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The Case for Condition Monitoring

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Manufacturers in the process industries as well as those in traditional discrete manufacturing (production of distinct items such as automobiles, furniture, toys, and airplanes) can greatly benefit from implementing condition monitoring (CM) programs for critical and essential assets - where the cause and timing of failure is unpredictable and downtime occurs randomly. As machinery and manufacturing processes increase in cost and complexity, the case for conditioning monitoring can be more easily justified.

Condition monitoring is typically implemented to save money but data suggests it can also increase productivity/availability and therefore also positively affect profitability.

Maintenance Strategies

In maintenance circles, there are four widely accepted strategies available for maintaining the wide variety of equipment installed in most plants.

Maintenance strategies are classified into these four general types: 1. Reactive (run-to-failure), 2. Preventative Maintenance (PM), 3. Predictive Maintenance (PdM) and 4. Reliability Centered Maintenance (RCM).

1. **Reactive** is a common approach to equipment maintenance for many plant assets. For assets with an extremely low probability of failure, are non-critical, pose no health or environmental concerns and are spared, this may be the appropriate approach and can help control maintenance costs.
2. **Preventative Maintenance** - For more failure-prone assets, plants traditionally have employed a preventative maintenance approach (or time based maintenance). PM is performed based either on time as recommended by the OEM or usage. Preventative maintenance fits well when failure is driven by age, run times, or number of cycles. However, studies have shown that most plants' assets do not fail due to wear but fail randomly over time. The following table shows results of various studies indicating the percent of a plant's assets that fail due to wear versus fail randomly.

Study	UAL	Broberg	MSDP	SSMD
Failure-Mode				
Age Related	11%	8%	23%	6%
Random (no wearout)	89%	92%	77%	94%

3. **Predictive maintenance** (PdM) attempts to identify potential issues before they can impact production by trending parameters such as vibration in order to gain a better understanding of the machine condition. Predictive maintenance typically involves condition monitoring (CM) approach. Commonly used technologies include vibration, infrared, ultrasonic, oil

analysis, and corrosion. In essence, a condition monitoring system is a proactive tool for the majority of machines that should be managed using a Predictive Maintenance (PdM) strategy where random failures are common or could severely impact safety, environment, product quality, or involve major repair costs and/or costly production losses.As the following studies show, PdM can really impact a manufacturer's bottom line.

Plants moving to predictive maintenance were able to:

- *50% reduction in maintenance cost
- 55% reduction in unplanned machine failures
- 90% reduction when process data was combined with predictive maintenance data
- Mean time to repair (MTTR) was reduced 60%
- Spare parts costs were reduced 30%
- Plant machinery life was increased 30%
- Machinery availability increased 30%
- **Reduction in maintenance cost – 30%
- Reduction in machinery breakdowns – 70%
- Reduction in downtime – 40%
- Increase in production – 25%

*A survey of 500 plants by Keith Mobley, "Introduction to Predictive Maintenance"

**US Department of Energy

4. **Reliability Centered Maintenance** (RCM) goes one step further. By understanding the condition of your assets through CM/PdM, if you can identify when something bad is about to happen early enough, you can take appropriate action to avoid failure. This would be similar to checking your cholesterol levels, blood pressure, and EKG, etc and then changing your lifestyle (diet, exercise, etc) in order to improve your body's reliability. RCM often involved implementing improved operations and maintenance best practices to eliminate or reduce such occurrences in the future.

Condition Monitoring Approaches

Condition monitoring architectures fall into three categories: a) manual; b) on-line continuous; and c) on-line scanning.

a) **Manual:** This involves a technician moving through the plant manually collecting condition monitoring data - either with a portable data collector or writing visible process data information, or making visual and audible observations about the asset. Manual data collection is often the way a manufacturer enters into the condition monitoring arena as a proof-of-concept practice or on important, yet less critical assets. Such a practice can be labor intensive, increase exposure to

safety risks, and potentially miss problems if the interval of data collection is not frequent enough to catch developing issues. Portable, handheld measurements may also lack repeatable results if sensors are manually held in place.

b) **On-line scanning systems** offset the repeatability concerns of the manual systems by using permanently mounted transducers. This does increase the upfront cost of the condition monitoring program but greatly reduces the re-occurring labor cost associated with manual data collection and also improves safety by reducing the amount of exposure technicians have to the machinery.

For important plant assets, on-line scanning systems may be better suited. While such systems do not provide continuous machinery protection, they are less costly to install and can still provide repeatable measurements and collect data much more frequently than manual. Of the on-line scanning approaches, there are wired solutions and wireless solutions.

Wired scanning can collect data a number times per hour if desired whereas wireless solutions are typically limited to collecting data only a couple times per day but are often less costly to install.

c) **A continuous monitoring system** offers machinery protection in addition to condition monitoring. It typically involves a dedicated monitoring system with msec relay response that can be used to shut-down a machine in the event of exceeding pre-set alarm limits. The dedicated monitoring system can also provide the front end to a condition monitoring and diagnostic solution where the machinery condition parameters signals are trended and analyzed. Such dedicated systems are typically prescribed for highly critical plant machinery where failures can occur rapidly and have significant impact to the plant's EHS (environment, health and safety) status and plant production. They can also cause high replacement/repair costs or greatly affects product quality.

Which approach makes the most sense? It depends on the criticality ranking of a plant's assets.

Criticality Rankings

Criticality of each plant equipment asset is assessed and ranked using failure impact on several business level factors, including: Safety, Environmental and Health concerns, Production, Operations and Maintenance Costs (O&M) and Product Quality.

The criticality ranking of equipment assets in the system will influence the Maintenance Strategy, which in turn will be used to define the corresponding condition monitoring architecture that will be applied.

Conclusion

With a great majority (77–94%) of a plant’s assets experiencing problems randomly throughout their life cycle, condition monitoring or a more proactive approach to maintenance can greatly reduce unplanned outages (55–70%), reduce maintenance cost (30–50%) and improve asset availability (25–30%), by understanding when machinery condition is changing and when problems are developing and need to be addressed.

The case for condition monitoring is no longer solely about reducing costs but studies have shown can be a real money maker for manufacturers.

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