IMPROVING ASSET INTEGRITY THROUGH RELIABILITY BASED MAINTENANCE

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OPTIMIZING ENTERPRISE ASSET MANAGEMENT WITH RELIABILITY BASED MAINTENANCE

In industries ranging from Offshore Exploration and Production, to manufacturing, to health care, to utilities and beyond, technological and industrial innovations have led to the proliferation of complex, capital-intensive assets.

The evolution from simple, labor-intensive assets to advanced capital-intensive ones has created a need for maintenance and asset management to evolve as well. But fostering best practices for maintenance in an age of rapid advancements in technology has been difficult because these new assets and business processes are often developed without input from maintenance managers and staffs. Additionally, stringent customer demands in terms of product quality and delivery deadlines have made organizations across the board hesitant to conduct maintenance, as it requires downtime they cannot afford.

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Reluctance to perform maintenance on critical assets may save time and keep them running in the short term, but by favoring performance today over reliability tomorrow, asset-intensive organizations may be setting themselves up for debilitating asset failure in the future. For this reason, many organizations are turning to a philosophy known as Reliability Based Maintenance (RBM).

This white paper will examine the role of RBM as it pertains to the development of an effective Enterprise Asset Management strategy. We will look at each step in the RBM process and draw on examples from a diverse array of industries to see how these principles can be put into practice.

WHAT IS RELIABILITY BASED MAINTENANCE'S ROLE IN ENTERPRISE ASSET MANAGEMENT?

Effective EAM consists of fostering the optimal management of the physical assets of an organization to maximize their value throughout their entire life cycle. This means that everything from the design, construction, commissioning, operation, maintenance and replacement of every asset must be done with the goal of optimizing asset reliability. In this case, reliability and uptime are synonymous: Managers want to ensure their assets are running in such a way that there is as little downtime as possible while still performing the necessary maintenance on critical assets.

This is exactly what RBM does. It's about developing and implementing systems, structures, processes and practices that use maintenance as a way to maximize asset reliability at the most cost effective level. RBM rose to prominence as a key maintenance philosophy because it was able to appropriate best practices from a wide variety of other technical strategies and combine them into one deliverable solution.

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Utilizing a combination of proactive maintenance strategies, asset-intensive enterprises can use the data they collect from their assets to prompt maintenance activities as well as enhancing their developed proactive maintenance. As the asset condition data reaches maintenance teams and managers, they can schedule maintenance exactly when and where it is needed. This transforms maintenance from a reactive, intrusive approach into a key process that is embedded within normal operations.

The seven steps to the RBM process are as follows: developing a Master Asset List (MAL), Asset Criticality Ranking (ACR), Proactive Maintenance Development (PMD), identifying Critical Spares, monitoring Reliability Analytics, performing Root Cause Analysis (RCA), followed by performing Proactive Maintenance Optimization (PMO).

Here is a flowchart that lays out the seven steps in the RBM process:

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DEVELOPING A MASTER ASSET LIST

One of the biggest obstacles to effective EAM is that many organizations don't actually have a complete working knowledge of all of the assets in operation. RBM, in support of an effective asset management program, cannot be undertaken without having a comprehensive Master Asset List that defines all of the assets that will be under the purview of the program. As the primary step in the RBM philosophy, organizations must use the MAL to develop a formal process by which they can clearly define the difference between assets and spare parts, thereby ensuring that certain items, such as work order data, are not too granular. Here are the standard guidelines for defining an asset:

- It is related to a defined business desire or requirement to track maintenance costs.
- It is regularly maintained in order to preserve the function for which it was acquired.
- It is repaired rather than replaced when it fails.
- It is within the scope of regulatory requirement to track performance or maintenance history.

The second step in developing an MAL is the construction of standard asset hierarchy. The MAL needs to be made into a structured asset/location hierarchy path so assets can be quickly located and identified when it comes time for maintenance.

From there, managers can create an accurate asset registry containing pertinent asset data like type/class, sub-type/sub-class, manufacturer, model number, etc. This data is entered into a Computerized Maintenance Management System, while all assets in the field are tagged with the corresponding CMMS number for quick identification. All of this data will go toward making it easier to research, find and compare assets and decide whether to repair or replace them.

"An ACR is a tool used to evaluate how asset failures impact organizational performance."

The Offshore Exploration and Production sector provides a useful illustration of the importance of a MAL. With so many disparate locations, facilities and asset types, it can be difficult for maintenance teams to know exactly what they need to attend to and when. The MAL contains all of this information and lets maintenance workers know what assets must be prioritized. For example, rig's blowout preventer – which is used to seal wells – is essential to the proper functioning of the rig and the safety of the workers.

ASSET CRITICALITY RANKING

Once an organization has established a comprehensive MAL, it must assign each asset on the list an Asset Criticality Ranking. An ACR is a tool used to evaluate how asset failures impact organizational performance. Some assets are integral to business operations, while others take on a supporting role. The ACR can determine which ones are critical to the functioning of the business and should thus be a priority in an RBM program. With this tool, assets are prioritized based on the following factors:

- Safety
- Quality
- Environmental impact
- Operational throughput
- Operational cost
- Current level of reliability

This prioritization should be applied to continuous improvement efforts as well as the Daily Management of the CMMS Workflow Process. When it comes to planning, scheduling and procurement of maintenance resources and spare parts, the assets with the highest ACR are attended to first. Offshore Exploration and Production is one industry for which an ACR is a key part of RBM.

With an array of subsea assets like risers, drill pipes, motors, blowout preventers and valves, and surface assets like derricks, mooring systems, IT infrastructure, crown blocks and several others, offshore oil and gas drilling is an asset-heavy endeavor. While every part of a rig is important, based on the criteria listed above, some are absolutely critical. Through many industry examples, it's clear that asset-dependent organizations need to have a well-defined list of priorities – given by the ACR – when it comes to knowing what needs to be maintained and when.

PROACTIVE MAINTENANCE DEVELOPMENT

One of the major developments in the practice of enterprise asset management and a hallmark of the RBM paradigm is Proactive Maintenance Development. Traditional maintenance programs were built around the core assumption that the rate of random asset failures was directly related to the age of the asset. However, this is not true in every case. For some assets, there is a high rate of failure during infancy that normalizes as the asset advances through its lifecycle. For others, the failure rate is completely random.

The traditional view of asset failure led to the creation of fixed-time maintenance schedules, where maintenance would be performed regardless of whether or not it was needed.

> “Developing an effective PM strategy will ensure the greatest level of uptime reliability at the lowest operational costs.”

A fixed-time maintenance schedule could also lead to under-maintenance, where the asset fails before its scheduled time, leading to downtime and unplanned reactive repairs. Both situations lead to unnecessary costs and downtime. To manage this, asset management had to move away from fixed-time schedules and embrace condition-based maintenance – a blend of proactive and predictive maintenance strategies.

Developing an effective PM strategy will ensure the greatest level of uptime reliability at the lowest operational costs. Additionally, it allows for the optimal utilization of maintenance resources by directing them only to the highest-value activities as determined by the ACR list. At its highest level, PM Development is carried out through a strategy known as Failure Modes and Effects Analysis (FMEA).

Predicting the various failure modes, or ways in which the asset could possibly fail, is a matter of using risk calculations for each failure mode and quantifying the level of remediation required for each mode. Essentially, FMEA is a review of asset sub-assemblies and components that can later be used to identify the causes and effects of failure modes. Using a number of predictive technologies, like motor, oil, thermal, ultrasonic and vibration analyses, along with older techniques like condition monitoring and lubrication, maintenance teams can gather data on critical asset and component part performance.

Here are the seven primary steps for a FMEA:

1. What are the functions and associated performance standards of the asset in its present operating context? (Functions)
2. In what ways can it fail to fulfill its functions? (Functional Failures)
3. What causes each functional failure? (Failure Mode)
4. What happens when each failure occurs? (Failure Effects)
5. In what way does each failure matter? (Failure Consequences)
6. What can be done to predict or prevent each failure? (Proactive Tasks)
7. What should be done if a suitable proactive task cannot be identified? (Default Actions)

PM Development is important for any asset-intensive business, but for offshore oil rigs, it's quickly becoming a requirement. The offshore industry is currently experiencing a contraction, and that means companies are looking to cold stack some rigs while maximizing utilization rates on those that remain in operation. With such a streamlined approach, it's critical that every rig still running maintain an optimal level of uptime.

Fortunately, the proliferation of Internet-connected assets and components is making it possible for rig maintenance teams to incorporate PdM strategies into their asset management. Data regarding vibration, temperature, lubrication levels and other key condition information can be sent directly from the asset to a central database. The maintenance team can use those virtual reams of data to predict the perfect time to conduct repairs on an asset, preventing unnecessary work orders and achieving high levels of uptime.

Incorporating new asset classes and providing ongoing maintenance or replacement for older ones will be the crux of asset management moving forward. IBM, a provider of EAM software, noted that maximizing grid reliability will be a matter of generating a steady flow of asset-related information to develop a PM strategy rather than the strictly preventative and reactive ones on which the industry relied in the past.

IDENTIFYING CRITICAL SPARES

RBM uses critical spare part identification as a way to classify spare parts based on how critical they are to maintaining asset reliability. In fact, only assets at the top of the ACR list will have their spare parts qualify as "critical." If a spare part is essential for the satisfactory operation of the critical asset, it will qualify as a critical spare part. There are two primary criteria to determine if a spare part will be identified in this way:

1. The component is directly linked to a failure mode that has a high failure consequence.
2. The failure of the component part causes the asset to operate at an unsatisfactory level or stop working altogether.

Following the completion of the critical spare parts classification, the assets are ready to run in routine operation. Once the assets are in operation, the next steps in RBM revolve around monitoring their performance and condition.

MONITORING RELIABILITY ANALYTICS

Once the PM strategy is in place, managers must rely on a set of metrics – known collectively as Reliability Analytics – to determine whether or not the strategy is effective. Each of these metrics has its own control limits – thresholds at which an asset will fail if they are crossed – designated to help managers determine if their PM strategies are effective.

Here are the four primary reliability analytics indicators:

- Failure Code Analysis (FCA)
- Mean Cost to Repair (MCTR)
- Mean Time between Failure (MTBF)
- Mean Time to Repair (MTTR)

This data will be pulled from the work order history stored in the CMMS. Control limits should be established for each indicator based on expected performance levels. The control limits for FCA and MTBF will focus on rate of failure while MCTR and MTTR will focus on cost and effort for repair, respectively.

Control limit monitoring can help maintenance managers determine if an asset has crossed the acceptable threshold for the aforementioned control limits and aid in finding a path toward remediation.

PERFORMING ROOT CAUSE ANALYSIS

If it is determined that the asset's operational performance is at a suboptimal level, Root Cause Analysis should be performed to identify the precise cause of the problems and prescribe corrective actions to return the operation or function to a satisfactory level and achieve the desired control limits. A standard RCA methodology that can be utilized is Cause and Effect Analysis. Here are the basic steps for RCA:

1. Develop a precise Problem Statement.
2. Develop potential Cause Categories for the Problem Statement.
3. Develop specific Cause Items for each Cause Category.
4. Pursue each Cause Item back to its Root Cause.

PERFORMING PROACTIVE MAINTENANCE OPTIMIZATION

If the Reliability Analytics show that the PM strategy is ineffective or if RCA identifies PM strategy deficiencies, Proactive Maintenance Optimization should be performed to enhance the strategy. Essentially, PMO is geared toward reviewing the existing PM strategy in search of the following opportunities:

- Find and remove low-value tasks that do not address failure modes.
- Replace fixed-time maintenance tasks with condition based ones.
- Strengthen work packages (tools, parts, task instructions).
- Allow operators to perform certain maintenance-related tasks during routine operation.
- Look for repeat failures and develop a proactive strategy to minimize their occurrence.

CONCLUSION

In Offshore Exploration and Production, physical assets are at the core of operations, and their optimal functioning is essential for the success of the business. But the rest of the operation shouldn't come grinding to a halt just because a critical asset is in need of repair. RBM, and the more general practice of EAM, gives enterprises a way to find a perfect balance between achieving optimal asset reliability and the appropriate costs.

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