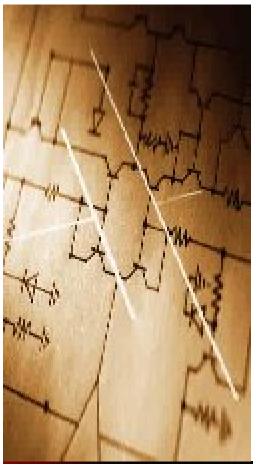
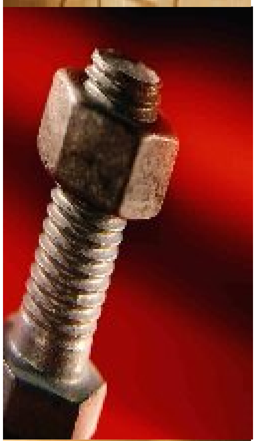



SYNERGISTIC

The Evolution of Maintenance™

Introduction

Synergistic Manufacturing Systems

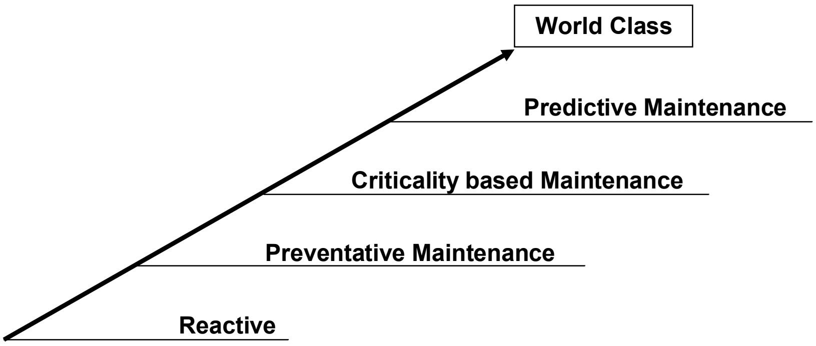


The Evolution of Maintenance™

The Evolution of Maintenance™ was developed to put the change process of maintenance into a logical sequence so that we can allow your maintenance department to recover the equipment reliability in your plant. Throughout the process fundamental parts of PM, TPM, MBP and RCM are engaged. The difference with this programme is that the elements of these programmes are engaged in the correct order to achieve measurable results on the bottom line.

This programme will in time yield maintenance budget savings, however the intention of this programme is to increase equipment reliability as quickly as possible. This will allow the potential of the existing plant to be unlocked leading to significant increases in plant output and corresponding profit increases.

The Evolution of Maintenance™ explained



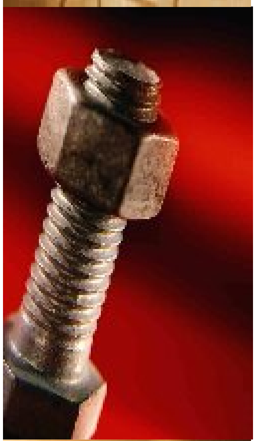
<u>Reactive</u>

In many plants at this level the maintenance people wait until the failing machines have stopped before fixing them. The problem with this is downtime from the failures gets more expensive as plants get bigger and the economies of scale work against you.

<u>Preventative Maintenance</u>

A popular solution is to check machinery to avoid the failures. Historically this has meant dismantling the machinery to survey the condition of the parts. In this programme however, you are encouraged not to do this because historically you can still expect a 10% start up failure caused by human error regardless of the level of skill in your maintenance staff.

Instead this step in the process should be used to collect information on equipment and to determine the overall condition of the machinery.

Simply record the following for each machine:

1. Check drive belts
2. Listen to gearbox and motor bearings
3. Check gearbox oil level
4. Check for oil leaks
5. Check motor and gear box temperatures
6. Check torque of slide arm bolts
7. Measure motor running Amps
8. Mega motor winding

Another clear option is to review the manufacturer's manuals and follow their recommendations. However many manufacturers know very little about maintenance and therefore the quality of the recommendations varies dramatically. Also it is normal for machinery manufacturers to insist on checks that are excessive in both scope and frequency. Their intention is to ensure that the machines get through the warranty period without catastrophic failures that the machinery supplier will be liable for. Secondly it is in the interests of machinery manufacturers to sell you spare parts therefore they recommend maintenance routines that favour this.

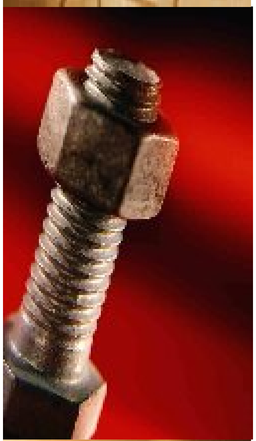
By all means use these recommendations but be realistic about the inspection frequency. This can be done by just going to the machine and having a look. Assuming that there has been no PM work done in the plant before this, any checks are better than nothing.

PM checks will reveal work that needs to be followed up. Some of it will be urgent, some of it can wait. It is important that urgent work gets done but care must be taken not to overload the planner while the CMMS is being set up. I would suggest your existing reactive maintenance people cope with planning and completion of this follow up work until the CMMS is fully implemented.

All other non-urgent follow up tasks must be listed and prioritised correctly within the new CMMS system.

It is extremely important that you don't roll out the formal maintenance checks until the system is fully set up and ready to go. The planned work orders that come from these checks will ensure that the follow up work immediately improves reliability.

Do not underestimate the value in local knowledge that comes from the existing staff who can often pinpoint the potential trouble spots from their experience. You can obtain very quick wins by addressing these issues at an early stage both by reacting to the immediate issue and locking down follow up checks that stop a repeat of the same issues in the future.

Check list for this step

At the completion of this step you must be able to achieve all the requirements below

1. Establish equipment numbering system and number all equipment on CMMS
2. Develop PM program for each piece of equipment
3. Have accurate equipment bill of materials
4. Provide PM inspection work orders from the CMMS
5. Include part requirements for planned jobs
6. Provide necessary drawings for jobs from links to the CMMS
7. Arrange for special tools and equipment
8. Provide cost information from equipment history
9. Work from weekly maintenance schedules negotiated with operations

Strict rules of the PM phase

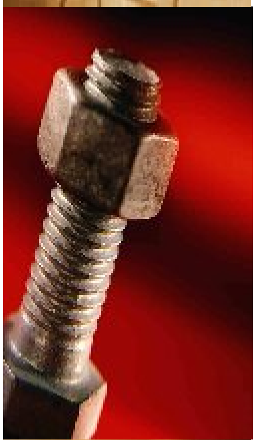
1. Keep the checks simple but capture as many as possible on each machine
2. On these first checks (during set up) capture all the follow up work but only do the urgent follow up work
3. Don't allow the planner (or the person setting up the CMMS) to deal with the urgent follow up work as this will slow down the set up and implementation
4. don't start the roll out of the formal maintenance PM checks until the whole system is ready

Criticality Based Maintenance

At this phase we implement a process loosely related to the criticality measure in RCM although I believe that a full RCM is overkill in some maintenance environments where the consequences of failure are negligible. We have simplified it for these low risk plants to allow for a smoother application.

Keep in mind the Pareto Principle is very evident here as 80% of the failures do come from 20% of the plant. The same is true with the costs in maintenance - 80% of the money is spent on 20% of the plant. What we are intending to achieve is the formal identification of these pieces of plant and to minimise their impact both in downtime and in cost. This can be achieved either by the light process as suggested below, or by completing a full blown RCM study.

Most maintenance departments categorise their plant between 1 and 5 for RCM criticality, or they use some sort of criticality matrix chart.

When completing a full and extensive RCM study most software packages link tasks to the assets based on the outcome of this criticality e.g. cost impact, consequence, frequency etc. If you are not using software then this is a hard process to do for every asset.

I say that this process is too intensive for most low risk plants that don't have serious consequences from catastrophic failures. Therefore you only need categories 1 to 3 this make the process much more understandable and manageable. For example:

- Cat. 1 - If this plant fails it will stop the process.
- Cat. 2 - If this plant fails there is a limited time before the process stops.
- Cat. 3 - There is built in redundancy so this will not affect the process.

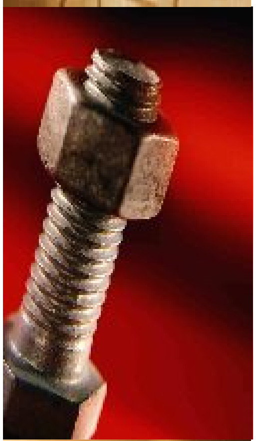
The reason for only three is that clear rules can be applied to these three categories. By following these rules you can quickly identify where to focus your maintenance efforts. This will ensure that you don't apply expensive predictive process to equipment that is not really going to give you justifiable reliability gains. The rules that apply to each criticality are as follows: -

- Cat. 1 - Asset based checks with a high level of predictive maintenance.
- Cat. 2 - Route based inspections with low level (yes/no) predictive maintenance.
- Cat. 3 - Operator Route checks with follow up managed by maintenance.

It is important to understand that I am presenting the lightest possible group of processes that can be implemented and still achieve a result. However in production plants that have significant risks in the process I recommend a more formal and comprehensive criticality assessment is undertaken. Significant risk comes from operations with economies of scale because of the cost of any down time or the consequences from catastrophic failure.

I have used RCM (Reliability Centred Maintenance) assessments in such plants with great success. There are some very good consulting companies that can train and coach your staff to complete this step. Keep in mind that the more comprehensive the programme, the more it costs to set up and run. Therefore there needs to be real risk in the process to justify this type of extended programme. However in the right application there are significant benefits for the reliability of the plant.

The most important thing that needs to be highlighted is that no level of criticality study should be undertaken until your maintenance department has completed the requirements of the first two steps of the evolution process.

Attempting to jump ahead by doing any form of criticality study will see you putting money into a high end programme that may not be sustainable because the foundation of your maintenance department has not been built.

<u>Predictive Maintenance Step</u>

It is extremely important that this predictive maintenance step is done after the criticality study. At this point having identified the criticality of each piece of equipment we now need to apply the correct form of predictive maintenance to the category 1 and category 2 pieces of equipment to ensure that we are effective in predicting the upcoming failures and to ensure that we are doing it as economically as possible. You can now disable the PM check for the category 3 checks as where their failure will not affect the process and where their failure will not have catastrophic effects on maintenance costs.

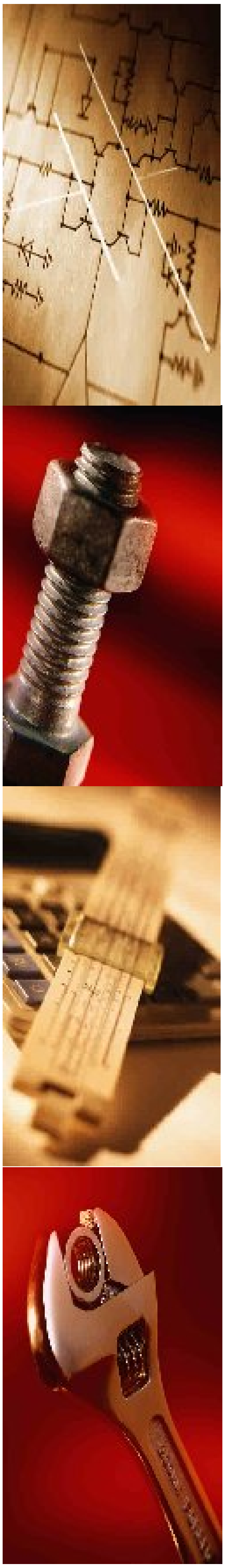
It is very easy to waste money on unnecessary activities at this point. Every plant that I have gone into that has set up some form of predictive maintenance activity has been doing considerably more predictive maintenance on plant than is necessary.

Often this is because an external provider for condition monitoring has been given a mandate to complete a study and come up with a recommendation. This will inevitably result in the over-checking of our plant. Over-checking has two benefits for these people:

1. They will charge you for the extra unnecessary work.
2. Reliability of all equipment will be improved whether it needs to be or not, incurring significant extra and unnecessary cost.

Even worse is the flood of information on equipment condition for machines that will not affect downtime. Often the focus becomes what is going to fail the soonest and not what will have the largest effect on plant downtime. Keep in mind that running some low criticality equipment to failure is the most economic way to operate it especially if it does not affect downtime.

This generates the 'I told you so' factor within the condition monitoring company, as every time there is a plant failure in a critical area (Cat 1) causing downtime, the last report showing deterioration in the condition readings will be produced as evidence. These Cat 1 items are often neglected due to being overwhelmed by the volume of Cat 2 and Cat 3 items that appear to need more urgent attention. This will inevitably overwhelm your planner and lead to avoidable Cat 1 failures causing downtime.



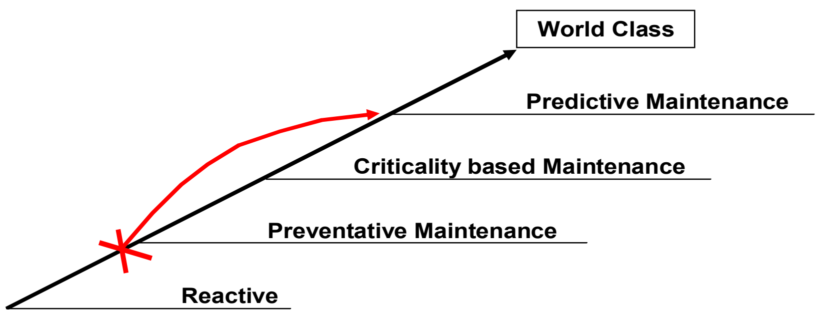
By completing this step properly you can take control of the scope of the input from your condition monitoring providers, and better still, you can use this scope to get quotes to complete this work. You will be surprised how much maintenance money this will save you.

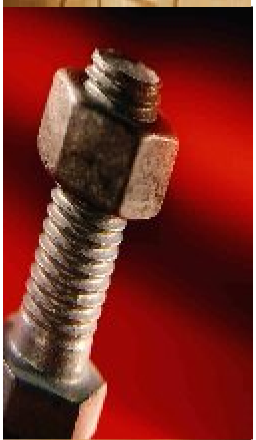
How does it go wrong?

Many companies claim to want to be ‘world class’ in all areas of the business. In truth this just means implementing good manufacturing practices until they determine that they are running ‘best practices’ or are ‘world class’ in the area being measured. I contend that there is no time in which you can stop making improvement-related change. It is just that the gains from the change get harder to achieve and ultimately more expensive against the increased returns. However, the day you believe you are the best and stop changing you will start going backwards. The drive toward ‘best practices’ never ends.

97% of all companies who attempt to implement ’world class’ practices, or just good manufacturing practices in maintenance fail to do so. It is interesting that all companies, regardless of the programmes they choose to run, seem to make the same mistakes. Having made the all-important step of identifying the need to change, they launch into it putting together PM checks for everything. However before they have completed this step they buy predictive tools (vibration analysis equipment, thermography cameras, oil analysis etc.) and use these tools on everything because it is lots of fun to do so.

In situations where the maintenance department doesn’t get approval to buy these tools they move to contracts with outside providers who come onto the site and do a survey that encompasses everything they can possibly do (because that’s how they get paid) and supply reams of data from all this analysis to the maintenance department. Consequently the volume of data from every asset on site (many of these assets have not been entered into the computerised maintenance management system CMMS because the PM phase has not been completed) overwhelms the maintenance department. The continued bombardment of data from the predictive checks, two thirds of which are on equipment that doesn’t require this level of attention is left to a CMMS that does not yet have systems in place to prioritise or complete this work.



What has gone wrong is the failure to have all the assets in the CMMS:

- This stops the development of more preventive checks on the critical assets as you move forward.
- The follow up work from the checks can not be prioritised, planned and scheduled because the system is not ready to process the influx of work
- Everything that has been entered is being checked from extremely critical through to work that will have little or no effect on plant downtime.
- Data from vibration analysis is trended and a vast amount of effort is put into the collection and processing of this data, most of which is of little benefit.

In effect what has happened is that the important step of completing the asset load into the CMMS has not been achieved and checks have not been set up for all the equipment. By not doing this and continuing to move forward, you run the risk of not entering equipment that is of high criticality and these critical assets often never get loaded.

If the planner gets overwhelmed by the follow up work from the first checks and the maintenance people get consumed playing with their new predictive maintenance toys the system will fail. The maintenance department will be forced back into reactive procurement due to the inability to plan efficiently, the critical asset still fail, generating downtime and ultimately any efficiency gains are lost.

In every site that I have visited, in companies that want to get to ‘world class’ in maintenance, this has been the case. Further, the maintenance auditing tool used to check on the progress of maintenance on these sites rewards the maintenance team for doing so.

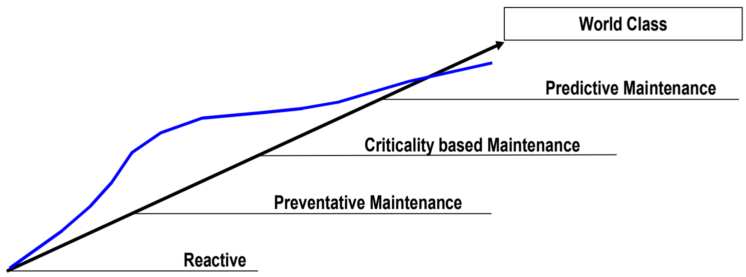
This is done simply by rewarding results for gains made in areas where the department is not yet ready to operate from a systems and processes point of view.

From here the tangible gains of plant reliability improvements can not be fully realised and the programme sponsor within Senior Management loses faith in the programme and makes some sweeping changes to reduce costs.

<u>The Maintenance Hump</u>

Following The Evolution of Maintenance™ there are consequences for the maintenance costs in your plant. If you are a Maintenance Manager you need to ensure that the programme sponsor in Senior Management is aware of this and has allowed for this in the maintenance budget.

The consequence of this change process is the ‘Maintenance Hump’. When this hump is applied to The Evolution of Maintenance™ it looks something like the diagram below. The faster you make change using this programme the bigger the hump and the worse the starting condition of your plant the bigger the hump.



The reason for the hike in maintenance cost is due to the requirement to continue doing the breakdown maintenance while committing labour to preventive maintenance checks and maintenance inspections. There is a cost to this labour as well as the requirement to repair the things that are found to be wrong with each machine that is being inspected. It is generally safe to say that if a plant has been stuck in breakdown mode, and assuming that the appropriate maintenance checks have not been undertaken, then the remedial work to recover the plants condition will be extensive. Hence the hump in maintenance cost.

When the condition of the plant has been recovered it is possible to predict a majority of the upcoming failures and thus avoid them. This has the advantage of only having to repair the equipment once and not having to patch it continuously to get production running. There is no rushing to get parts when the plant is down thus incurring elevated freight costs along with being unable to negotiate a better price for the required parts. By avoiding these extra hits in cost the maintenance costs drop due to good maintenance practices. Combined with this, a significant improvement in equipment reliability means your plant is on the fast track to bigger profits and sustainable growth.

Sean Stayner

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