Cerrejon: Achieving Reliability from Data

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Abstract

Which, among limitless, maintenance related data is relevant to physical asset reliability improvement? Secondly, how do we transform that data into decision models for effective risk management? Finally, how do we continuously update those models for verifiable asset reliability improvement? These questions drive our relentless pursuit of new maintenance technologies. This article reports on Living RCM as a solution to the long standing problem of achieving physical asset reliability from data.

1. Introduction

Managers and maintenance engineers imagine a future where technology can offer a kind of "magic box" that collects and assesses relevant data, identifies recurring failure modes, predicts the remnant lifetime of critical parts and recommends an optimal moment for intervention by a repair crew. Responding to this vision the maintenance technology industry has reasoned that the maintenance process should include certain activities and information sources, namely:

1. Condition monitoring of vital equipment and systems,
2. Failure prognostic algorithms with which to process relevant data, and
3. Equipment failure and maintenance records (also known as "age data").

Activities 1 and 2 have attained notable technical maturity over the years. Data acquisition systems, sensors and decision support software abound in the market. The missing element (item 3) has remained stubbornly elusive. The Enterprise Asset Management (EAM) system often fails to satisfy the reliability analyst's need for consistent, accurate, and complete age data. Unfortunately, realistic prognostic algorithms (item 2) for practical maintenance decision making depend on adequate input from item 3.

2. The Problem

Age data is a record of events where a part has either failed or was renewed preventively in order to preempt its failure. Disappointingly, the EAM process often fails to satisfy the requirement for accurate and complete age data. Carbones del Cerrejón, a mining operation in Colombia, discovered the reliability data "gap" when its reliability engineers attempted to apply prognostic decision modeling algorithms to fleet maintenance planning. They failed to achieve the required level of Condition Based Maintenance (CBM) predictive performance.

3. The Solution

To resolve the problem Carbones del Cerrejón set out to implement a "Living" RCM (LRCM) process that would guarantee *perfect* transcription of a technician's observations following execution of each work order. Accurate age data allows Cerrejon's analysts to construct prognostic models by correlating instances of failure (as determined by age data) with condition monitoring data patterns preceding the failure event. For this type of analysis, a data sample must differentiate between failures and *suspensions*. A suspension is a renewal of a Failure Mode (e.g. a part or component) for reasons *other* than failure.

Pattern finding procedures need to "know" whether a given ending event was actually due to failure. Mislabeling a suspension as a failure would mislead the algorithm and result in poor predictive performance. The LRCM process ensures that each work order will represent a valid data point in a statistical sample. A sample is a collection of Failure Mode life cycles that includes their ending age and state. The age and state (failure or suspension) of a Failure Mode at its life ending constitute its "age data". The benefits from applying Reliability Analysis (RA) procedures such as Proportional Hazard Modeling (PHM) to historical records can be attained only if the data is of sufficient quality so as to be analyzable. "Analyzable data" consists of age data that is at least 90% accurate. Such accuracy was achieved through the MESH LRCM work order documentation process.

4. The Benefits

The benefits of the MESH LRCM implementation were identified on the strategic, tactical and operational levels.

Strategic:

- MESH LRCM monitors "low level" indicators. "low level" means measurements of actual behaviors which, logically, bear indirectly on the high level metrics of interest to our shareholders, such as equipment up-time, operational cost, and profitability.
- HSE performance is a business goal no less critical than is profitability. Poor performance in HSE can dramatically reduce profitability. LRCM encourages periodic evaluations of a failure mode and reassessment of its potential risk.

Tactical:

- Optimization of maintenance plans based on new failure modes identification on a daily basis
- The LRCM procedure encourages consistent terminology
- Less time cleaning data and more time analyzing information and incorporating it into the decision process. 40% increase in reliability analysis capabilities
- LRCM allows us to consolidate knowledge from experienced staff and contractors in an organized and structured way. This ensures a continuous increase in technical skills.
- Reduced number of events of certain recurrent failures due to the attention LRCM focused on the failure instance count in the knowledge tree as it is displayed in the work order user interface
- Reduce maintenance cost up to 8% for the equipment whose reliability is monitored in the LRCM system.
- Significant improvement in data from the field and shop. 50% increase in data integrity as measured by the number of work orders whose data is of "analyzable quality".

Operational:

- Information coming into the EAM corresponds to what was actually found prior to executing a work order.
- The work order information recorded through LRCM is relevant, concise, complete and accurate.
- Less time to register information in the Work Order. 30% increase in efficient and less time to select a failure mode.

5. Conclusion

The LRCM process fulfills our stated corporate requirement that physical asset maintenance performance improve continuously. Good equipment reliability, safety, and productivity depend on the quality and timeliness of data. LRCM, by making the right data available, ensures competent staff, good prognostic decision models, and a process of continuous improvement.

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