DEVELOPING PROACTIVE MAINTENANCE STRATEGIES

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INTRODUCTION

Maintenance has been around almost as long as humans. Everything eventually needs maintenance, though reasons to maintain different types of assets often differ. With increasing pressures to optimize costs and reduce the risk of industrial incidents, it’s critical that inspection and maintenance efforts be streamlined for utmost efficiency. Balancing inspection costs with safety and regulatory compliance can only be achieved by understanding the risk that an asset poses to a manufacturing facility. That process is called Asset Performance Management (APM).

In very broad terms, we can categorize maintenance as either aesthetic maintenance or operational maintenance. We do aesthetic maintenance in our daily life, like maintaining a coat of paint on our house, maintaining the cleanliness of our vehicles, maintaining our lawns/ gardens and maintaining ourselves. We carry out operational maintenance on our typical household assets like washing machines, driers, refrigerators, air conditioners, vacuum cleaners, vehicles, etc. at varying levels and intervals. However, do we follow a strict schedule to maintain our household assets? The frank answer would be ‘No.’ We prioritize them based on the risk of not maintaining them. For example, in our household portfolio, we all may agree that not maintaining our vehicles is the highest risk, as we may get stranded in some remote area or may get stuck while on holiday or business travel. On the other hand we may not consider maintaining our vacuum cleaners or refrigerators because they do not cause any immediate concern on failure, though their unavailability may cause us some inconvenience. Rather, we might not worry about an asset until it actually fails.

Nevertheless it still is maintenance. We don’t have procedures & systems in place to maintain these particular assets because the stakeholders – ourselves and our family – understand and accept the risks associated with them. However, this philosophy can no longer be extended to industrial maintenance because of multiple stakeholders, the enormity of risks associated with industrial operations and varying risk tolerance limits.

In industry, it takes forward thinking leaders to define and develop new processes that are effective and drive improvement. In our maintenance strategy, we have been moving away from a layered architecture to a near real time environment, which can dramatically improve the quality of strategic decisions. The transition to proactive asset performance management allows industry operators and leaders to more efficiently manage sustainability risk across the enterprise. But first, let’s look at how we arrived at this point.
conjunction to business loss and human health/safety – i.e., environmental norms. Many industry segments simply have to prevent failures to eliminate or mitigate environmental emissions caused by equipment breakdown.

These factors resulted in the concept of ‘preventive maintenance’. Why not maintain assets before they break? Be proactive instead of reactive. Industrial subject matter expertise and operational history were combined to determine the timeframe and activities that need to be carried out on each type of equipment.

However, since the human brain seeks new challenges, we started questioning our scheduled maintenance approach. Do we really need to maintain certain assets when they are functioning just fine? Why not optimize maintenance strategies? We spend time and resources just to find out that many assets are in good condition. And many times, we induce problems when we open equipment which is in good operating condition. In turn, this logic led to the concept of predictive maintenance. A simple LLF (Look, Listen and Feel) approach often could tell volumes about the condition of an asset. As technology advanced, various predictive maintenance techniques like ultrasonics, vibration analyzers, infra red cameras, thermography, etc. were used to observe the health of assets and take timely corrective action before an abnormal condition could manifest itself in the form of a failure.

Did we stop with this new level of asset performance success? As humans, we tend to be competitive, even to the point of improving on our own performance. So, the logical question that arose was “Why maintain something which presents such a low or even zero risk to business?” In a complex industrial arena there are various types of equipment operating under a variety of conditions. Some pose very low threat to business and safety while some pose very high risk due to failure. Hence, the concept of Risk-Based Maintenance evolved. That was further divided into Reliability Centered Maintenance (RCM) for rotating equipment, Risk-Based Inspection (RBI) for static equipment, and Safety Integrity Level (SIL) analysis for Safety Instrumented Systems (SIS). Qualitative risk modelling was developed for other types of equipment not falling in these categories.

STRATEGY MANAGEMENT

In today’s world, we need to operate in the precision category in order to compete and sustain our business. The process of deciding what to maintain and how to maintain it will vary depending on the type of business environment. Precise maintenance strategies have to align with business needs and regulatory norms.

The process starts with identifying and prioritizing assets that need to be maintained. The best way to begin is to conduct a criticality analysis on your assets. The two common ways of carrying out criticality assessment include: Qualitative Methodology and Semi-Quantitative Methodology.

The qualitative approach is the simpler of the two methods, and involves subject matter experts prioritizing the assets based on some criteria. Traditionally, assets were classified as Vital, Essential, or Desirable based on their importance to operations. Later when OSHA regulations were introduced, assets were given an additional identity and were called safety critical equipment (SCE), process safety critical’ (PSE) or process safety management critical (PSMC). With the evolution of the risk-based methodology, wherein corporations developed a risk matrix that considered both Probability of Failure (POF) and Consequence of Failure (COF), where POF and COF levels were defined by business needs considering safety, environment and production components of the risk. Business also defined the acceptable risk criteria or the level of risk tolerable to the corporation, considering business and regulatory requirements. This matrix can be used to qualitatively screen assets by summoning a team of subject matter experts (SMEs) to identify POF and COF of failure based on industry experience.

A semi-quantitative approach to screening assets is also possible within the risk matrix. Screening can consider only the consequence of failure, or both consequence & probability. Considering the consequence, corporations can develop a simple semi-quantitative screening criteria to identify safety, environment and production loss consequence in the event of failure. Factors can include equipment metallurgy, fluid (flammable, reactive, inert), toxic component, operating pressure and temperature. Considering probability a component of the risk matrix in a semi-

HISTORY OF INDUSTRIAL MAINTENANCE

Industrial maintenance has played an important role since the start of the industrial revolution in the 18th century, though the term revolution and the exact century or date is a subject of debate among historians. By nature, the initial form of maintenance that was followed was ‘breakdown maintenance’ or ‘fix it as it breaks’. This simplistic methodology resulted in increasing number of accidents, lost lives and serious business consequences. Maintenance challenges grew with the spread of mechanized industry and with the development of strict regulatory norms for the welfare of society. This also had a bearing on the business growth as competition grew, breaking the ‘monopoly’ rule. As the oil & gas industry evolved, a third dimension was added in
quantitative criticality assessment may complicate the process of screening, unless industry wide data is readily available to compare failure mode/ failure frequency statistics for each asset type under consideration.

Once criticality of the assets have been identified based on one of the above methodologies, assets can be passed through the strategy development process. For high critical assets, risk/ reliability based approaches like reliability centered maintenance (RCM), risk-based inspection (RBI), and Safety Integrity Level (SIL) analysis can be applied. For less critical assets, a simple qualitative assessment might involve a team of SMEs to develop maintenance strategies. It should be noted that for very low criticality assets even ‘no maintenance’ can be considered as a viable maintenance strategy, unless prior experience indicates that a minimum level of maintenance may prove more cost effective than refurbishing or replacing the asset after complete breakdown.

One of the most evident threats to sustainability are asset failures that cause a huge impact in terms of maintenance costs and lost production. While it is important to focus efforts on preventing such events from occurring, it is equally important to focus on seemingly low impact but high frequency failures, or chronic failures. Chronic failures use a lot of manpower, but may not cost significant cumulative maintenance dollars. In many cases we fail to look at the associated production loss due failure or unavailability of the equipment. Hence, identifying ‘bad actors’ considering total cost of unreliability becomes important to focus our improvement efforts. Also, due to their repeated occurrence they might give a false appearance of being the norm, or part of the required maintenance. Because of these hidden losses, there is a need for benchmarking to identify assets having chronic failures and drive ‘failure elimination’ efforts to improve sustainability and availability while reducing costs.

For a proactive maintenance strategy to remain effective, the following ever-greening activities are essential to the process:

a. Bad actor analysis using Integrity Operating Window (IOW) Monitoring, Health Indicators, Metrics, Benchmarking, Key Performance Indicators, etc.

b. Root Cause Analysis (RCA) to analyze and prevent recurrence of failures for both sporadic and chronic events. Chronic events can be identified using bad actor analysis, and prioritized for RCA considering total cost of unreliability (Maintenance Cost + Lost Opportunity Production Value)

c. Re evaluation of RBI analysis using updated inspections and related inspection confidence levels (typically following turnarounds)

d. Routine operator rounds to identify tell tale signs (per approved maintenance strategies)

e. Updating maintenance strategies/plans using past observations from incidents/ failure analysis.

Adding context to data helps reduce unplanned downtime by identifying potential failures in real time.

**Root Cause Analysis Basics**

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Sometimes failure analysis can be a simple task, and other times, the analysis could take more than a year to identify the root causes that led to the failure event. Different levels of risk and rigor determine different levels of analysis.

General methods of analyzing past performance of assets include variations of root cause analysis, including: Five why, fishbone, tripod diagram, bowtie, fault tree, event tree or logic tree analysis. Different tools can be used, like MS® Excel and Word, or more structured tools. But we need to remember that the primary outcome of any investigation or analysis should be some type of actionable recommendations. We also need to track the implementation of those recommendations in a structured way as part of an overall process to eliminate the problem. As a note of caution, recommendations that reside in a spreadsheet or Word document are generally waiting to be lost or not acted upon.

MESSAGE

This kind of risk based maintenance approach can help maintenance personnel to identify the cost component of unmitigated risk vs. mitigated risk and the amount of money required annually to mitigate the risk. This way the maintenance department or inspection department that was traditionally considered to be a mere cost center can turn into profit management centers, elevating their importance, presence and reputation in the view of top management.

We also need to accurately identify problems and then uncover solutions. Very often, the kind of solutions that we find are “below the surface.” The above ground “failure” is well known. We all know what happened; or we all think we know what happened. Something broke. Something was fixed. But what we don’t know is the underlying cause(s) of that failure.

We have moved from a reactive maintenance mode to one of being proactive by applying the principles of asset performance management. Asset performance management (APM) is all about connecting people, information, and devices to create a holistic view of plant operations used to better manage reliability strategy and operational risk.