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Operational Data and Maintenance Reliability

November 8, 2011, Saskatoon, Canada,
Canadian Mining Institute (CIM)
Maintenance Engineering/Mine Operators'
(MEMO) Conference

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Abstract

As OEM sensors and interfaces have grown in number, the available data from equipment in the mining environment has continued to multiply. This equates to an increased visibility of operating performance, mechanical and electrical health, and predictive monitoring that can directly improve maintenance reliability and scheduling. With increased visibility, where should a reliability engineer begin to look to directly impact Capacity Assurance? More specifically, what source will provide inputs to the Failure Modes Effects Analysis (FMEA)? Results from these analyses must be documented, and they must contribute to the overall mission of the mining company; these results must reduce costs and increase profits. Through detailed data capturing, documenting, and analysis, Modular Mining Systems' Time Tracking application, used in the MineCare® maintenance management solution, can drive decisions and provide direct impact to engineering projects for continuous improvement in the mine maintenance organization.

Biography

Justin Johnsen is an experienced leader with over 15 years' work in the realm of heavy equipment maintenance and mine asset health management. In his present role as Product Manager for Maintenance Systems and Interfaces at Modular Mining Systems Inc. (Modular), he brings real world experience to develop industry-leading technology solutions. Prior to Modular, Mr. Johnsen spent 5 years with Freeport McMoran implementing and standardizing remote diagnostics at three Phelps Dodge mines in Arizona, finishing his time as Superintendent of Maintenance and Engineering at the Morenci, Arizona Copper Mine. Mr. Johnsen began his career serving eight years in the U.S. Navy as a mechanic until his honorable discharge in 2004. While serving in the Navy, he also completed a B.S. in Mechanical Engineering Technology from Old Dominion University in Norfolk, VA.

Operational Data and Maintenance Reliability

Capacity Assurance is achieved when an equipment unit, system, or subsystem accomplishes the expected longevity associated with the desired results for its use. In order to achieve Capacity Assurance, reliability professionals are tasked with identifying, documenting, and improving all aspects associated with the item that may fail to achieve expected capacity. When performing a FMEA on mining equipment, organizations need to consider all aspects of the equipment unit. As reliability professionals, we typically consider performing the Root Cause Analysis (RCA) process on the equipment systems and subsystems. However, it is not routine to expend the same energy on an unscheduled down status. It might sound unusual to most to consider status as an area of concern, or as a necessary area on which to concentrate resources to research failure modes, causes, and effects. Although system and subsystem FMEA is typical and very beneficial, the maintenance philosophy to balance the amount of Preventive/Predictive/Reactive maintenance is difficult to change in mining for several reasons. One reason is that mining is operationally driven. This is primarily why it is important to review and analyze the status data. Performing the RCA on status data ensures that the assigned status is appropriate, that repeatable tracking occurs for similar failures, and, most importantly, that the assigned status is easily associated with the FMEA results from the previous system and subsystem analysis.

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Figure 1: MineCare Time Tracking application - Operational FMEA Workflow

Operational data may not quickly indicate which system is creating the largest draw of maintenance resources, or even the largest cost to the maintenance department's budget. However, it will lead the reliability engineer to the system and subsystem that are creating the biggest loss in production (Fig.1). Hidden losses from production should be analyzed as they can provide larger benefits to the company's profit line than the savings from improvements implemented as a result of the FMEA on the system and subsystem themselves. Additionally, projects based on the philosophy of operational data-driven reliability are more likely to be sustained, since all sides of the organization receive direct benefits.

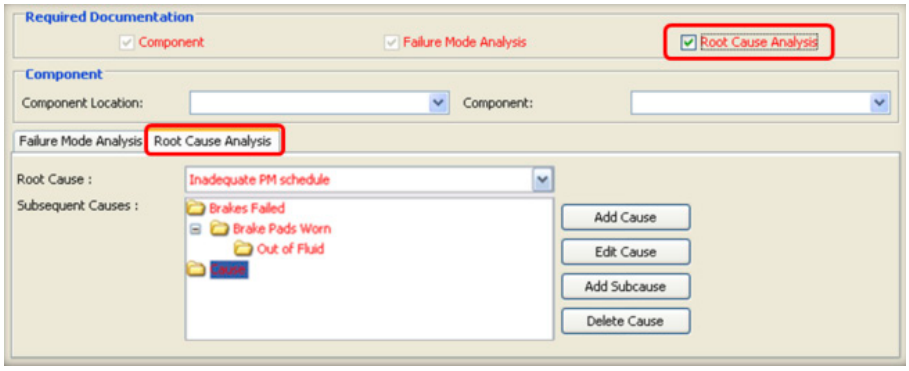

Figure 2: MineCare Time Tracking application - Status Related RCA

For the implementation of this philosophy to be successful, changing the paradigm to no longer accept unscheduled downtime must be a top priority. Every single unscheduled down should have a Root Cause Analysis (RCA) performed (Fig 2.). Currently, there is acceptance and planning for a percentage of unscheduled equipment to be out of service. As maintenance managers, superintendents, and engineers, we focus on the projects that data indicates as using the most tradesmen and capital resources. They are necessary projects, and with successful implementation of a FMEA process they can be extremely profitable. However, there is an area of unknown monetary losses that require our acceptance. We must consider these projects with the intent to gain money by improving operational readiness and production, rather than the intent to save money by reducing maintenance. The organization loses substantial potential revenue with each unscheduled down of equipment.

This analysis could lead us to an expected system of known failures, or it could lead us to a simple system that is known more as an irritation than an area of reliability concerns. For instance, we may find that a system such as the side-view mirrors on our large haulage vehicles is the largest cause of unnecessary downtime. If we allocate 15 minutes per day for almost every unit to have mirrors replaced, adjusted, or cleaned, we may have a simple system costing the organization substantial revenue loss. We can associate the appropriate failure modes, causes, and effects for a mirror that could influence our RCA on this system of downs. This RCA may produce policies, procedures, or even equipment modifications to eliminate this pestering issue that may not produce large savings in maintenance but can produce substantial revenue improvements for the organization.

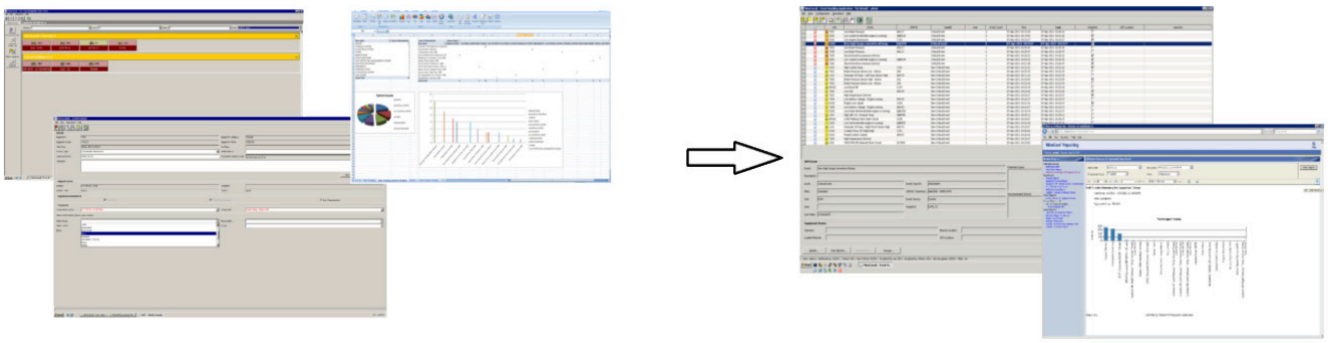

Figure 3: MineCare Time Tracking, Event Handling, and Reporting applications – Status RCA related to Machine Health

Additionally, as the systems move from a simple example to more complex systems, we can accurately document the FMEA for each system and subsystem. The ability to link the FMEA indicators with the RCA for each unscheduled down will allow essential association between status and equipment health (Fig. 3). The philosophy is simple in theory, but it is significant in potential. As maintenance engineers continue to perform and evaluate the FMEA for an on-board system, their research and analysis provide new indicators to prevent future failure. As the data on-board the equipment continues to become more available remotely in real time, maintenance professionals have the ability to predict events with greater success. When we shift our focus to maximizing production, we will obtain two simultaneous goals: reduced maintenance costs and increased revenue.

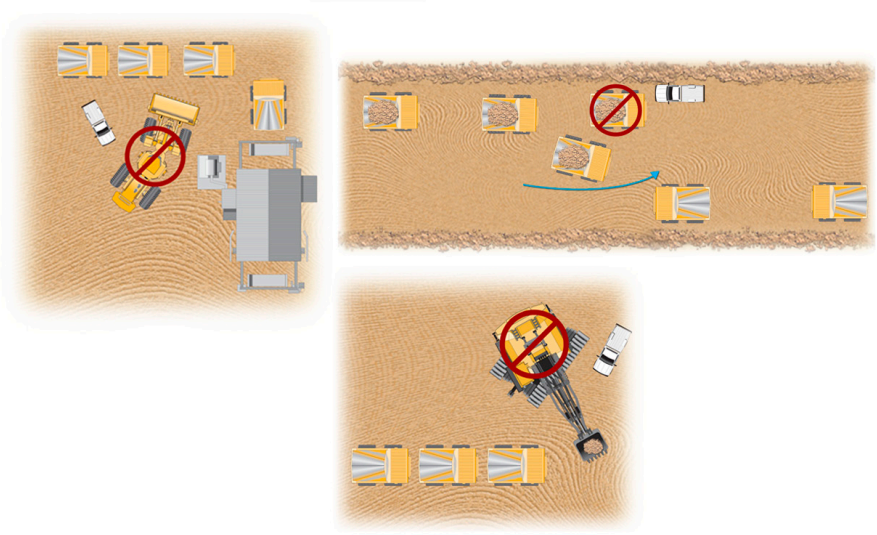

Figure 4: System of operational equipment affected by defects

As the mine operates with several different equipment types with specific functions, the equipment units in the mine become a system relying upon each other to operate efficiently. Just as the mechanical and electrical systems on-board equipment, the mining equipment units themselves work together to form a system for peak performance. A defect in this system of operational equipment affects total system efficiency (Fig. 4). In the same way poor engine performance prompts research into why a defect occurred, diagnosing unscheduled status events as unacceptable requires an understanding of why a defect occurred in our system of operational equipment. The data must come from accurate tracking of the operational status of equipment, detailed FMEA performed on systems and subsystems, equipment health sensor and alarm data, and a means to collect, consolidate, and compare the information. To complete the operational RCA there are a few fundamental steps to follow:

- Document the system and subsystem that caused the unscheduled down.
- Document the failure modes, effects, and causes associated with the system and subsystem that caused the unscheduled down.
- Analyze and track all machine health alarms or sensor data that indicated impending failure or poor performance of the system and subsystem that caused the unscheduled down.
- Discuss and document findings from the operators, supervisors, engineers, and technicians to complete the RCA.

With the substantial data collected from each defect in our operational system, we can analyze not only the status that is creating the largest loss in revenue, but rather we now know what system(s) and subsystem(s) is directly causing the largest loss. With a wealth of data and information on the system and subsystems causing the largest loss to production, maintenance professionals can immediately identify the projects to improve maintenance and operations. This enables the reliability department to achieve the ultimate goal of Capacity Assurance of the overall operational system, resulting in revenue gains for the company.

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