



Mark Bitto / ABB Inc / PSPG / CIBO Technical Focus Group / June 2015

Instrumented and Actuated Systems Condition Monitoring of Rotating Equipment



Condition monitoring of rotating equipment

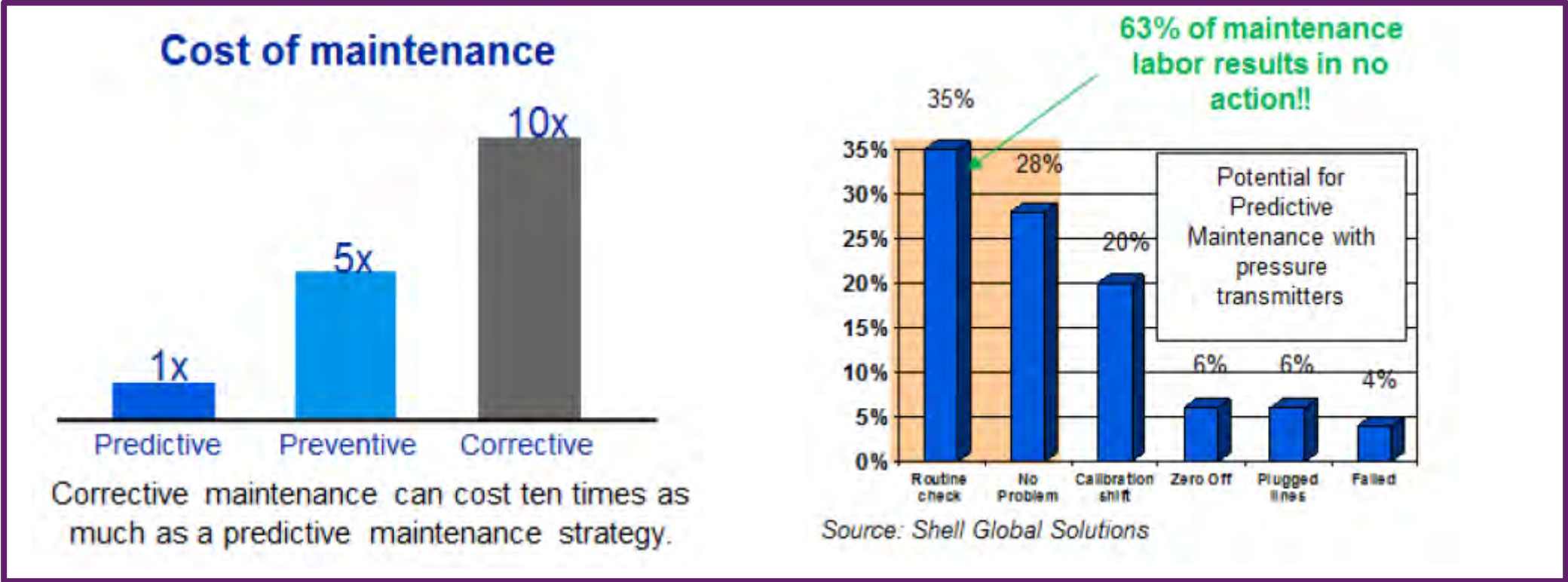
About the speaker



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Condition monitoring of rotating equipment

Asset management and optimization



- Wealth of plant data used to identify and alert on degrading asset performance before failure occurs
- All asset levels: field devices, process / electrical / environmental equipment, control loops, power supplies, communication and network equipment, etc.
- Moves maintenance from corrective maintenance program to proactive or predictive maintenance program

Condition monitoring of rotating equipment

Why is it important?



Measurement of vibration levels can detect degrading performance -- The greater the vibration, the less the "smoothness," and the greater the potential for equipment failure or unplanned shutdown



- Rotating machines are the backbone of nearly all major plant operations
 - Steam and gas turbines
 - Motors
 - Generators
 - Agitators
 - Fans, pumps and compressor systems
- Modern reliability studies show that nearly 66% of all machine failures occur randomly – *with early but often undetected warning signs*

Condition monitoring of rotating equipment

Vibration related machine problems: Causes



Consequences

- Catastrophic machine failure
- Parts fatigue failure
- Loss of efficiency & production quality
- Human safety factors: annoyance, injury, death

- **Function:** Machine has moving components which are subject to forces due to dynamics of motion: rotation, cyclic motions, impacts
- **Inadequate design:** Machine elements and surfaces are not designed to deal with functional forces, and the resulting non-functional motions are of larger amplitude than desired/designed
- **Manufacturing processes:** Machine surfaces and parts are not made according to spec and/or required tolerances, allowing for either too loose or too tight fits, contributing to rubs, impacts, etc.
- **Installation:** Many opportunities during installation to create poor vibration scenarios: misalignment of train elements (motor/fan or motor/pump), misalignment of bearings and couplings, loose foundations and bolting to foundation, faulty component application
- ***Wear and Abuse: Typically due to poor maintenance practices, not solving issues, not monitoring for problems***
- ***Operational maintenance: Reactive maintenance strategy, run to failure, inappropriate routine & periodic maintenance, creating long-term problems with components***

Condition monitoring of rotating equipment

Relation between vibration and bearing life

Impact of Vibration Reduction on Bearing Life
 (Assuming Dynamic Load is the Major Force Component)

% Reduction in Vibration	% Increase in Bearing Life	
	Ball Bearings	Other Rolling Element Bearings
5	17	19
10	37	42
15	63	72
20	95	110
25	137	161
30	192	228
40	363	449
50	700	908

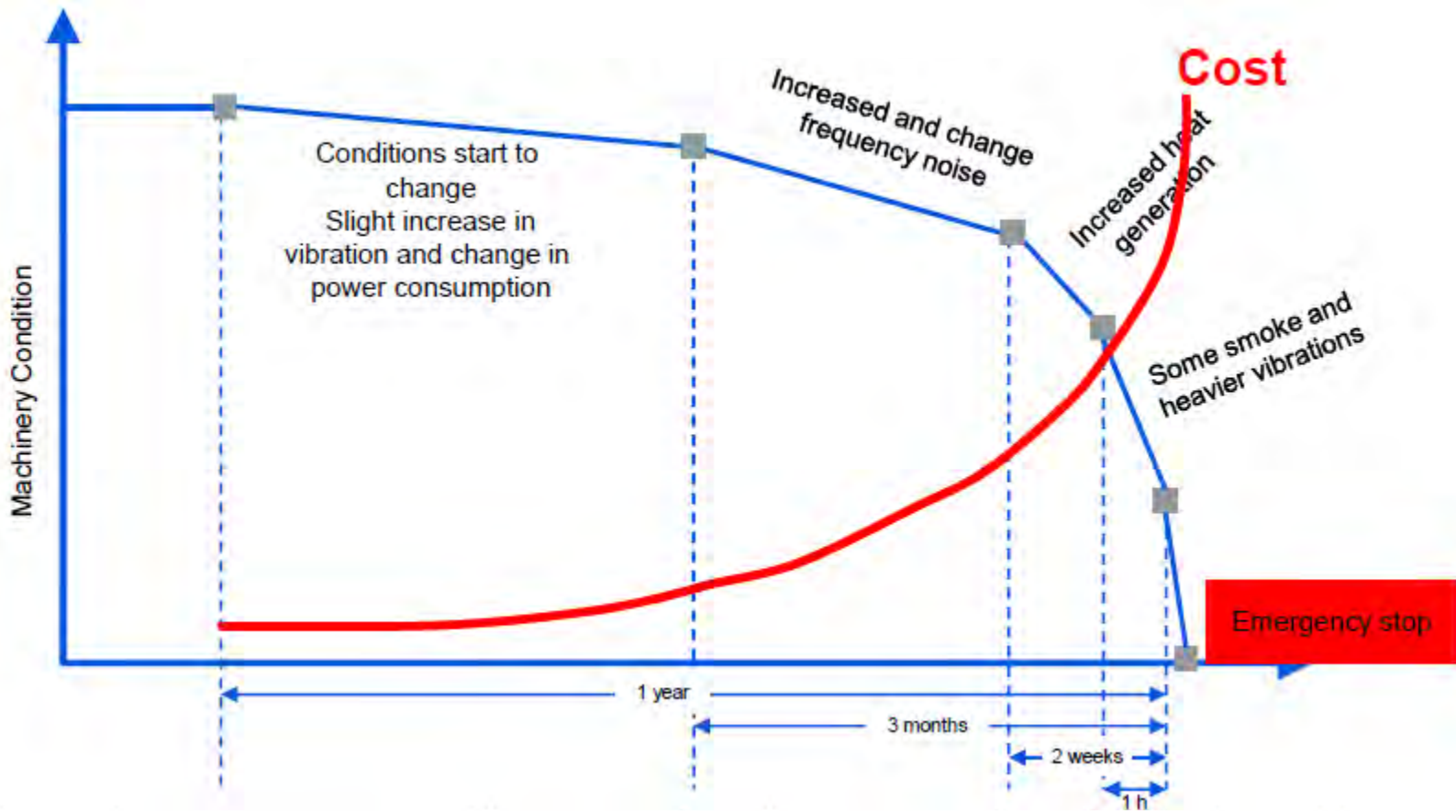
Source: L. Douglas Berry, Vibration Versus Bearing Life, Reliability, Vol. 2, Issue 4, November 1995



Condition monitoring of rotating equipment

Realizing the value of a proactive / predictive maintenance strategy

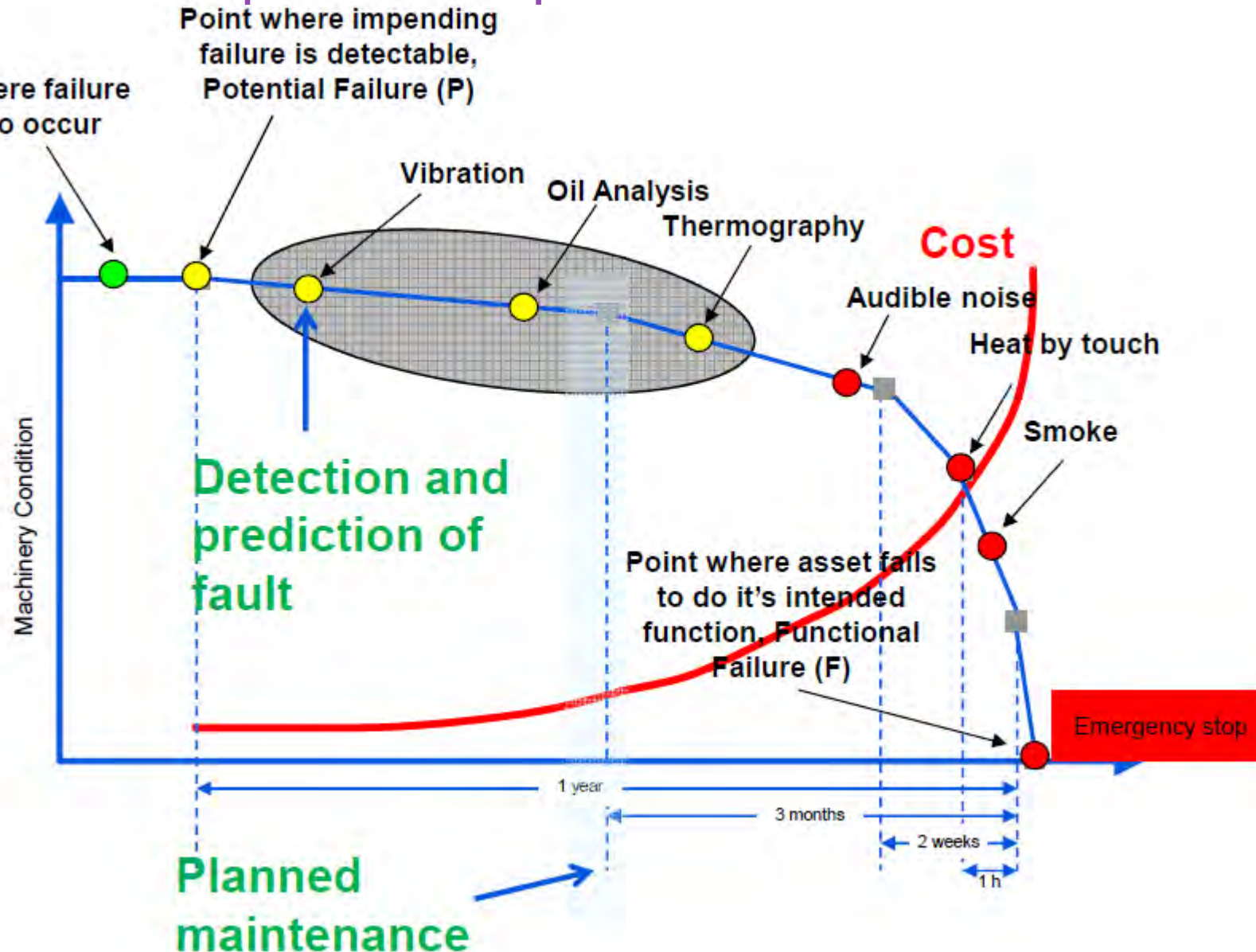
An active maintenance strategy with structured work process and modern tools enables early fault detections, reduces costs and avoids expensive breakdowns



Condition monitoring of rotating equipment

Realizing the value of a proactive / predictive maintenance strategy

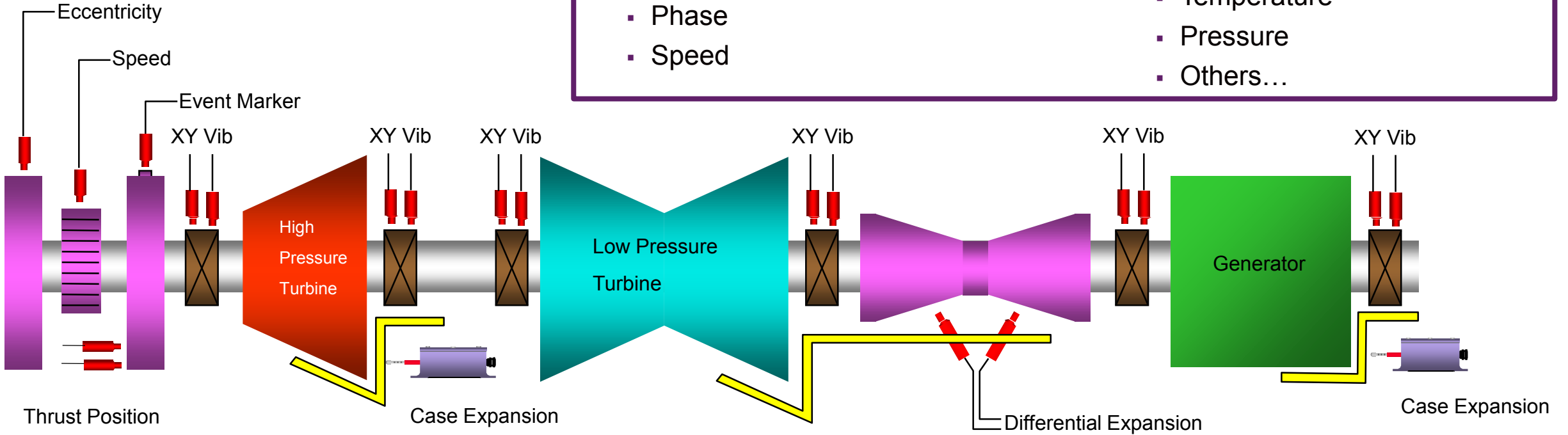
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Condition monitoring of rotating equipment

Major measurement categories

- Major measurement categories:
 - Motion (vibration, eccentricity)
 - Position (thrust, rotor position, differential expansion, case expansion)
 - Phase
 - Speed
- Process parameters:
 - Load
 - Flow
 - Valve position
 - Temperature
 - Pressure
 - Others...

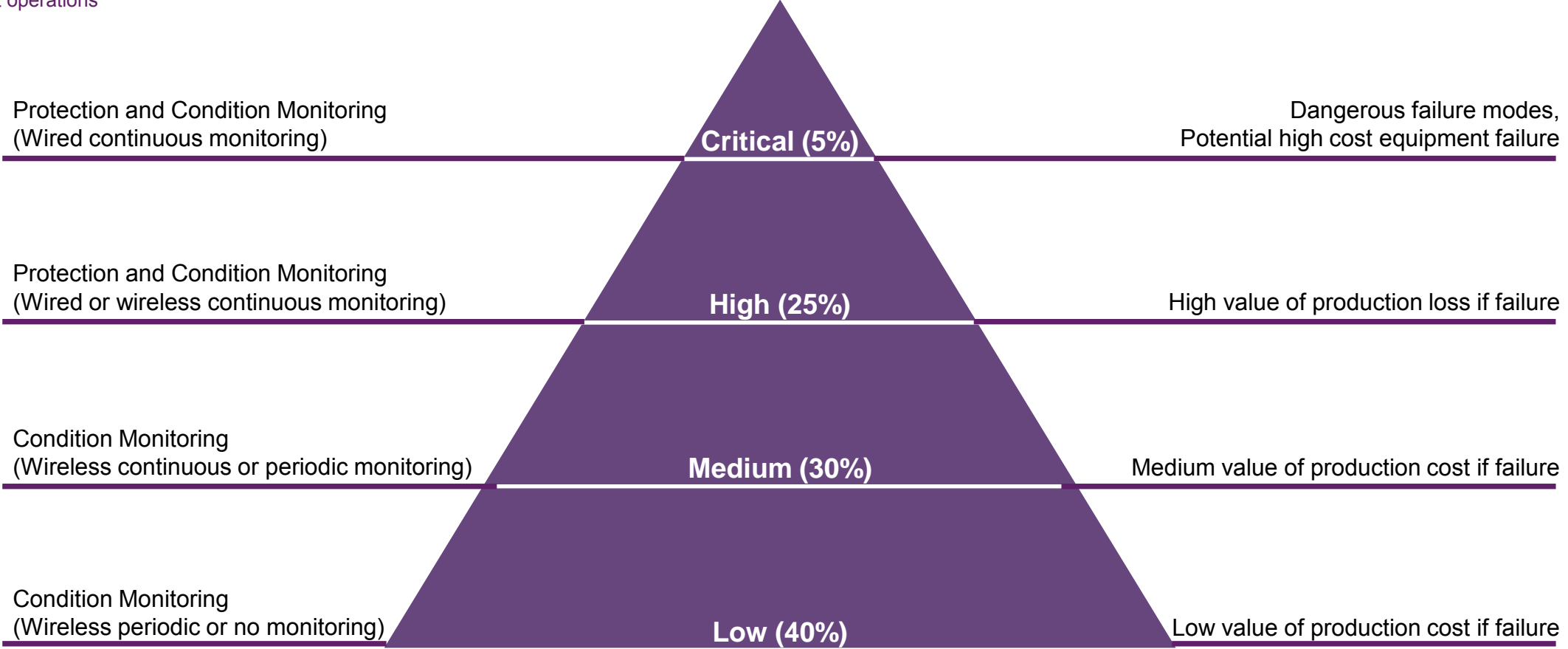


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Prioritizing asset management focus

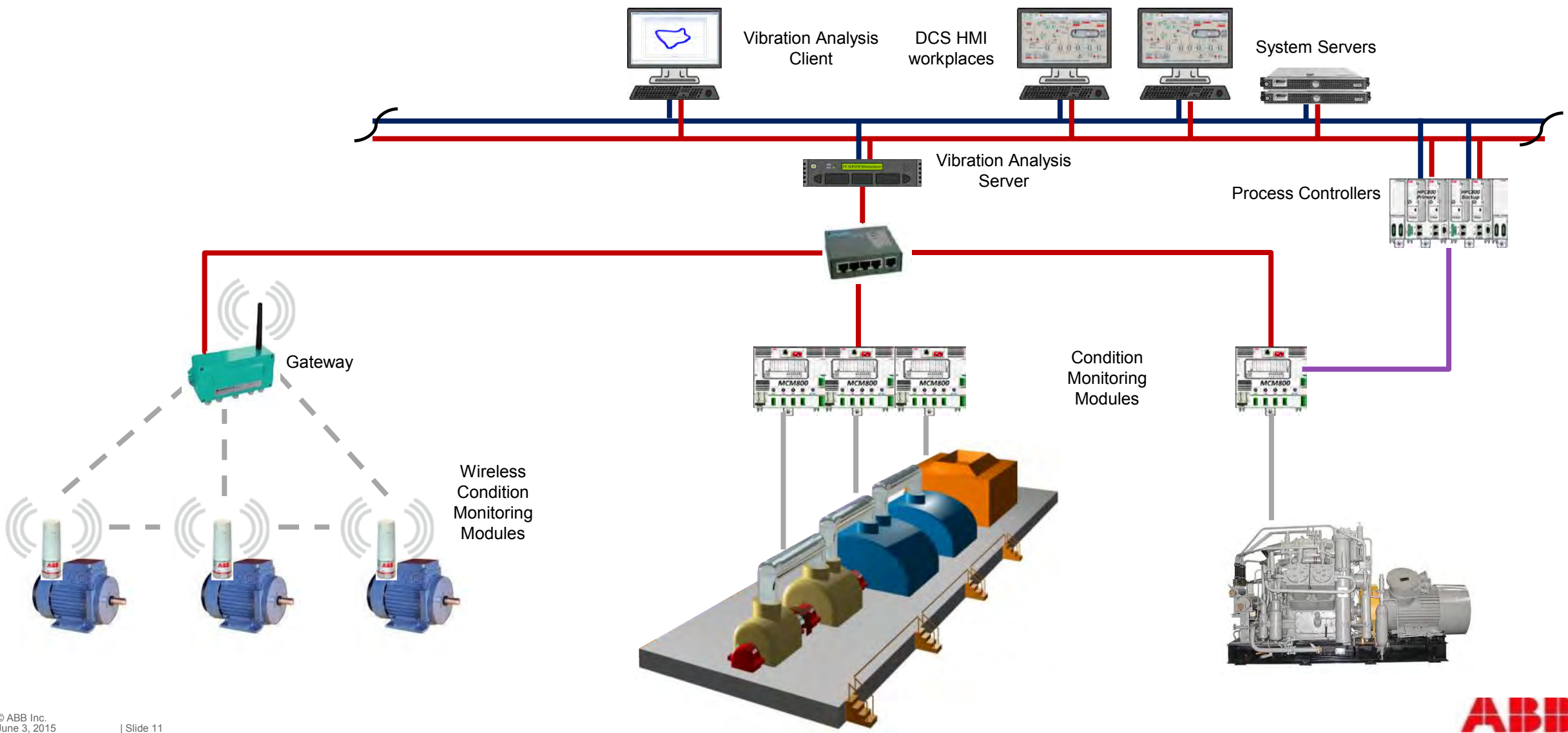
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Asset categorization



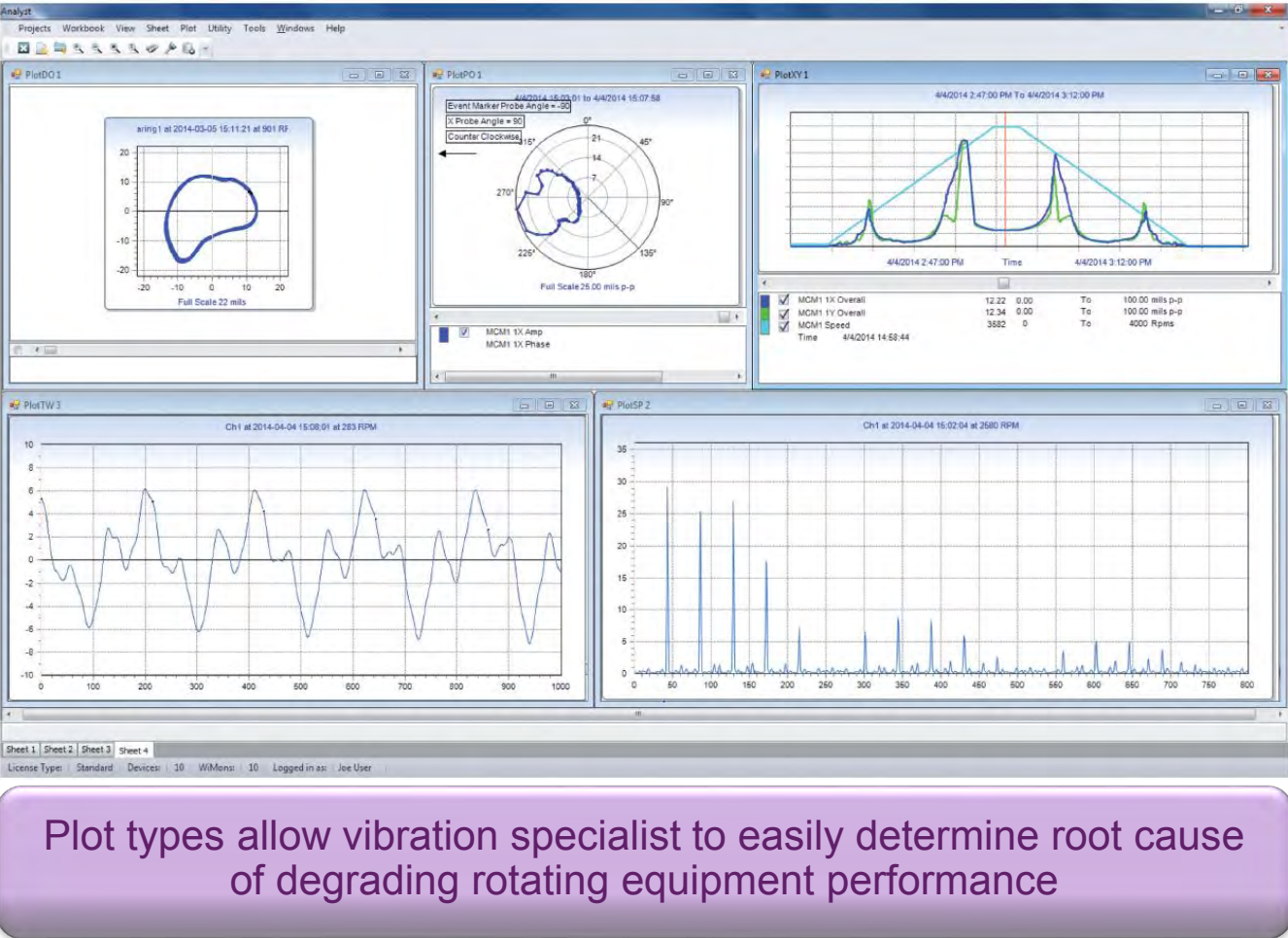
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System overview



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Vibration analysis



- Displays the waveform data and process variables in variety of plot types

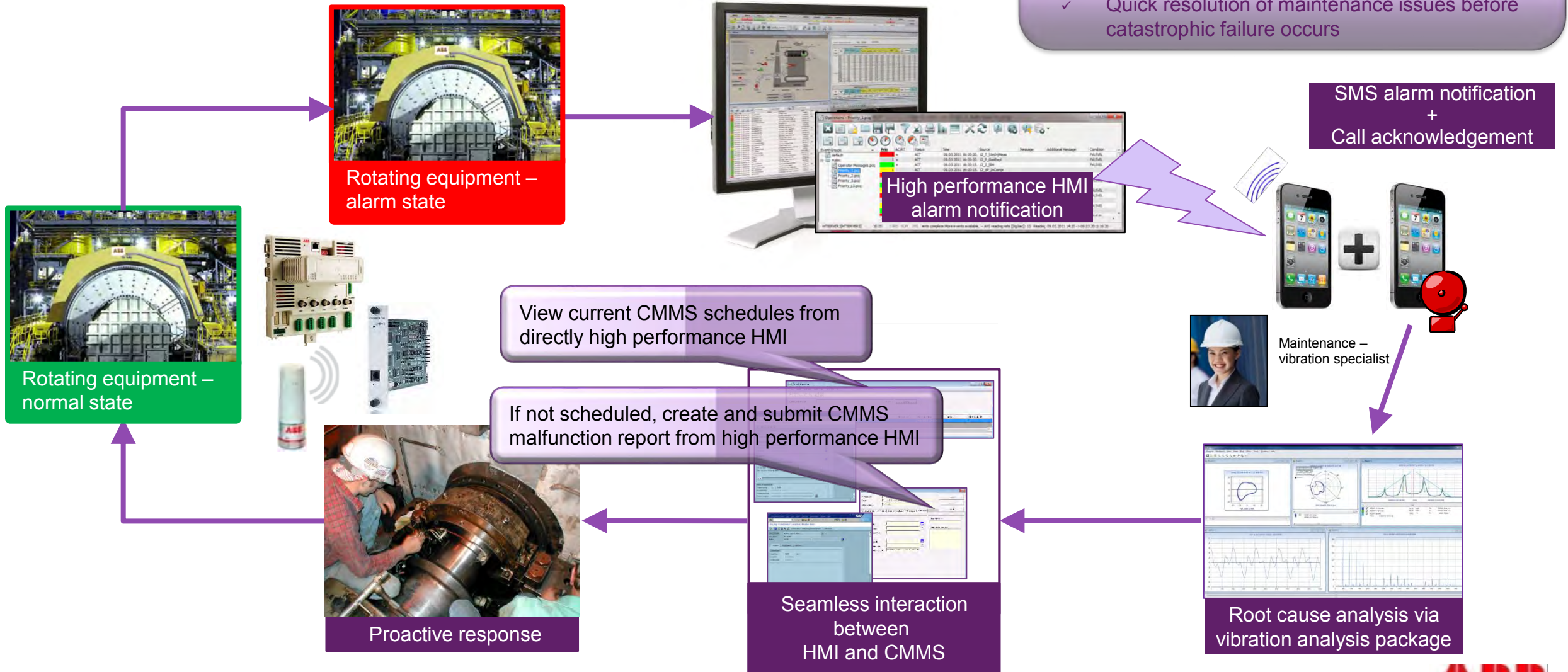
Process variables	High-precision waveform data
X - Y plot	Time waveform
Bode plot	Direct orbit
Polar plot	Direct time waveform
Polar + trend plot	(Full) spectrum
Filtered orbit plot	(Full) cascade
Shaft centerline plot	

- Monitor current condition of the equipment
- Compare present and past conditions to assist in predicting potential risks and failures, and preparing for schedule outages
- Allow configuration of the vibration modules prior to equipment operation

Condition Monitoring of Rotating Equipment

Streamlined proactive remediation work process

- ✓ Predictive condition alarming
- ✓ SMS alarm notification with remote users
- ✓ Detailed root cause analysis
- ✓ Easy communication with and navigation to asset specific CMMS activities
- ✓ Quick resolution of maintenance issues before catastrophic failure occurs



Condition monitoring of rotating equipment

Summary



- Improves operation by using proactive rather than reactive maintenance
- Reduces annual maintenance costs by minimizing scheduled (but not required) maintenance practices
- Continuous on-line performance monitoring eliminates production losses due to unplanned outages
- Extends the life of rotating equipment by identifying performance degradation early (before costly replacement or service required)
- Minimizes safety events due to catastrophic failures
- Integration with DCS increases awareness of performance issues and streamlines the remediation process

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