Reliability-Based Maintenance as a Breakthrough Strategy in Maintenance Improvement

by
Grahame Fogel and Dave Petersen

Introduction

Industrial plant maintenance is gaining attention as the next great opportunity for manufacturing productivity improvement. As companies invest in more high-tech and expensive equipment, they become more reliant on the need to reduce equipment redundancy without sacrificing reliability and availability, accomplishing this within an ever decreasing availability of operating capital. E I Dupont has said that maintenance was once its "single largest controllable cost opportunity, representing $100-$300 million per year corporate wide". It is estimated that U.S. Industry needlessly squanders in excess of $200 billion each year on inadequate or unnecessary maintenance procedures. Within the last ten years a wide range of advanced maintenance technologies have been developed which can help manufacturers reduce their maintenance costs while simultaneously increasing plant reliability.

Reliability-Based Maintenance (RBM) has emerged as perhaps the preferred advanced maintenance philosophy in North America. RBM was initially conceived as a solution advocating the logical balance between the four technical strategies of traditional maintenance: reactive, preventive, predictive, and proactive maintenance. Since the Reliability-Based Maintenance "recipe" has evolved to additionally include the appropriate technical strengths of Reliability Centered Maintenance (the RCM Process) and the people/work concept of Japanese-based Total Productive Maintenance (TPM). This broadened formula for Reliability-Based Maintenance has been driven by users and implementers in an effort to incorporate the tangible benefits of all advanced maintenance strategies and philosophies into a single deliverable solution. A historical perspective of the development of the various maintenance strategies follows.

Historical Discussion of Maintenance

In surveying the last sixty years there has been an enormous evolution in the sophistication of machinery used in production processes, mainly driven by the demand for increasing productivity as a competitive issue. This has led the equipment evolution from purely mechanical systems to precision electro mechanical systems with sophisticated computerized controls.

Pre-1930 machinery was robust, overdesigned, and long lasting. The major failure modes were wear or metallurgical. The maintenance plan was simple, machinery was rebuilt after failure by skilled craftsmen. In the 1950's productivity was becomming more of an issue. The prevailing maintenance philosophy was the belief that "machinery failure" was an accepted and unavoidable part of manufacturing life. This led to designing processes which had significant standby capacity and large spares inventory, with a strategy of ever increasing scheduled intervention (addictive maintenance). It was also a time of evolving relations between the workforce and management where Unions played a defining role, creating strict job definitions within the maintenance organization.

Until the early 1970's, most plants worldwide performed maintenance in a reactive, or breakdown, mode. Reactive maintenance is expensive because of extensive unplanned downtime and damage to machinery. With the availability of mainframe computers in the 70's, many companies implemented periodic preventive maintenance strategies to encourage planned maintenance inspection and repair in preference to reactive maintenance. This still dominant maintenance approach typically utilizes maintenance scheduling software to track and schedule calendar-based maintenance activities, and to automatically trigger required work orders. As the adoption of preventive maintenance grew, original equipment manufacturers habitually began to oversubscribe PM recommendations in an attempt to reduce their warranty exposure, thereby increasing overall maintenance costs with needless open-and-inspects.

As maintenance costs ballooned, a maintenance optimization procedure called Reliability-Centered Maintenance (RCM) was developed in the late 70's to help reduce the ever increasing volumes of work orders resulting from the implementation of computerized scheduling. The early RCM procedures were heavily influenced by safety issues because RCM has its origins in the airline industry. About the same time a maintenance philosophy called Total Productive Maintenance (TPM) was gaining momentum, particularly among Japanese manufacturers. TPM advocates a partnership between maintenance and operations departments such that basic maintenance activities (cleaning and inspections) are performed by operators. TPM has been adopted successfully in Asia and some parts of Europe, but it has suffered in North America due to union opposition.

In the mid 1980's, advances in instrument technology coupled with widening adoption of the personal computer provided the capability of "predicting" machinery problems by measuring machinery condition, using vibration, thermal, and ultrasonic sensors. This technology is commonly referred to as Predictive Maintenance (PDM), or condition monitoring. Another more advanced maintenance strategy called Proactive Maintenance (PAM) assists in further extending the failure cycles of plant machinery through the systematic removal of failure sources. Finally, in 1992, Reliability-Based Maintenance was introduced which effectively combines the strengths of all of the aforementioned strategies and philosophies into a single deliverable maintenance solution.

As we review the history of maintenance it is interesting to observe that prior to the early 1970's, the maintenance function was little changed since the beginning the industrial age. There were no improvement strategies developed, no re-engineering attempts, little investment and attention. The perceived purpose was to, first, repair things when they failed, and second, paint the parking lot and mow the grounds for visitors. Until recently, maintenance has always been perceived as a "necessary evil", beyond optimization and improvement.

Today, machinery is a complex hybrid of semiconductor controlled electro mechanical devices designed to operate with a much more demanding duty cycle. The maintenance manager in every manufacturing environment must now ask himself where he and his team stand in terms of whether they are sufficiently equipped, trained and organized to be effectuve abd competitive. Modern maintenance has to be in step with the demands of a much more sophisticated manufacturing environment. In order to succeed the basic philosophy of maintenance must continue to evolve in step with the changing demands of manufacturing and competition. An owner, in order to be competitive, requires maximum uptime from the machine operating at near its design capacity. And of increasing concern is the environmental aspects of the effect of plant operation.

Progressive companies are perceiving that maintenance is a worthy investment area, and as such the investment has to be carefully managed and measured for it's returns. From this, the ideas and practices of our breakthrough process have evolved. One difficulty has been the establishment of well accepted metrics of maintenance performance in order to apply tangible criteria against alternative competing investments.

Financial Impacts of Maintenance

Let us explore some of the more significant issues which the maintenance function impacts on a day-to-day basis. First, and most obvious, is production availability. Without 100% process and machinery uptime, we have less than 100% production availability, resulting in lower than planned sales. But can't lost production be made up on weekends? It certainly can if eroding margins are acceptable. Of course, one might consider shipping out of built up inventory so long as this doesn't conflict with company Just-In-Time manufacturing plans.

A second impact of maintenance is product quality. It stands to reason that well-balanced and well-aligned machinery and processes will produce a consistent, higher-quality product. But can't off-quality product be re-worked? It certainly can if eroding margins are of no concern. Of course, one might consider shipping the off-quality product anyway, so long as Quality isn't an issue with the company's customers.

Insurance premiums are another consideration. Many manufacturing facilities purchase "downtime insurance" in case of catastrophic failure. Some major insurance companies provide advanced high-tech maintenance services, the cost of which if utilized by the customer, is offset with lower insurance premiums. NRC regulations require "efforts to predict and prevent machinery failure" in broad terms, punishable by hefty fines. Energy consumption is still another consideration. Manufacturing facilities typically waste significant excess energy in operating poorly aligned and lubricated power transmission systems. How about safety and loss-time injury? Over 50% of loss-time injury accidents occur within maintenance, the majority of which result from the panic pressures of getting equipment back on-line after failure.

An important additional requirement for consideration today is minimal environmental impact from associated production processes. Within this new assignment, maintenance has enormous responsibilities. The consequences for failure cannot only be safety critical but can have enormous negative reputation implications for the corporation. One only has to recall Union Carbide's Bhopal, India disaster as a reminder.

The significant point made is that the implications of an advanced maintenance strategy (or the lack of one) are far-reaching within the corporation. The measured budget line item costs of maintenance typically range between 5-and 15% of total costs depending upon the process, but at what place in the company's income statement are the implications of reactive-type maintenance on production availability, injury avoidance, power consumption, environmental regulations, and insurance premiums represented? Typically not in maintenance. As we begin to recognize the far reaching economic and fiscal impacts of maintenance, we must also recognize that we will need to define new ways to measure maintenance performance.

A Business Perspective of Maintenance

Businesslike demands are often made of the maintenance function, but seldom is the performance of maintenance measured from a business viewpoint. Most operations managers suggest that the maintenance function should be measured by the **uptime** parameter. Maintenance technicians, however, voice that they have little real control over uptime, and that "downtime" is more a result of excessive machinery abuse related to production demands rather than improper maintenance procedures. In fact, maintenance is more commonly measured by the "speed in which machines are back-up-and-running after catastrophic failure".

Another popular measure of maintenance performance is labor overtime. Logic should tell us that labor overtime is not a valid measure of performance. It is more a measure of nonperformance. Put simply, if we demand reduced overtime, we are not seeking improved performance, but instead are simply seeking a reduction in nonperformance.

Maintenance as it is typically measured is a "zero-sum-gain", and in a zero-sum world, all one can do is hope to break-even. Even if maintenance aggressively manages their expenses and comes in under budget, the question has to be asked "What was sacrificed?"...... Availability,...Quality,...Capacity? To reiterate, if these parameters are not measured in relation with each other, how can one truly quantify positive gains in a zero sum world ?

World-class manufacturers monitor their performance by the parametric measures of quality (ergo Deming's influence), cost ("value" is the politically correct term), and delivery (just-in-time). Maintenance should be measured similarly. Maintenance manufactures capacity, so world-class maintenance organizations should be measured against their capacity quality, capacity costs, and capacity delivery.

No company can be a world class competitor if it's factories are not up to the task. It is therefore an issue of the highest strategic importance to create a maintenance function which provides maximum capacity and availability at optimum costs. The concepts of Reliability Based Maintenance provide a framework to achieve **"Breakthrough"** within the maintenance function, measured by a set of metrics consistent with other critical business performance measures within the organization. This marks the beginning of the recognition that maintenance provides a significant opportunity for manufacturing productivity improvement.

Reliability-Based Maintenance

An effective Reliability-Based Maintenance operation is not just a well run refined predictive maintenance effort, but a new philosophy which forces fundamental shifts in the way maintenance is managed and measured. A first step towards breakthrough is to understand the function of maintenance. The function of maintenance in a world-class operating environment is

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.