5 Essentials of a Preventive Maintenance Program

By Andrew Gager

How managers can move their organization from reactive emergencies to planned activities

fnPrime™

Studies have shown that in a culture of reactive maintenance, organizations are spending three to four times more than planned activities. In some instances, significantly more based on the consequence of the failure.

How many times have facility managers heard someone say, "That's the way it's always been," or "I understand what you're saying but we're different." These are the wrong responses. Instead, departments need to be moving from reactive to a culture of preventive maintenance.

This ebook outlines five essential components of a preventive maintenance program and how to move the facility from reactive emergencies to planned activities. Keep in mind that preventive maintenance alone is not likely to provide a world-class maintenance program. It must be combined with other maintenance strategies to optimize your efforts and results. Preventive maintenance then, is defined as performing regularly scheduled maintenance activities to help prevent unexpected failures in the future.

Best practice for any PM program is when time-based maintenance activities are warranted. The ratios of preventive work verse predictive maintenance versus corrective activities varies widely based on the industry and facility but following these five essential principles will allow the end user to achieve higher performance and reliability from their assets.

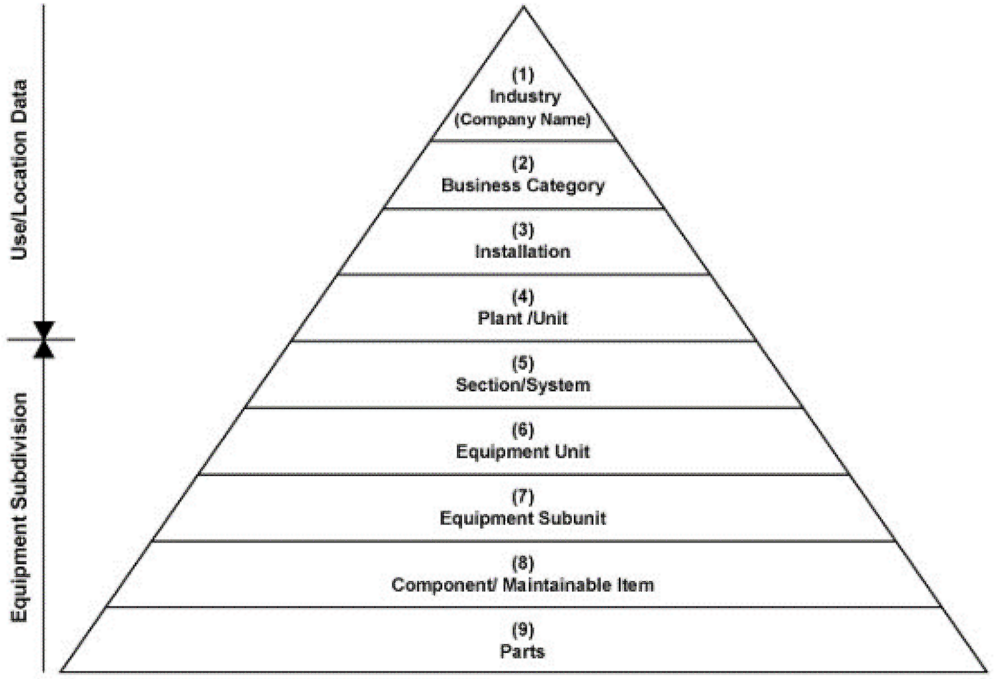
Where those facilities are in their lifecycle, and how their age and condition will impact the organization's ability to pursue its goals and the bottom line.

1. Asset Hierarchy

First and foremost is the accuracy and validation of the asset hierarchy. Whatever computerized maintenance management system (CMMS) facility managers are using, the asset hierarchy must be accurate. Organizations need to know what equipment they have and the relationship cascading down from site, building, system, unit, and components. This is absolute. From this information, asset criticality can be defined and thus starts the process of reviewing the current maintenance strategies, processes, and work management practices.

Validation of the asset hierarchy is conducted by walking down the facility and capturing system and asset information. The hierarchy is structured in such a way referred to as "parent-child" relationships.

One benefit of establishing the parent-child relationship is the development of preventive and predictive maintenance activities. Another is how maintenance schedules are built and how each activity is prioritized. Once developed, the asset hierarchy parent-child relationship allows the end user to easily identify which assets will be considered as maintainable assets.



2. Criticality Considerations

Now that the asset hierarchy and criticality has been established, how do managers identify where to begin the journey of shifting from reactive to proactive? There are several options.

The first is called the "bad actor" list. Based on the Pareto principle, which states that 80 percent of the issues comes from 20 percent of the causes, this program is designed to identify performance gaps in the current maintenance strategies by analyzing unplanned failures. These failures are based on several factors: the consequence of the failure, excessive maintenance costs, unplanned downtime, safety, etc.

Another option is to start with the asset or system identified as the most critical.

Consider performing a Failure Modes & Effects Criticality Analysis (FMECA). FMECA is an analytical method which may be performed at either the asset or system level. FMECA is an extension of a FMEA by including a criticality analysis, which is used to chart the probability of failure modes against the severity of their consequences. The result of this analysis allows the development of mitigations or strategies to address activities that will produce the greatest value and reduce risk. Conducting a FMECA workshop is normally performed as a cross-functional activities. During these sessions the process is defined with all components (inputs & outputs) that impact the performance of the system or equipment. Then identify the mechanism (component) for failure (mode). Classify the potential effects of the failure (effect), potential cause (root cause), any current

controls in place to address that failure mode and then calculate the impact of that failure on the system (RPN). There are several templates for FMEA's or FEMCA's on-line or software specific available for purchase.

An example is below:

After the asset hierarchy has been established and verified, criticality must be determined. Not all assets carry the same weight of importance or consequence from failure. Asset criticality analysis is a systematic methodology that ranks assets for work management prioritization, maintenance strategy development, and other reliability projects or improvements. It provides the foundation for determining the impact that specific assets have on operations. Criticality analysis and scoring is a systematic approach of assigning a criticality rating to assets based on their potential risks to safety, health, environment, or the facility. There are

FUNCTIONAL FAILURE	COMPONENT	POTENTIAL FAILURE MODE(S)	POTENTIAL EFFECT(S) OF FAILURE	POTENTIAL CAUSE(S) OF FAILURE	CURRENT CONTROLS	CURRENT PROCESS KNOWN FREQUENCY	RISK ASSESSMENT (AS IS)				RECOMMENDED IMPROVEMENTS/ ACTIONS
							SEV	OCC	DET	RPN	
insufficient discharge pressure	impeller	improper installation	less product	wrong rotation	none	none	10	10	10	1000	
insufficient discharge pressure	system inlet/filters	blocked	less product	obstructions in lines or pump housing	none	none	9	9	9	729	

other criteria that potentially can determine criticality such as the reputation of the company or security concerns.

This criticality score can also be called risk calculation or Risk Priority Number (RPN) determined by creating a scoring system or matrix based on several factors including severity or consequence of the failure, frequency of the failure, and ease of detection of the potential failure.

Once managers have calculated the RPN, they can begin to develop a maintenance strategy to address that failure mode. The output will be the establishment of a new maintenance task (i.e. PM task) to address that potential failure or at the very least, reduce the RPN to an acceptable or tolerable risk.

This is considered an analysis workshop since it will take some considerable time to identify the function of the asset or system, component(s), as well as identifying all potential failures, causes, and scoring. The members of the analysis team would be considered "Subject Matter Experts" (SME's) and should represent several stakeholders including maintenance, operations, reliability engineers, supply chain, supervisors, planners, suppliers, etc.

PM Task	PM Required	Vibration	Thermography - Electrical	Thermography - Mechanical (rotating)	Thermography - Stationary (non-rotating)	Ultrasound - Electrical	Ultrasound - Mechanical (rotating)	Ultrasound - Stationary (non-rotating)	Motor Circuit Analysis On-line	Motor Circuit Analysis Off-Line	Lubrication Analysis	VT (visual testing)	Other

When conducting a formal FMEA or FEMCA workshop, these meetings tend to take several days or even weeks. Set-up a room with the appropriate equipment (projector, laptop, whiteboard, etc.) so this may be the dedicated room to work. Remember, the input is to identify all the ways that the equipment/system and accessories can fail. This usually takes quite a bit of effort and time. Once that is complete, next determine the best activity or action to address those failures modes. The output is to mitigate or eliminate those potential equipment or system failures.

Documents and manuals should be gathered and brought to the workshop such as OEM manuals, historical corrective maintenance work orders, current PM's, and any other relevant information to assist the team in defining failure modes and causes. OEM Manuals can be a good starting point to review their recommendations. Keep in mind some of the recommendations need to be tempered based on past experiences and histories.

3. Task Priorities

When reviewing failure history, failure modes, and the current PM tasks, it's imperative that each PM task addresses a failure mode or modes. If the task is not addressing a failure mode, ask what the value in doing that task. When writing a PM or task there are five basic questions that need to be addressed:

1. What is to be done
2. How is it to be done
3. What is acceptable
4. What course of action should be taken if the results are unacceptable
5. Are there any safety concerns

When developing these programs, managers should keep in mind preventive maintenance tends to be time based whereas predictive technologies are condition based. Utilizing

predictive maintenance strategies (in the right conditions and environments) can detect potential failure long before it becomes a functional failure. When managers operate in this realm, maintenance planners have what's called a "planning horizon." This means they have time to plan the corrective work correctly and ensure resources are available when scheduled sometime in the future.

Since preventive maintenance programs are time based, they can fail randomly between

PM frequencies. The tricky part is calculating the right frequency to execute those PM's — daily, weekly, monthly, quarterly, annual, etc. Calculating Mean-Time-Between-Failure (MTBF) is one measure managers can use to assist in determining frequency.

1. Inspections
2. Servicing
3. Calibration
4. Testing
5. Alignment
6. Adjustments
7. Installations

There are seven primary activities to include when developing PM tasks:

A good PM task is designed to ascertain the health of an asset to determine if that asset can perform the intended function until the next inspection.

One tip: Don't underestimate the value of a vigorous lubrication program. According to the Society of Lubrication Experts, 50 percent of all bearing failures are due to abrasion or simply put "lack of lubrication" and 60 percent of all mechanical failures are directly related to poor or improper lubrication practices.

1. Gather and Validate Equipment Hierarchy
2. Assess Equipment Criticality
3. Identify Maintenance Requirements (FEMCA)
4. Develop Equipment Maintenance Plans (EMP)
5. Develop Maintenance Tasks/Procedures
6. Workload Smoothing or Manpower Leveling
7. Prioritize and Schedule Maintenance

The PM program follows seven steps in development and execution:

Managers cannot make good business decisions based on feelings. If each department supervisor was asked whose equipment is most critical to the operation, each of them

will gladly state theirs is. There must be some methodology or tool that takes the emotion out of prioritizing work. Typically, the priority of the work considers, safety, health, environment, the timeframe for potential failure, the criticality of the equipment or system, the impact or consequence of the failure.

Usually there is a matrix that considers these areas with a scoring based on the severity or timing. These matrixes are built into most CMMS's today and are configurable. For example: a work request that comes in for a safety issue and with a belief there is eminent danger will most likely have a priority 1 assigned. Meaning, all hands on-deck and correct this issue within 24 hours. Then there is the opposite example. A technician may capture a bearing wearing down by taking an ultrasound reading. History says departments have three months before that bearing seizes. That priority on that corrective order may be a priority 3 or 4 based on how managers configure the timeframes for each priority number.

Here's an example of priority timelines:

Priority 1 work – Must be completed within 48 hours
Priority 2 work – Must be completed within 7 days
Priority 3 work – Must be completed within 15-30 days
Priority 4 work – Must be completed within 30-90 days
Priority 5 work – Must be completed within 6 months - 1 year or considered for shutdown work

All corrective work (remember, PM's are not included here. They should already be scheduled based on frequency), have a priority number. Priority work 3-4-5 are placed in the planner's backlog. That may sound wrong, but backlog is good. Managers want backlog. A world-class organization has 2-3 weeks of what's called ready backlog. These are the jobs where departments have the materials, tools, and resources to complete now. These are the jobs that the planner/scheduler uses to determine next week's "frozen" schedule for maintenance work and agreed to by operations.

Departments also want 4-6 weeks of total backlog per skill. Those are the jobs waiting to be planned by scoping, determining material requirements, specialty tools, work centers (i.e. mechanical, electrical), contractors, safety concerns, permits, correct sequencing of tasks and steps, etc. This 4-6 week of total backlog includes all maintenance activity not yet completed (Not past due work). This includes all corrective work, PM's, predictive routes, inspections, standing work, etc

4. Resource Management

Organizations must ensure that the appropriate resources are in place. If departments don't have the right parts, at the right time, in the right quantity, to the right specification, then everything else will fail.

To successfully move towards a proactive culture, there must be a solid materials management program in place. This includes a high level of inventory accuracy with standard operating procedures in place and a first-in-first-out issuing policy. The PM program should also include someone to manage and care for the spare parts inventory. This person will manage supplier agreements, oversee the vendor managed inventory, develop strategic sourcing policies, identify critical spares, and set minimum and maximum stock levels along with reorder points.

All these items, process, practices, policies must be in place to support a world class maintenance group and the facilities goals and objectives.

In addition to products, organizations need to have the right people with the skillsets and competencies to execute the work management strategies. Managers can ensure this by conducting a job task analysis. This means asking what are the tasks that are required for the position? What are the minimum skill requirements to execute each task? Then conduct a skills assessment against those requirements for each position. From this assessment, a skills gaps matrix is developed. From the skills gap analysis, a training program is established with a budget.

There are a lot of organizations that schedule their maintenance teams and individuals to 100 percent or 90 percent utilization. However, world-class utilization is 65 percent. By scheduling a person to 90 or 100 percent is setting them up for failure. If they are achieving that utilization, one should question the validity of the time estimates on the PM's or corrective

work. Based on current studies, the average utilization of a typical technician is between 17-24 percent.

To move from reactive to proactive maintenance, managers should break their team up into three work groups. One dedicated

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to executing PM/PdM work, one group dedicated to corrective work, and the third group dedicated to responding to emergencies.

Best in class organizations assign 60 percent of their maintenance workforce to PM/PdM work, 30 percent to corrective work, and 10 percent to answering emergency calls. Now with that said, if teams are currently working in a reactive environment, this won't work.

Managers can start tracking the number of hours consumed for emergency work each week. They still need to account for those average hours but also need to execute PM & CM work as well. Maybe start out with a ratio of 20-20-60 because the amount of emergency break-in work is so high. But as things settle down and work begins to get planned and prioritized, then the ratio may switch to a 30-30-40 for example. As the organization matures, that moves to a 40-30-30 ratio and so on.

5. Action Plan

Planners should be releasing all PM's for the next 30 days and conducting what's called "90 day lookahead." Planners should be working in the future. By looking 90 days out, they can see the workload coming down the pipeline and move work in or out of the weeks that exceed the available hours of the workforce. This is called level loading. Managers want to level the amount of work across the weeks, so we don't have one week with too much work and not enough to keep staff busy the next.

There's also a process called "52-week rough cut scheduling." This, too, is a leveling tool to look down the road for major work such as shutdown or turnarounds. By doing so, managers can make recommendations about staffing and support.

The Computerized Maintenance Management System (CMMS) plays a major role in fully realizing the department's efforts. As mentioned previously, managers and others can not make good business decisions using poor data. It is imperative that the information in the CMMS is of high quality to a standard. Accurate asset registry, hierarchy, bills of materials, proper work order process, PM's, PdM strategies, planning, scheduling, materials, priority system all contribute to the success of the department and moving from reactive to world-class.

And finally, never forget the people side of the business. None of these strategies will function without the support of people. Leadership, supervision, and culture all play a major role in determining those that succeed or those that fail.

Moving from a reactive environment to a proactive culture takes time. Management must build a strong cocoon around the maintenance group so things can evolve and improve. It won't happen overnight but how does one eat that elephant? One bite at a time.

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