The Challenges of Condition Based Maintenance

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Abstract

An effective condition-based maintenance regime requires a good understanding of asset criticality, failure rate modes, and, effects; as well as the total cost of failures. Therefore, understanding what to monitor for a given asset requires reliability and related financial data.

Keywords: *FMEA, RCM, CBM, CMMS, LCC, Failure, Assets*

Introduction

In many instances, the installation of significant assets has been planned, designed, bought, and installed with very little consideration given to maintenance, operations, and support (El-Haram and Horner, 2002). According to El-Haram and Horner, this practice has been expensive because the cost of maintenance, operation, and support constitutes a significant portion of the asset life cycle cost (LCC).

Overman and Collard (2003) note that a study performed for the commercial airline industry in the early 1960s to validate the failure characteristic of aircraft components revealed that 11 percent of the components demonstrated a failure characteristic that supported a scheduled overhaul or replacement (time-based maintenance). However, the remaining 89 percent exhibited random failure characteristics for which a planned removal was not effective. Nonetheless, some maintenance organizations continue to perform intrusive time-based maintenance.

The airline study led to the development of condition monitoring (CM) technologies and reliability-centered maintenance (RCM) (Overman and Collard, 2003). RCM followed three distinct tracks: commercial aviation, military aviation, and commercial industry.

According to Overman and Collard, the commercial track became the most diverse, and RCM was divided into two main groups: classical and hybrid processes. The hybrid RCM is an attempt to cut the process short, leaving out some steps; because RCM analysis can be a tedious endeavor, requiring identification of system requirements and defined boundaries (Moore, 2006).

The Society of Automotive Engineers (SAE) saw a need to write a standard (SAE JA 1011) that defines what a process should include for it to be a "true" RCM process. That is a process that conforms to the original RCM concept and one that consists of all of the steps necessary to keep from being dangerous (Overman and Collard, 2003).

Condition Based Maintenance

Condition-based maintenance (CBM), if technically feasible and economically justifiable, could reduce maintenance costs and improve asset reliability. Technical feasibility implies that there is an unambiguous indicator of failure initiation (Wiseman, 2006). CBM uses real-time data to determine the health of an asset. It shifts the maintenance emphasis from reactive to proactive. However, its implementation often requires the installation of monitoring instrumentation, which could be costly for existing assets.

CBM requires the installation of monitoring devices on subsystems or parts of an asset to measure degradation. Whenever the monitor detects degradation, a report could be transmitted to a computerized maintenance management system (CMMS), which could issue a work order.

Breuker, Rossi, and Braun (2000) note that a trade-off exists between the costs and benefits of real-time monitoring. For instance, performing frequent maintenance inspection results in high labor costs; conversely, infrequent maintenance inspection might lead to asset degradation and the possibility of premature failures (Breuker et al.).

Hence, the costs and benefits of remote monitoring should be compared to the costs and benefits of frequent and infrequent maintenance inspections.

An effective CBM requires a good understanding of asset criticality, failure rate modes, and effects, as well as the total cost of failures. Therefore, understanding what to monitor for a given asset requires reliability and related financial data (Crespo Márquez and Sánchez Herguedas, 2004). Reliability data determine failure rates, and financial data determines the potential payoff, if any, of a monitoring regime. If internal reliability data is not available public records, manufacturer's data, and expert judgment may be used.

CBM should be based on asset criticality (safety, environmental, and operational impact) and cost (failure rates). Several techniques, such as failure modes, effects, and criticality analysis (FMEA), and reliability-centered maintenance (RCM), which are components of integrated logistics support (ILS), have been used to identify and select cost-effective maintenance strategies (El-Haram and Horner, 2002).

El-Haram and Horner (2002) note that ILS is a managerial and technical approach that ensures that the client/user will receive an asset that meets performance requirements with the minimum LCC.

A CBM regime on standby units, such as protective devices, or infrequently used assets would not be effective since, upon startup, hidden failures could occur. However, to counteract, hidden failures Tsang (1995) recommended faultfinding (FF) tasks. FF tasks are performed at scheduled intervals to check the state of assets or items with dormant functions. A typical example is an emergency generator that is generally idle until needed.

Many maintenance organizations equipped with CBM do not adequately respond to alerts and alarms. However, some CBM systems are integrated into the CMMS, so that a work order is automatically generated when signals from a monitored point trigger alerts or alarms. The integration of alerts and alarms into the CMMS is particularly suited for continuous processes where failure and downtime can be extremely costly.

Applying FMEA

FMEA is a systematic approach for identifying all possible ways that an element within a system can fail, as well as the causes of each failure and its effects (El- Haram and Horner, 2002). Crow (2002) noted, "The early and consistent use of FMEAs in the design process allows the engineer to design out failures and produce reliable, safe, and customer-pleasing products. FMEA also captures historical information for use in future product improvement."

Failure is when an asset, component, or element cannot fulfill its mission. For many assets, however, certain symptoms (soft faults) often occur prior to total failure, such as excessive vibration, abnormal heat (Knapp et al., 2000), solid contents in oil, and so on.

Sensors capable of detecting pre-failure signals can provide alerts and alarms, notifying the asset operator of the potential of an impending failure. For other assets, failure (hard faults) may occur instantaneously and cannot be predicted; generally, these failures are exogenously generated.

The FMEA procedure is straightforward and well documented; it is described in NDP Solutions.

Applying RCM

RCM follows FMEA; it is a systematic approach in identifying the most appropriate and cost-effective maintenance tasks for an asset's elements, services, and equipment from a rigorous analysis of consequences of failure (El- Haram and Horner, 2002). To apply RCM, the organization needs to fully understand the functions of physical assets, and the nature of failure related to these functions (Jardine, and Tsang, 2005). According to Jardine and Tsang, the primary objective of RCM is to preserve the system's capacity, rather than to keep the asset in service.

Conclusion

When purchasing critical assets, the statement of work (SOW) should specify that the suppliers perform FMEA and RCM analysis, as well as recommend strategies to minimize maintenance costs through the implementation of CBM, or other effective maintenance regimes. Moreover, if CBM is deemed cost-effective, the supplier should identify subsystems, parts, or elements of the systems that would benefit from remote monitoring.

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