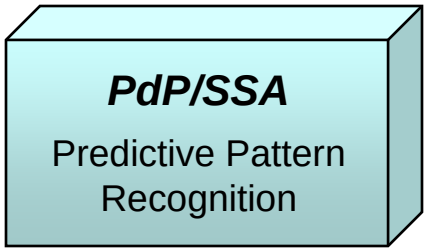
Outputs include:

- Overall condition status indications
- Condition Assessment
- Data plots & drill down
- Sensor integrity information
- Reports

PdP = Predictive Pattern Recognition

- Focus on systems and equipment components
- Optimizes plant process data handling
- Models based upon system & component types
- Utilizes same inputs and IVM technology
- Incorporates operating state determination for improved model monitoring results
- Integrates with CMAX and PMAX applications for more thorough condition and risk assessment information

PdP Attributes



Adaptable to all plant systems & components

Models based upon operating state for improved problem identification

Utilizes pre-configured system/component models

Built in logic-tree analysis

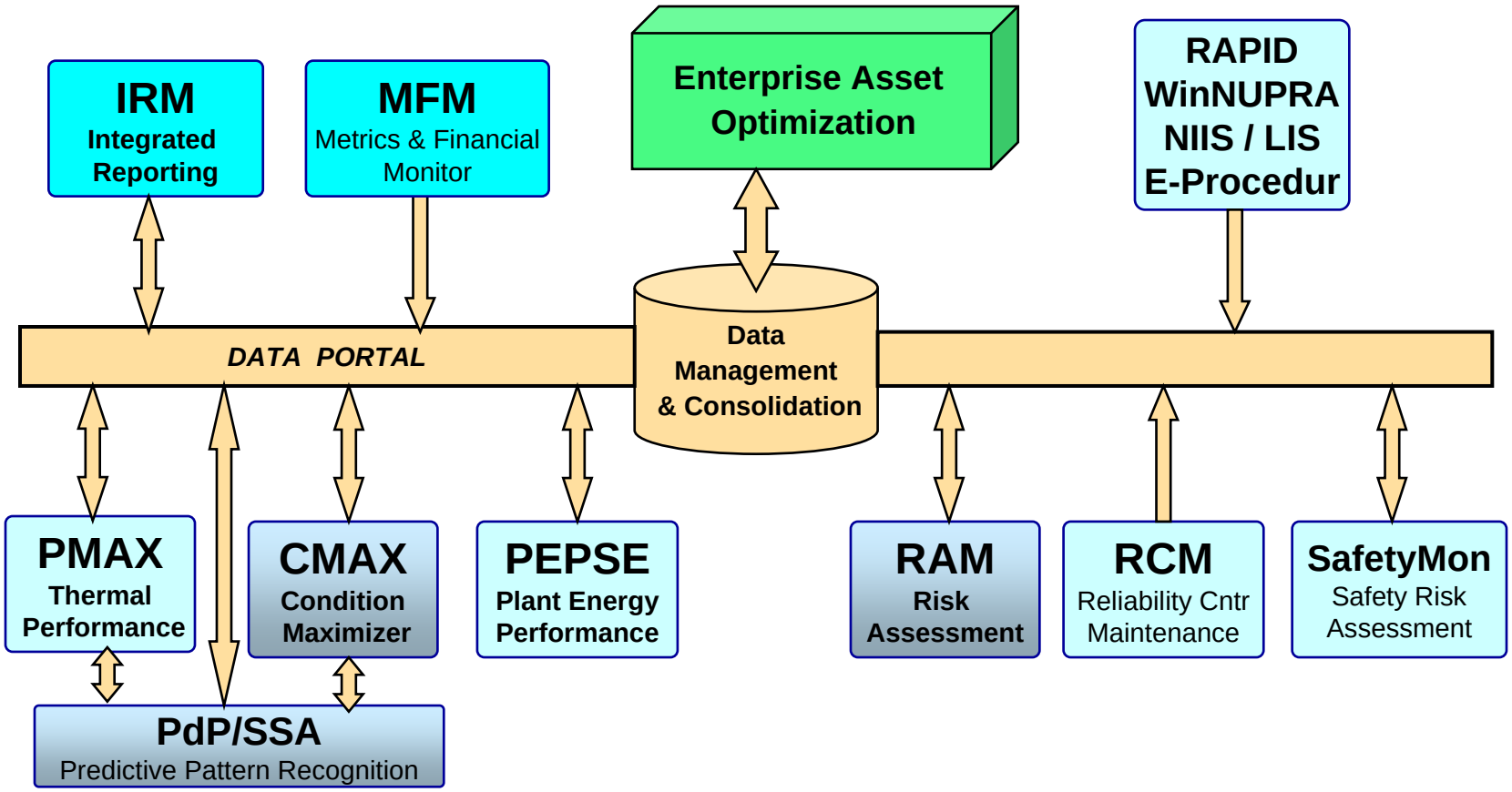
Primary inputs include:

- Process data
- Other real-time data sources

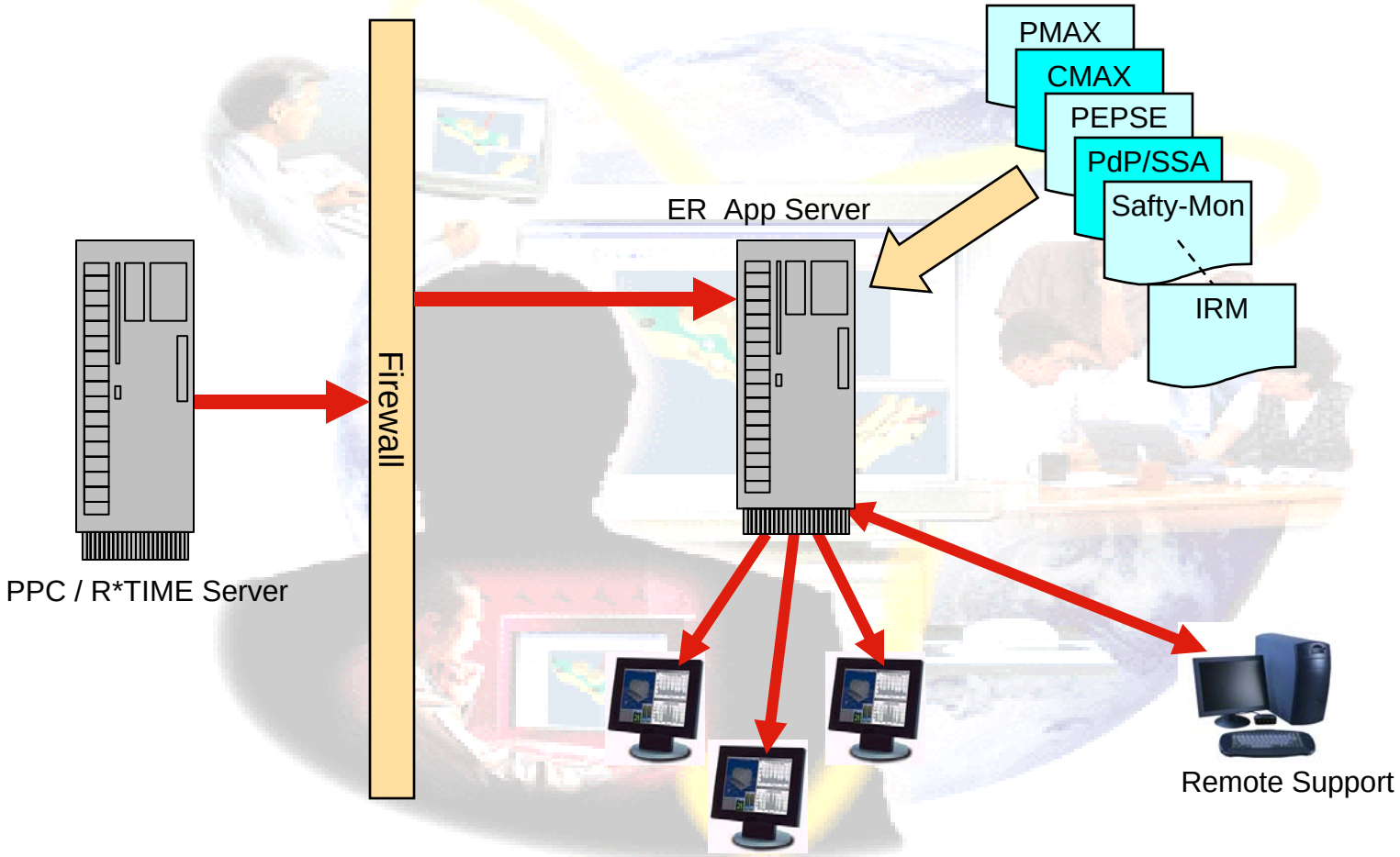
Outputs include:

- Acceptable / Unacceptable status indicators
- Data plots and drill down
- Sensor integrity information
- Condition prediction analysis
- Reports

Scientech's Information Management



Application Handling



Scientech's Condition Monitoring Solution

Thermal Performance Monitoring -*PMAX*

+

Condition Monitoring w Diagnostics -*CMAX*

+

Predictive Pattern Recognition -*PdP*

+

Plant Performance Assessment -*PEPSE*

+

Risk Assessment -*Safety Monitor*

+

PdM Technologies

Total Condition Assessment

Scientech's ER/CM Focus

Key Focus Areas:

- **Effective Equipment Condition Monitoring**
- **Supportive Tools and Applications**
- **Real-Time Communications**

Tools

- Advanced CM Applications & Programs
- Diagnostic & predictive capabilities
- Technology Integration
- Additional IT Supporting tools

Support

- Reliability Engineering Consulting
- Program Developments
- CM/PdM/CBM Application Strategy
- Onsite/Remote Data Review & Analysis

Summary - Scientech's ER Solution Focus

- **Provide Tools and Services That Best Address the Client's Needs**
- **Enhance Existing Monitoring Applications**
- **Provide Condition and Predictive Applications**
- **Incorporate Best in Industry Missing Elements**
- ***Be a Key Provider in the ER/CM Market***

Continued success is the result of continued improvement.

Questions?