SoftSols Group Limited | White Paper

The Need For Effective Maintenance

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Why maintenance management?

The nature of any item of equipment is that there is always an inherent risk that it will breakdown. By breakdown we mean that the item is unable to perform the function for which it has been designed. To restore the functionality an action requiring time and usually materials must be undertaken. Once this action has been completed the equipment should be able to perform its design function.

We have now described the activity of maintenance. We are trying to maintain the design capability of the equipment. The next question is why do we need to maintain this capability? The reason is that an investment was made to acquire the equipment and we need to have a return on that investment i.e. performing the function for which it was designed.

The art of good management is to maximize the return on investment so we need to minimize the time that the equipment is “broken down”, hence the requirement for maintenance. We need to undertake a repair to restore the functionality.

In this paper we will refer to a perfect model for maintenance - the family car. It is probably the easiest example to understand in the context of maintenance activity. Let us take this example and examine it with reference to the statement made at the beginning. A motorcar is a series of elements assembled to provide the function of transporting people and goods from point A to point B on demand. The output of the car is kilometres/miles on demand. If any part of the car is not functioning as designed e.g. the cooling system or the lubrication system it will prevent or delay the delivery of kilometres/miles. In the event that the car overheats we are required to fill the radiator with coolant. This should allow the car to deliver additional output. We have now maintained the car.

What are the benefits of maintenance?

The benefits of maintenance are as follows:

Reduce breakdowns of plant & equipment (5 – 15%)

Effective Planned Maintenance reduces the risk of breakdown by inspection and replacement of parts. If equipment is in good condition it will prove to be more reliable, therefore run longer.

Reduce stock holdings (15 – 25%)

By identifying and recording the spare parts used it is possible to identify obsolete and redundant stock. By introducing an Inventory Management system the identification of duplicate stock will also reduce the overall stock.

Reduce inventory stock outs (15 – 30%)

By recording the usage of spare parts and by utilizing Kit Lists to predict the requirement for spares the occasions when stock is not available are greatly reduced.

Improve labor utilization/productivity (5 – 15%)

Effectively planning tasks and coordinating resources increases productivity. By making support information such as drawings, procedures and documentation, available at the right time, work can be completed more effectively.

Reduce scrap (5 – 15%)

Where plant and equipment is kept in good order then the risk of making bad product is reduced. A good example would be mould inspection.

Reduce lost time

By effectively planning repairs, having spares available, having the correct tools and skills will reduce the time taken to maintain or repair an asset. Historical information will assist in the diagnostic process. Using the breakdown reporting feature it is possible to highlight the process when maintaining an asset.

Extend asset life

By effectively maintaining the condition of an asset it is possible to extend the useful life of the asset. If the meantime between failure is still acceptable and the incident of breakdown is still acceptable then there is no requirement to replace the asset.

Reduce capital expenditure

By extending the useful life of the asset the requirement for capital is delayed. This will avoid the interest burden on borrowings or allow capital sums to appreciate.

Reduction in the Unit cost of production

If increased throughput is achieved with the same amount of resources then the unit cost is reduced.

How are the benefits achieved?

The benefits of maintenance can only be derived by implementing a systematic approach to the maintenance function. The approach must be subscribed to by the organization as a whole. This last point is significant as traditionally the attitude towards maintenance has been:

a) It is a necessary evil
b) It is a black hole of costs

The starting point, in a large number of cases, is that maintenance is undertaken on a reactive basis i.e. wait until breakdown occurs before maintenance occurs. This is the most expensive form of maintenance. The stoppages are unscheduled, production is disrupted, and resources may not be available resulting in extended downtime. The consequential costs of downtime are:

a) Lost production
b) Non-recovery of overheads
c) Process restart costs
d) Lost sales
e) Lost customers

There are organizations that can effectively run this way. These would typically have a lot of plant redundancy built into the process so that in the event of breakdown the process can be switched to alternative equipment. This allows maintenance to be carried out whilst the equipment is off-line and not affecting the production process. This method, however, is capital intensive.

The next step forward is **Planned Preventive Maintenance**. This can be defined as:

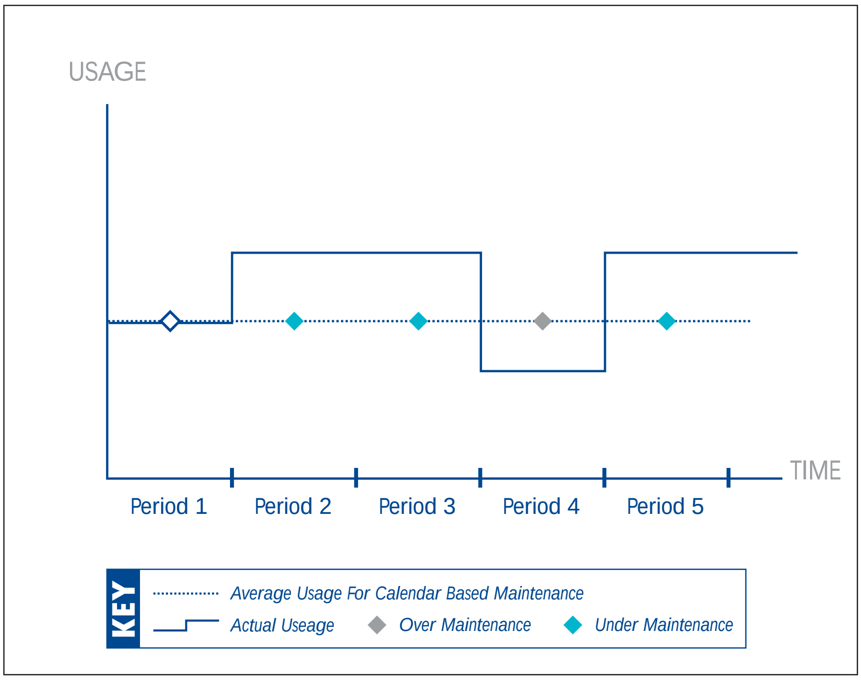
> ‘The correction or prevention of faults by a program of inspection and the replacement of parts.’

The program is developed so that the activities and the frequencies are such that the risk of unplanned shutdown is greatly reduced and the incidence of breakdown is reduced.

The frequency of activity can be determined by a number of factors. The most common is based on calendar time giving us frequencies based on day, week, month and year. Examples of this would be daily inspection, weekly lubrication, monthly replacement of filter and annual refurbishment. This approach assumes that the asset is worked at a constant level throughout the period and does not take into account any fluctuation in usage. Where there is a fluctuation in usage then there is a risk of under maintenance in a period of high activity and over maintenance in a period of low activity.

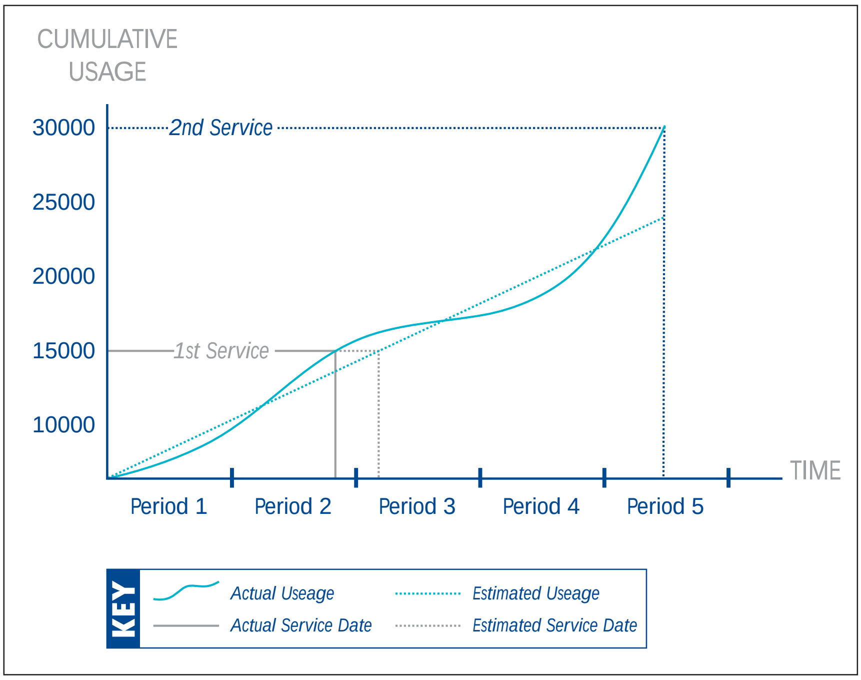
In the example below *(Fig 1)* only week 1 fits the pattern of activity. Weeks 2 and 3 are showing under maintenance whilst week 4 is showing potential over maintenance.

Fig 1: CALENDAR BASED MAINTENANCE



Where activity tends to fluctuate then a more appropriate method of scheduling maintenance is **Meter Based Maintenance**. This method will match planned maintenance activity to that of the equipment. Going back to the example of the family car, this is how services are scheduled e.g. very 15,000 kms. Once the meter measuring activity, in this case the odometer, has reached the specified amount then maintenance occurs. This may be on an irregular calendar basis *(Fig 2)*.

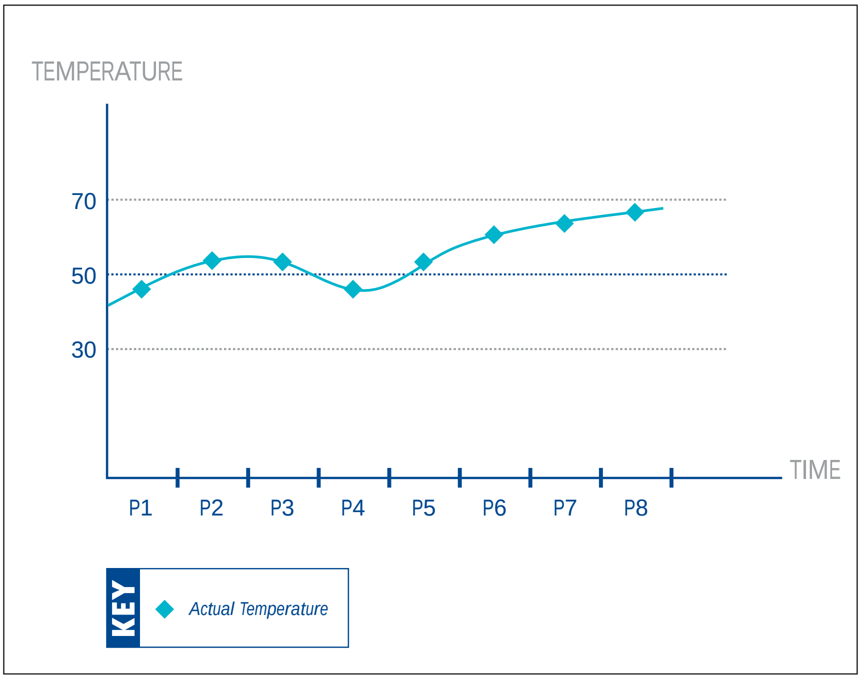
Fig 2: RUN TIME MAINTENANCE



Because of the changing usage the time between each service can vary.

However in both the scenarios above there is a risk of over maintenance. This is because the equipment may be operating perfectly well at the time maintenance is scheduled. Any planned maintenance activity is not really necessary, incurring unnecessary cost and unnecessary down time. To overcome this problem planned maintenance can be scheduled on a **Condition Basis** *(Fig 3)*. This can be summed up in the expression " If it ain't broke don't fix it". The principle of condition based maintenance is that a certain condition, such as temperature, is measured on a regular basis. If the reading is within certain levels then no action is taken. If, however, the temperature exceeds these levels then it indicates that there is a problem that requires maintenance activity.

Fig 3: CONDITION BASED MAINTENANCE



The other aspect of condition based maintenance is that reasonable predictions can be made of the likely condition of the equipment being measured. We can therefore reasonably refer to this form of maintenance as **Predictive Maintenance**. This allows the operator to plan a scheduled shutdown before the predicted failure time. In figure 3 above, no action is taken whilst the readings are below 70 but as the curve indicates the temperature is likely to exceed 70 at a specific time so action should be planned.

The final method of scheduling maintenance is on a **Project Basis**. This is usually undertaken where the process is continuous such as a blast furnace, oil refinery or a ship. In this case major maintenance is planned for the time when the process is stopped. Everything is then done over a planned shutdown period. This is best viewed as a project as there will be multiple activities and complex scheduling of resources. During the time of production reactive maintenance is carried out to maintain the process.

What are the measures?

Once a system of planned preventive maintenance has been introduced the results of the investment need to be monitored. There must be an effective return on investment. We therefore need to measure:

a) Availability of equipment
b) Reliability
c) Downtime
d) Fault analysis
e) Mean time between failure
f) Mean time to repair
g) Backlog of work
h) Labor utilization
i) Planned vs. unplanned work
j) Budget vs. actual cost
k) Spare parts inventory value

Let us look in more details at the measures:

Availability of Equipment

Through effective maintenance the availability of equipment should be increasing. By reducing the number of unplanned stoppages the actual running hours of the equipment should increase. Instead of looking through every record a percentage is calculated by dividing the actual hours of use by the planned hours of use. This will highlight the poorly performing equipment items. If the percentage is plotted over time it will indicate the increasing/decreasing performance and hence the effectiveness of maintenance.

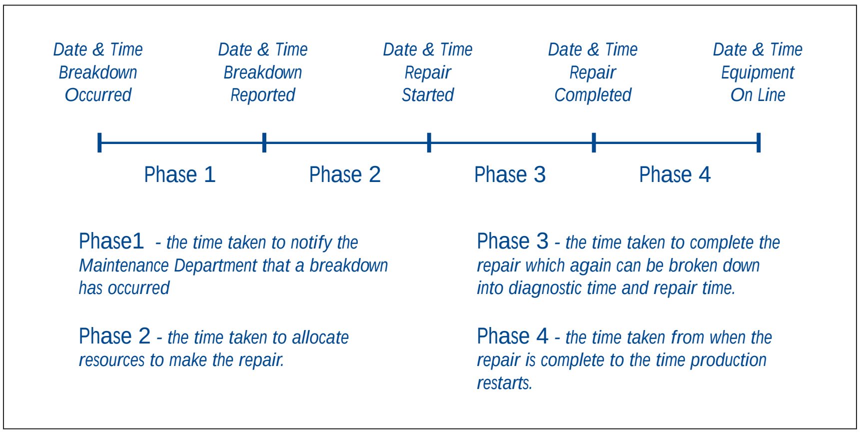
Reliability

Maintenance procedures should be such that the risk of breakdown is reduced. If the equipment is in good operating condition then it should be available to work as required.

Downtime

When a breakdown does occur it is important to minimize the effect in terms of lost production time. Downtime is the time from when the breakdown occurs to when the equipment restarts production. This time can be broken down into a number of elements (Fig 4).

Fig 4: ELEMENTS OF DOWNTIME



What can also be measured is anything that can cause delay. This includes lack of materials, denied access to the equipment, meal breaks etc.

When looking at overall down time measures can be introduced to minimize the time taken at each phase.

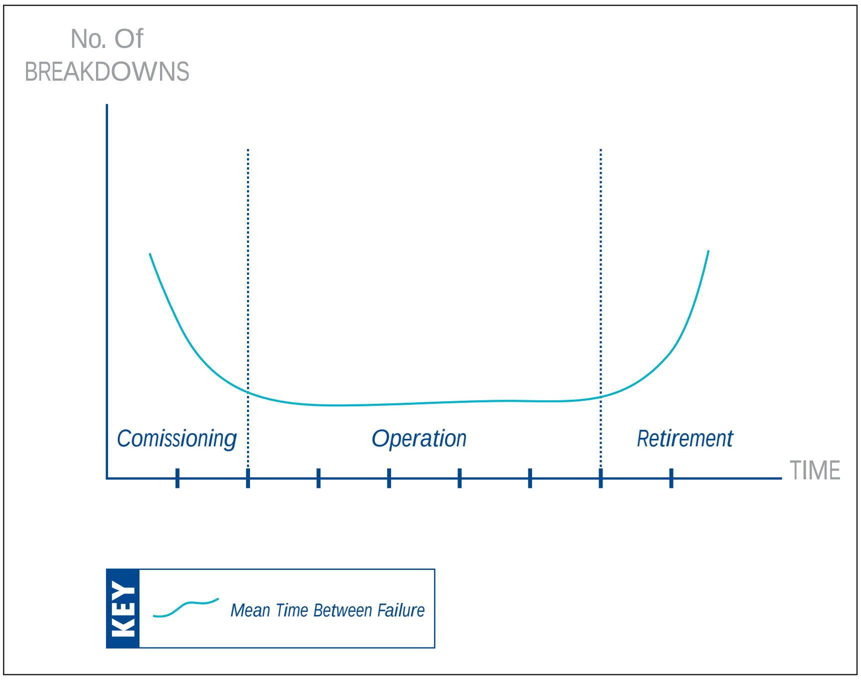
Fault Analysis

If a breakdown does occur we need to know the reason. By tracking faults it is possible to highlight recurring faults, identifying the requirement for engineering change, process change, change of supplier, improved operator training etc. By recording information relating to symptoms, causes and solutions it is possible to construct a diagnostic knowledge base.

Mean Time between Failure

One of the standard measures of reliability of equipment is how long, on average, will the particular piece of equipment operate before the risk of breakdown. The measure of the success of maintenance is to record an increase in the meantime between failure. The change in the MTBF will also indicate that the equipment is nearing the point of replacement. The Bath Tub Curve (Fig 5) best illustrates the characteristics of equipment.

Fig 5: THE BATH TUB CURVE



During the Commissioning phase there is usually a high incidence of breakdown but decreasing over time as modifications are made etc. During the operating life there is normally a random occurrence of breakdown. Once into the retirement phase there is an increasing trend in the numbers of breakdowns. The MTBF will indicate this trend so that capital replacement strategies can be put in place.

Mean Time to Repair

How long, on average, does it take to complete a repair? This measure follows on from the recording of downtime. Again the success of maintenance is measured by the decrease in the meantime to repair.

Backlog of Work

By measuring the number of outstanding jobs at the end of a specified period and comparing the number to the end of the previous period it is possible to measure how successful you are at managing the maintenance requirements. As well as the number of jobs, the number of estimated hours of work should also be calculated for each craft/trade. This will indicate conditions such as the wrong skill mix, poorly trained staff, increasing maintenance requirements etc.

Labor Utilization

Labor utilization is the measure of available hours vs. actual hours worked. This measure can be used to show how effectively we are allocating work, whether the skill mix is correct. It may also illustrate that our recording systems are not working correctly. Again the increase in the percentage of labor utilization is what we are looking for.

Planned vs. Unplanned Work

The purpose of effective maintenance is to move the ratio of activity from unplanned to planned maintenance. As the balance swings in favor of planned maintenance it will indicate that the maintenance strategy is effective.

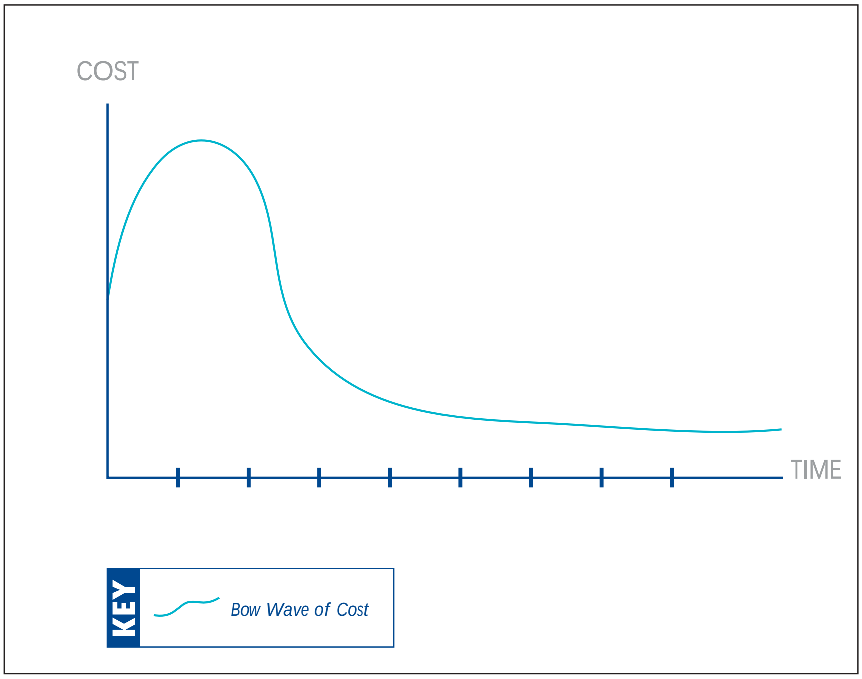
Spare Parts Inventory Value

With the introduction of effective recording of the usage of spare parts it is possible to rationalize the stocking of spare parts. Through the planning of maintenance activity it is also possible to rationalize the purchasing process, both of which should help to reduce the amount of capital tied up in the holding of stock.

Budget vs. Actual Cost

Cost is always indicative of the success of any strategy. We should always hope to see costs reducing or at least within the budgeted limits. The other purpose of this comparison is to prompt investigation into both over and under expenditure. Under expenditure will suggest that some planned task has not been undertaken which may have other consequences (Fig 6 - see over). You should always bear in mind that when starting on a planned maintenance strategy there may well be a surge of cost to bring existing equipment up to a maintainable level.

Fig 6: THE BOW WAVE OF COST



There is an ever-increasing number of key performance indicators being developed to measure the effectiveness of maintenance.

Computerized Maintenance Management Systems (CMMS)

To achieve the benefits and provide the measures the implementation of an effective system is essential. The facilities available in most CMMS supplied today will provide the required tools to make a preventive maintenance strategy successful. However, the installation of a system is not a guarantee to success. It is the basic understanding of the principles of preventive maintenance that ensure tools such as CMMS can be used to produce the desired benefits to any organization.