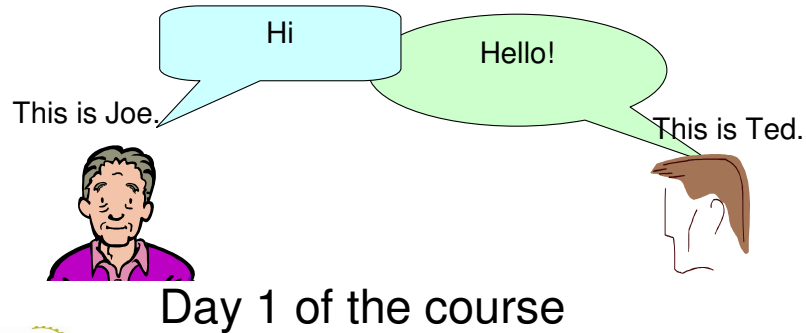


The role of Maintenance Planning in business and its foundation basics

Joe and Ted will take you through the course presentation.



Lifetime Reliability Solutions

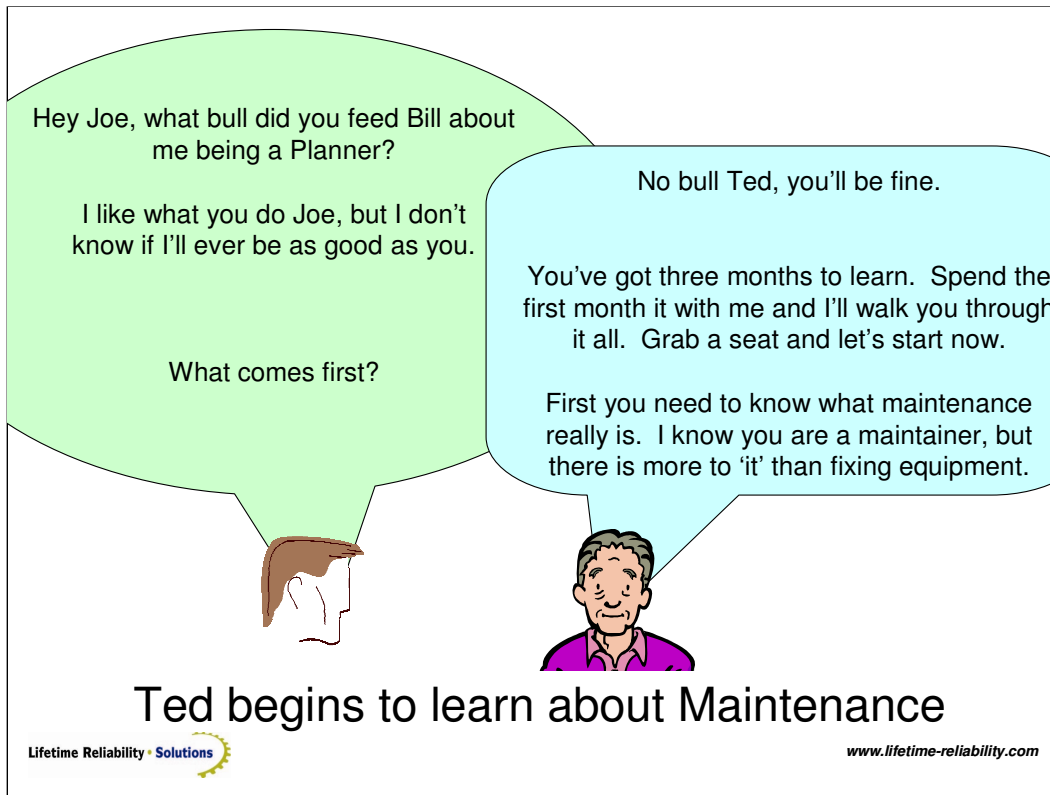
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Maintenance Planning and Scheduling exists because it gives value to those businesses that use physical assets, including plant, equipment, machinery, facilities and infrastructure, in providing their product to paying customers. The value planning and scheduling contributes is by minimising the waste of time and resources used in caring for an operation's physical assets, so production can be maximized.



In a small operation the planning and scheduling function can be part of the role and duties of workplace supervision. It becomes part of a day's work for the Team Leader, or a Workshop Supervisor. Unfortunately the planning part of planning and scheduling is dropped when time becomes tight. Shortly after planning stops the jobs start going wrong and consequently the amount and cost of maintenance increases.

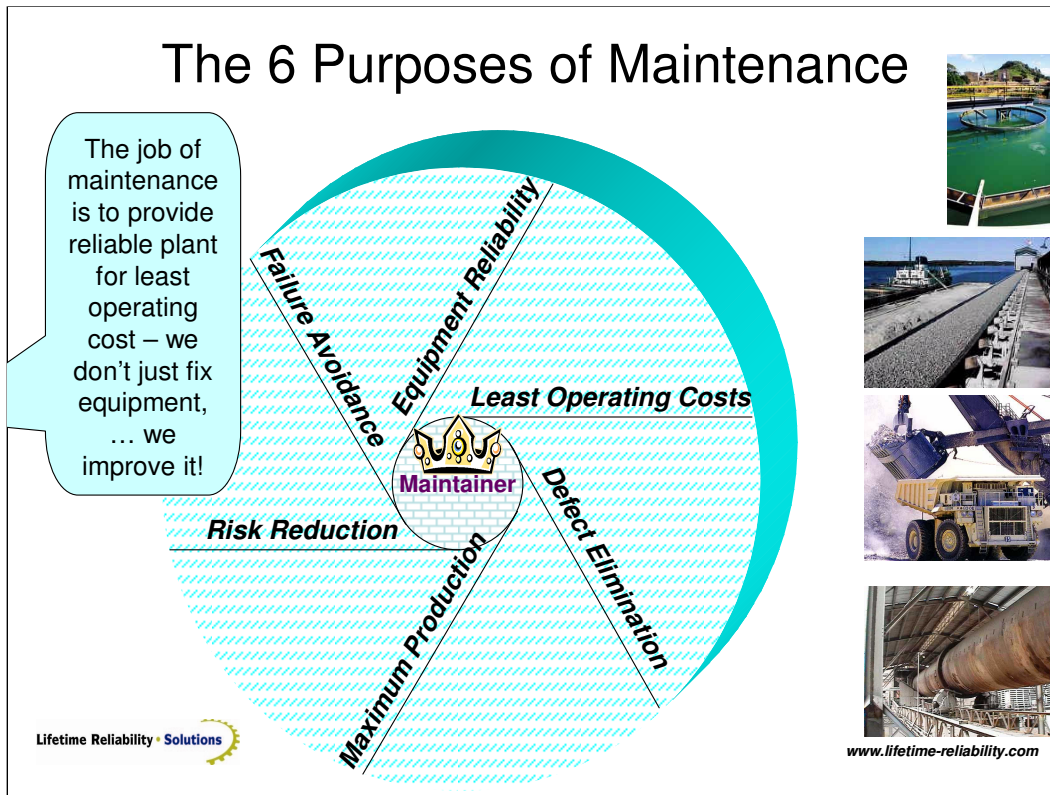
In larger operations planning and scheduling become the whole job of a person. In still larger enterprises the planning and scheduling are separated and designated persons do each job.



To be good, really good, at a job, any job, you have to know everything about it. Things like - why it is done that way, what was its history, what works and what causes problems, how to fix the problems if they appear. When you become expert everything is easy. But that takes exposure to situations along with discovering the best way to handle them. It takes learning all that you can from others, and from what is written by others about what you want to be good at.

I remember talking with a guy that I had worked with for years and he surprised my by saying he was a competition rifle shooter. When he talked to me his passion for target shooting welled-up from him. He described how he measured the gunpowder into the cartridge; just the right weight to get the right trajectory. Not enough and the bullet went low, too much and the rifle kicked high. He told me how the bullet tumbled its way to the target and as it rolled end over end any turbulence in the air would cause it to stray from target. He said how terribly important it was to adjust the sighting for the strength of the crosswind blowing. He described how he lined-up the target and virtually 'coached' the bullet to the bullseye. He knew everything there was to know about his sport and the requirements to master it. He was an expert marksman.

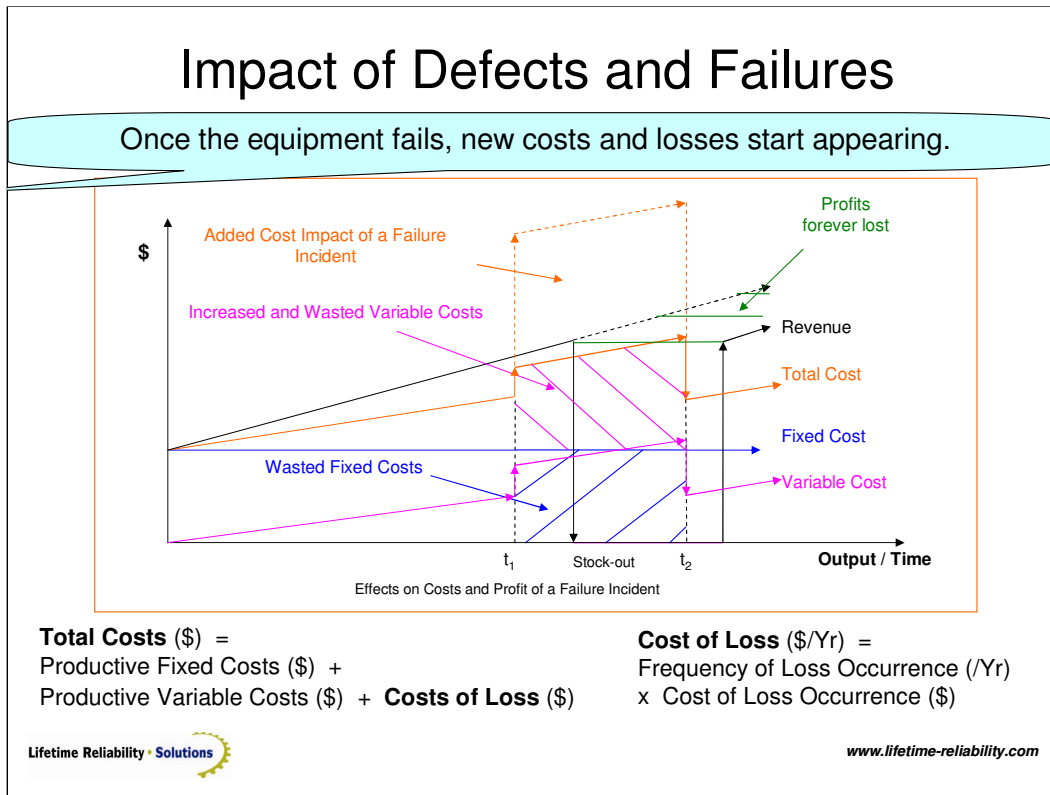
You will need the same passion and dedication to become a 'top-gun' Planner.



Maintenance has a greater purpose than simply looking after plant and machinery. If that was all that was necessary then maintainers would only ever fix equipment and do servicing. In today's competitive world, maintenance has grown into the need to manage plant and equipment over the operating life of a business' asset. It is seen as a subset of Asset Management, which is the management of physical assets over the whole life cycle to optimize operating profit.

There are at least six key factors required of maintenance to achieve its purpose of helping to get optimal operating performance. These are to reduce operating risk, avoid plant failures, provide reliable equipment, achieve least operating costs, eliminate defects in operating plant and maximise production.

In order to achieve these all people in engineering, operations and maintenance need great discipline, integration and cooperation. There needs to be an active partnership of equals between these three groups where the needs and concerns of each is listened to and



This slide shows what happens when a production failure incident impacts in the model business.

The incident starts at time t1 and stops the operation. A number of unfortunate things happen. Future profits are lost because no saleable product is made (though inventory can be sold until stocked-out). All fixed costs are wasted because there is no production. Some variable costs fall because they are not used. Others, like maintenance and management costs, suddenly rise in response to the incident. The losses and wastes grow. Some stop when the plant is back in operation at time t2. Others continue for months. The costs can be many times the profit that would have been made in the same time period. If a failure happens in a business that prevents production, the costs escalate and profits stop. Fixed costs are wasted and variable costs rise as rectification is undertaken. To these costs are added all the other costs that are spent or accrue due to the incident.

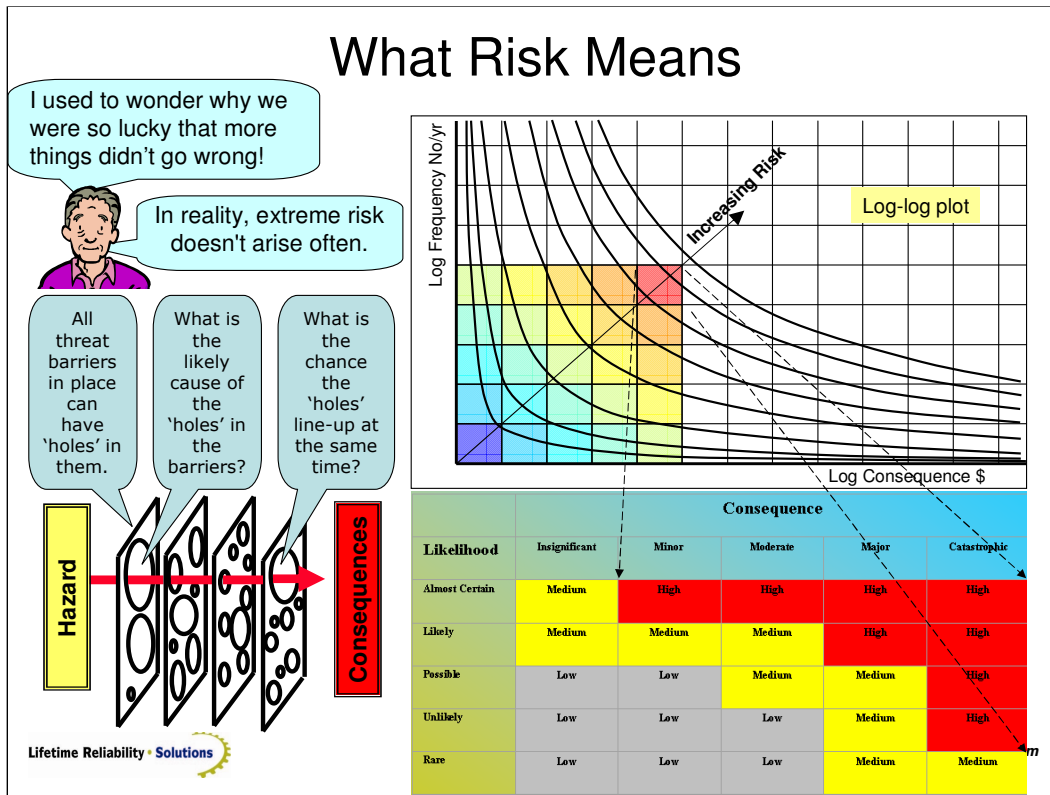
Production need to recognise that the cost of failure is a separate waste that needs to be controlled and reduced. A more accurate cost equation is shown in Equation 3.

$$\text{Total Costs (\$)} = \text{Productive Fixed Costs (\$)} + \text{Productive Variable Costs (\$)} + \text{Costs of Loss (\$)} \quad \text{Eq.3}$$

Equation 3 is powerful because it recognises the presence of losses and waste in a business. From this equation is derived another that explains how businesses can lose a great deal of money.

$$\text{Cost of Loss (\$/Yr)} = \text{Frequency of Loss Occurrence (/Yr)} \times \text{Cost of Loss Occurrence (\$)} \quad \text{Eq. 4}$$

Equation 4 tells us that money is lost every time there is a failure. The equation is a powerful one, which means failure costs are not linear and while one incident may lose a few dollars, another can total immense sums of money.



The slide shows a typical risk matrix used in industry today. Notice how the high risk portion, which was a small part in the log-log plot, has become a large part of the risk matrix. This is the effect of converting risk, which is power law, back into a linear scale. We must be very careful when using the standard risk matrix that we do not make everything into a high risk just because it occupies a large part of the matrix. We must realise that it is unrealistic that all risky situations have a high risk. In reality high risk is the exception, rather than the rule.

- Each threat or escalation barrier can be represented as a piece of Swiss cheese
- The holes represent weaknesses in the processes that form part of the barrier. The weakness can relate to the design of the process or its implementation.
- If the holes in the threat barriers line up this forms the chain of events that lead from a hazard to an event.
- If the holes in the escalation barriers line up this forms the chain of events that leads from an event into a consequence.

This explains why often bad things happen but they do not automatically end in catastrophe. It takes a number of things to go wrong (i.e. the holes in the Swiss cheese line-up) at the same time before a disaster happens. But when it does, then the consequences can be life-ending.

Equipment Criticality Matches Business Resources to Business Risk

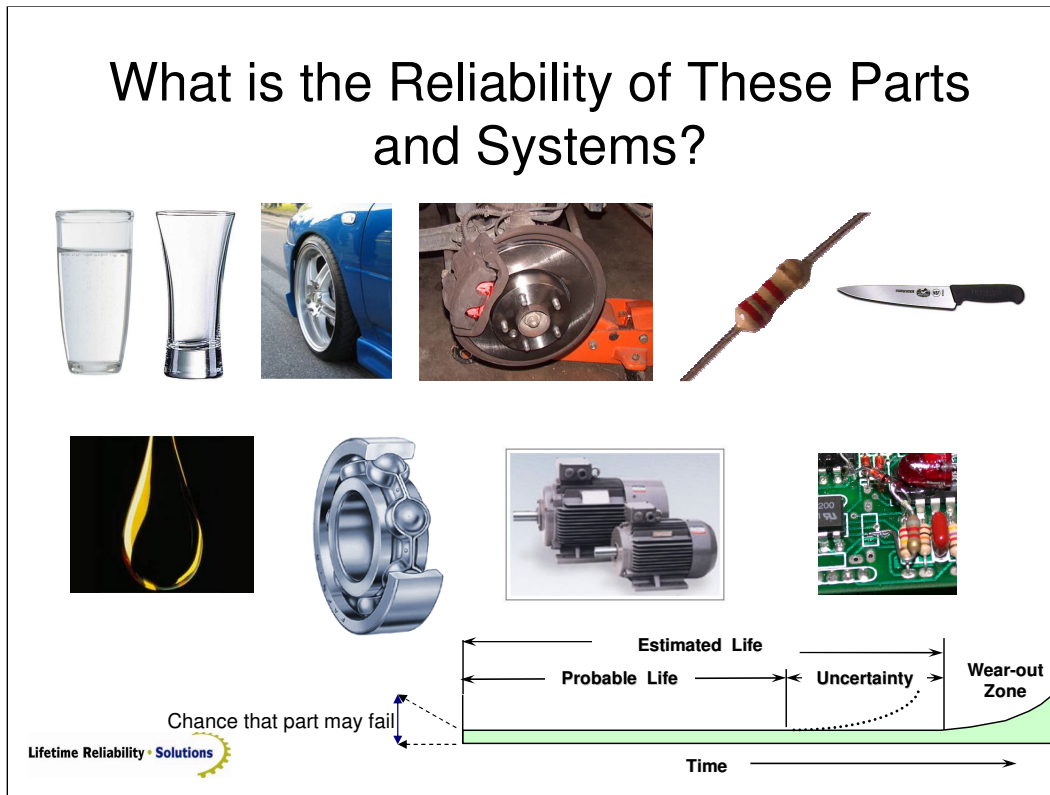


The concept of Equipment Criticality is used to determine the importance of plant and equipment to the success of an operation. It provides a way to prioritize equipment so that efforts are directed towards the plant and equipment that delivers the most important outcomes for the business. Typically the Equipment Criticality is arrived at by Operations and Maintenance personnel sitting down and working thorough every item of equipment and applying the risk matrix to determine the risk to the enterprise should the equipment fail. The risk rating becomes the 'Equipment Criticality'.

A more rigorous method, and one based on financial justification, is to use the 'Optimised Operating Profit Method'. By applying DAFT Costs when calculating the risk from equipment failure to the enterprise, it permits each item of plant to be graded in order of true financial impact on the operation should it fail. The 'Equipment Criticality' then reflects the financial risk grading.

It is important that every item of plant and equipment be categorised, including every sub-system in each equipment assembly. We need to know how critical is the smallest item so we understand what is important to continued operation. There have been many situations where smaller items of equipment, such as an oil circulating pump or a process sensor, were not identified for criticality and were not maintained. Eventually they failed and the operation was brought down for days while parts were rushed to do a repair. Be sure that you know how important every item of equipment is to your business.

What is the Reliability of These Parts and Systems?



The activity is to draw the likely reliability curve for each of these items and 'systems'? The reliability curve for a part is like the curve on the bottom of the slide – it is called a 'hazard curve' for an individual part (There is a different curve for an assembly of parts). If we can estimate the dates between which it will fail we can change the part with a new one beforehand.

For the parts in the slide we do not have any real data, but using our experiences we can visualise the shape of the probability of failure curve for the items shown. For example the likelihood of the glasses failing due to internal faults is zero. But the likelihood of them failing due to mishandling is real, and people experience it when they break a glass. It is reasonable to expect breakages will begin on the day of purchase and continuing for as long as the glasses are used. Hence we can draw the intrinsic probability of failure for a million identical glasses, or the hazard curve for a glass, as a straight line starting from the day the glass is purchased. The number failing each day is unknown, but our life experience suggests that one glass broken every year in a household is a reasonable likelihood. Hence if 1,000,000 glasses were sold in packs of 12, something like 83,300 households would have the glasses. The hazard curve for the glasses would be a straight line at 0.083 probability per year.

The same analogy can be applied to all the items shown in the slide to show that probability of failure curves can be drawn to reflect the chance of real-world failure.

Failure Prediction Mathematics – Weibull Reliability of Parts and Components

A decreasing failure rate < 1 would suggest 'infant mortality'. That is, defective items fail early and the failure rate decreases over time as they fall out of the population.
Hence need high quality control and accuracy in manufacture and assembly or 'burn-in' on purpose.

A constant failure rate ~ 1 suggests that items are failing from random events.
Hence cannot predict when a particular part will fail so use condition monitoring to check for failure mechanism.

An increasing failure rate > 1 suggests "wear out" - parts are more likely to fail as time goes on.
Hence change parts as part of a PM on a time basis.

The Maintenance Zones of Component Life

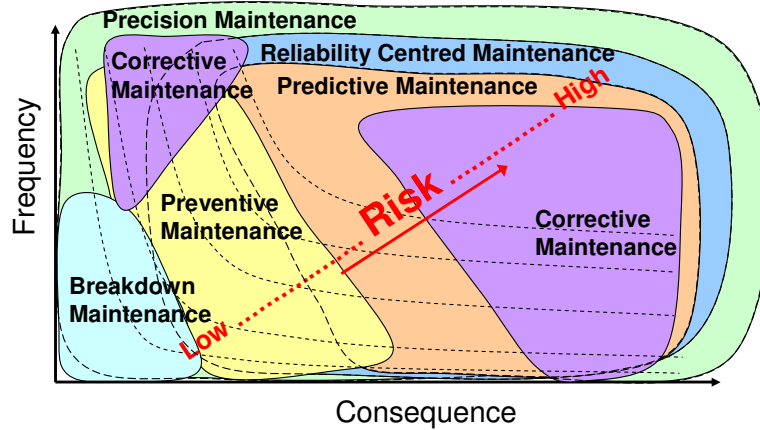
Mr Weibull (say Vaybull) discovered the mathematics to model the life of parts. It uses historic failure data from your CMMS to estimate what life a part has in your operation.

In 1939 Waloddi Weibull developed a distribution curve that has come to be used for modelling the reliability (i.e. failure rate) of parts and components. The Weibull distribution uses a part's failure history to identify its aging parameters. One of these is the beta parameter, which depending on its value indicates infant mortality (< 1), random failure (~ 1) or wear-out (> 1 to 4).

Once the primary mechanism of failure is known appropriate practices can be put into place to remove or control the risk of failure. Infant mortality can be reduced by better quality control, or it can be accepted as uncontrollable and all parts overstressed intentionally to make the weak ones fail. The resulting parts will then fail randomly. In the case of random failure there is no certain age at which a part will fail and all that can be done is observe it for the onset of failure and replace it prior to complete collapse. When a part has a recognisable wear-out it is replaced prior to increased rate of failure.

Match Maintenance Strategies to Risk

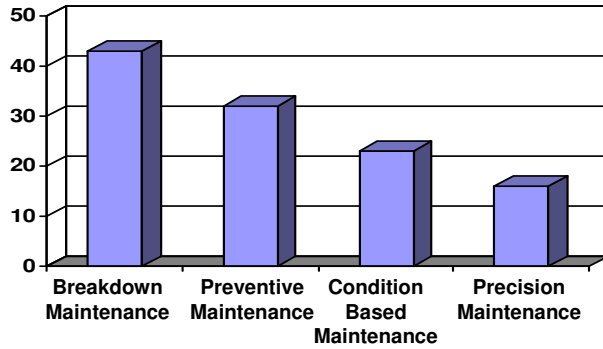
One way to choose the maintenance type is to match against the risk matrix. The high risks must be prevented by using the right maintenance type for the situation.



Move from Reactive to Proactive to Risk Reduction.

The maintenance strategies can be matched to operating risk. Where risk is high, proactive strategies reduce the chance of failure and so lower the maintenance costs. Where risk is low, consequence reduction strategies can be applied because cost of failure is low. Chance reduction strategies are viable in all situations, but consequence reduction strategies must be carefully chosen because they do not prevent failure, rather they only minimize the extent of the losses. Hence using condition monitoring in high risk conditions must be accompanied with rapid response capability to address the failure before it goes to

Precision Maintenance Delivers Big Savings



Typical Maintenance Cost \$/kW/Year

Precision Maintenance requires precision craftsmanship in every interaction with our machinery. The best way is to train your crew to be highly skilled and versatile people who do absolutely top quality work in all that they do. The payoff for the organisation is magnificent.




Ted, it's now time to move into the actual day to day work of the Maintenance Planner. These past few days were meant to give you a good understanding of why we have maintenance and the role it plays in ensuring maximum production for the least cost. Next time we meet we'll start you learning the Maintenance Planning process.

What process? Isn't it just scoping out the work and ordering parts?

Ahh ... you young guys think you know it all! No, what you say is the smallest part of the job. The big part is making sure things go right the first time! And for that you need a process, a system!

The sessions on Maintenance and Reliability end ...

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