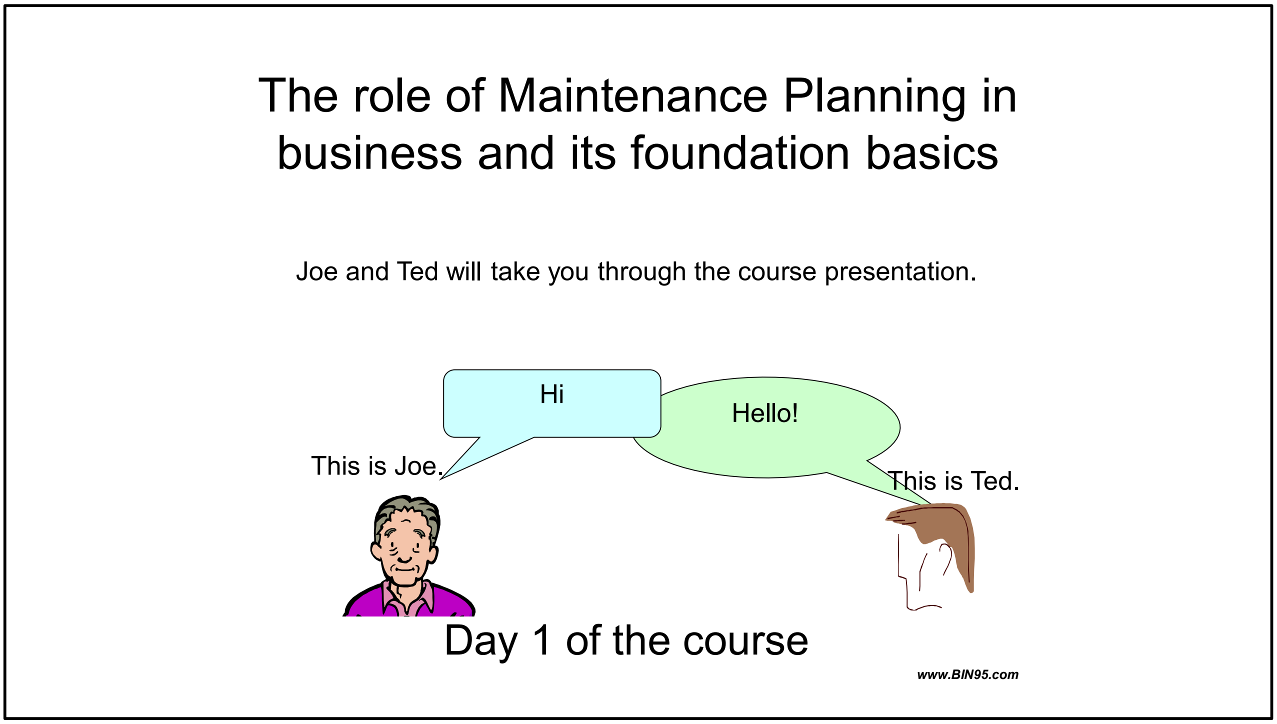
Day 1 sample:



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 portion 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.

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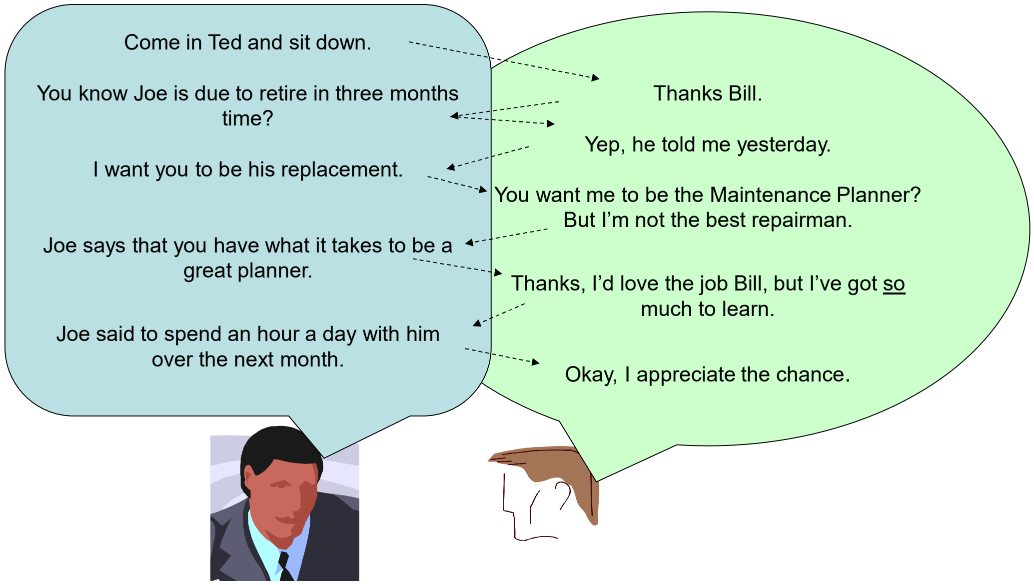
Day 1 sample:



Ted is asked to become the Maintenance Planner

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Usually a person from the maintenance crew is asked to move into maintenance planning. Often it is a person who knows the plant and equipment well. The thinking behind the selection is that this person will know what to do in the planner's roll because they are so experienced with the machinery. But planning has got nothing to do with how skilled one is with their hands when working on machines. Planning is about being methodical, disciplined, forward thinking and an excellent organiser. If you are not strong in all those four requirements, then get exposure and experience in the weak areas so that you become more aware and able in doing them well.

The best training is hands-on training. Do a thing, and you will learn it faster and more thoroughly than reading or hearing about it.

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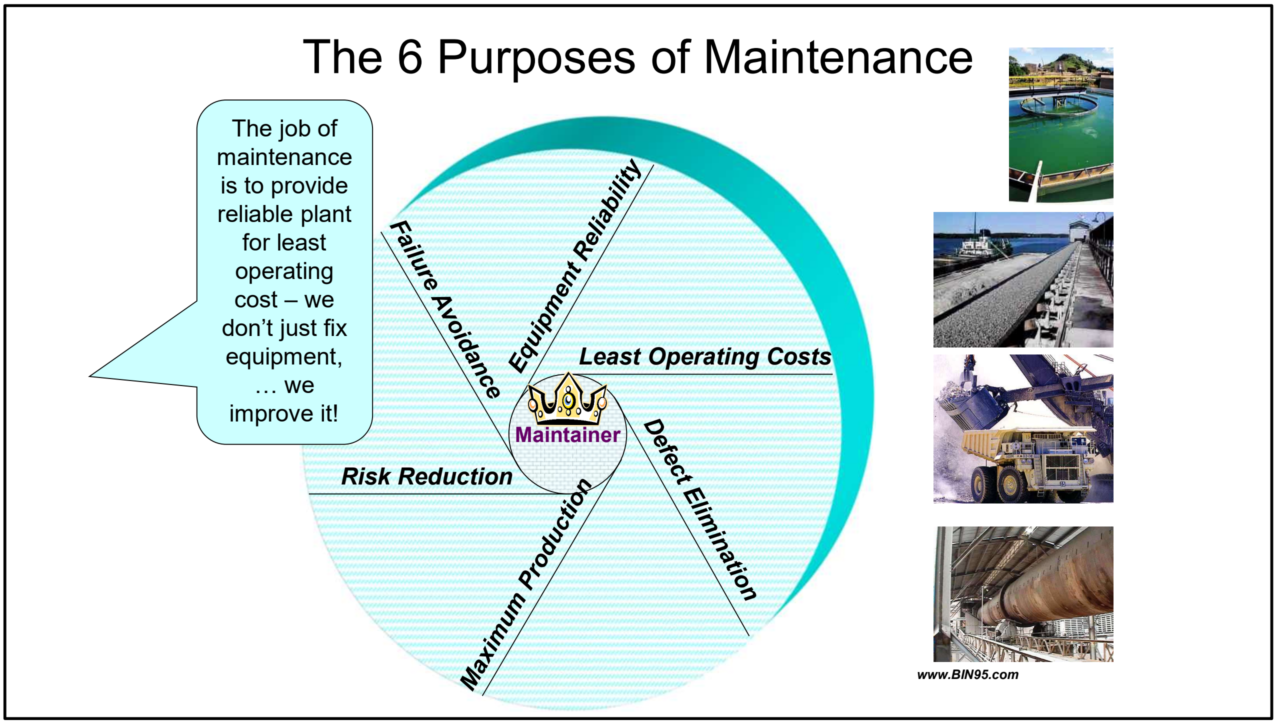
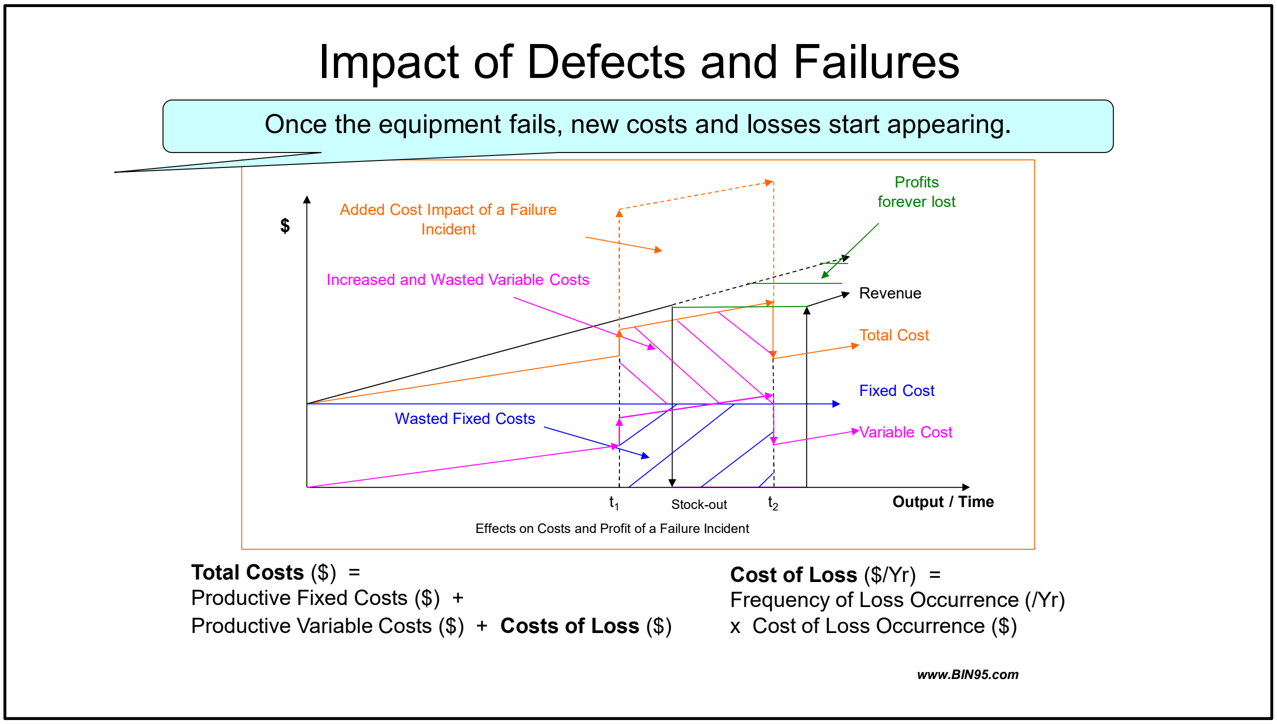


Maintenance has a greater purpose than simply looking after plant and machinery. If that was all that was necessary then maintainers would only ever fix equipment and do servicing. In today's competitive world, maintenance has grown into the need to manage plant and equipment over the operating life 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 integrated into the work



This slide shows what happens when a production failure incident impacts a 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.

Total Costs ($) = Productive Fixed Costs ($) + Productive Variable Costs ($) + Costs of Loss ($) *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.

Cost of Loss ($/Yr) = Frequency of Loss Occurrence (/Yr) x Cost of Loss Occurrence ($) *Eq. 4*

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

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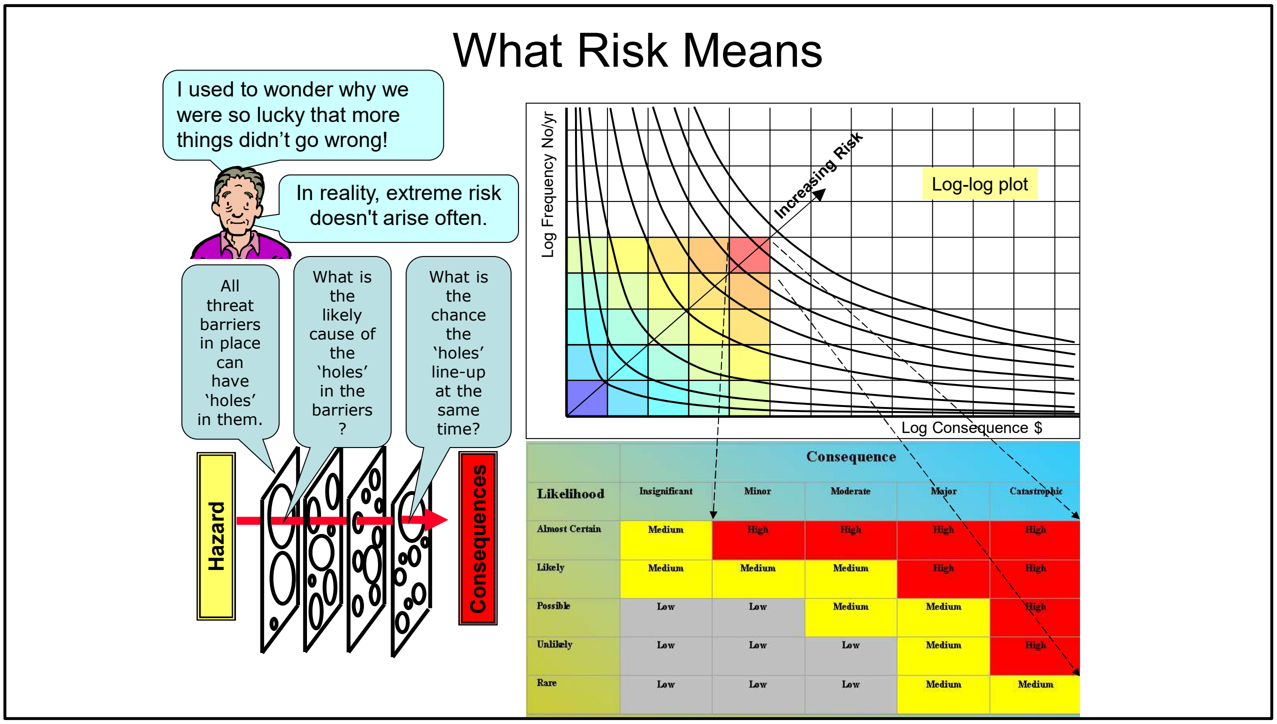

The slide shows a typical risk matrix used in industry today. Notice how the high risk portion, which was a small part in the log-log plot, has become a large part of the risk matrix. This is the effect of converting risk, which is power law, back into a linear scale. We must be very careful when using 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 at the same time (i.e. the holes in the Swiss cheese line-up) before a disaster happens. But when it does, then the consequences can be life-ending.
The matrix also asks another question of us: Is it better to spend a lot of money to fix one large risk, or to spend the same money and fix many small risks? If many small risks can be removed, the result will be fewer annoying little problems to overload us, and take our attention away from controlling the large risks. With the small risks gone we can better manage the remaining large risks.

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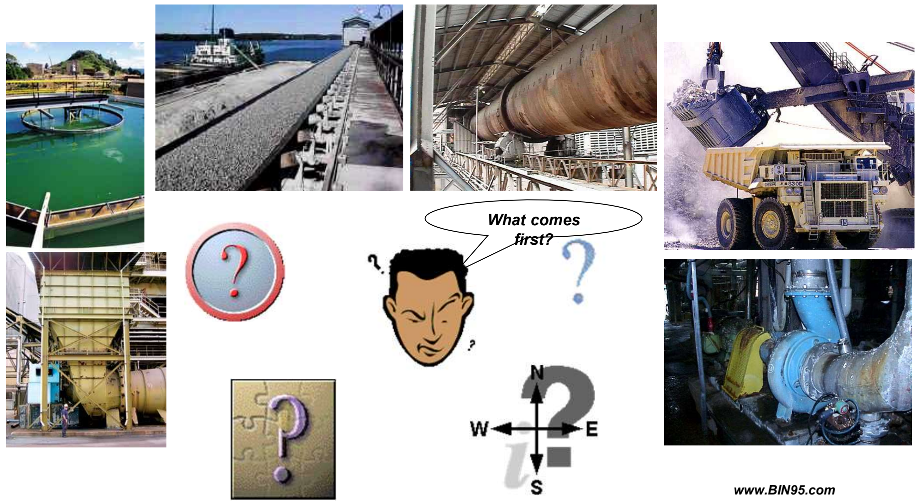
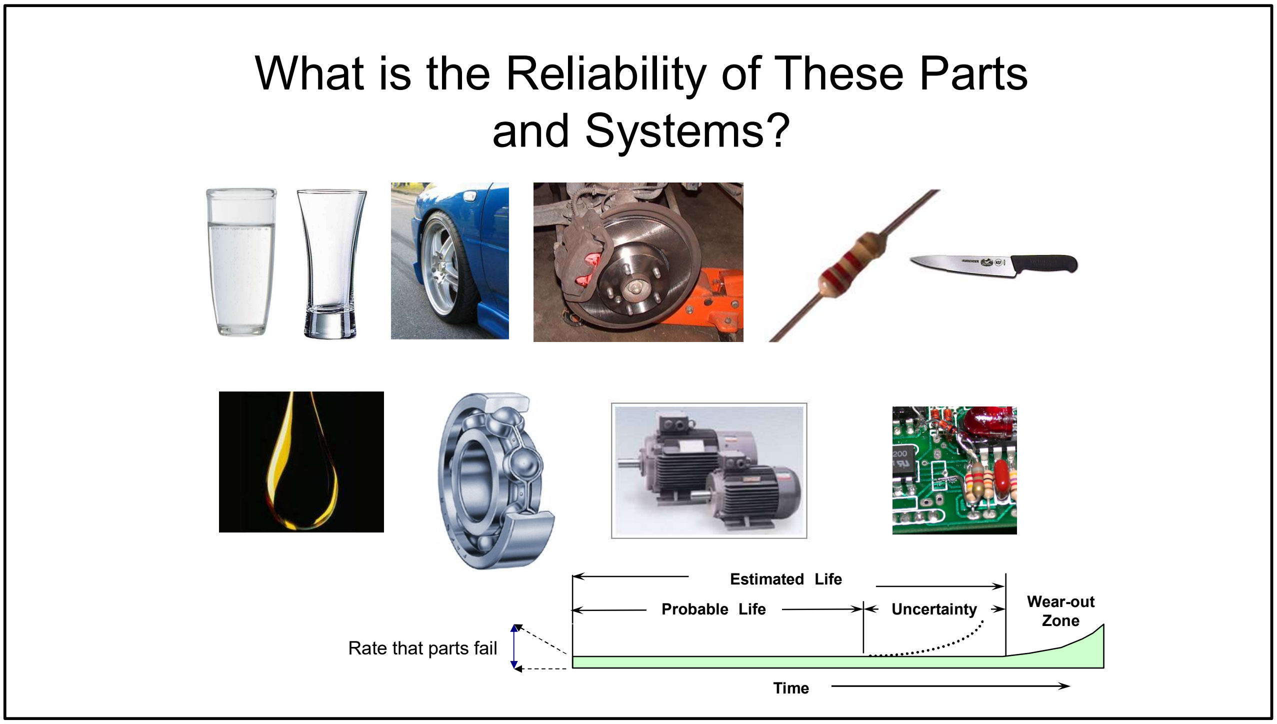
Equipment Criticality Matches Business Resources to Business Risk



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.



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.

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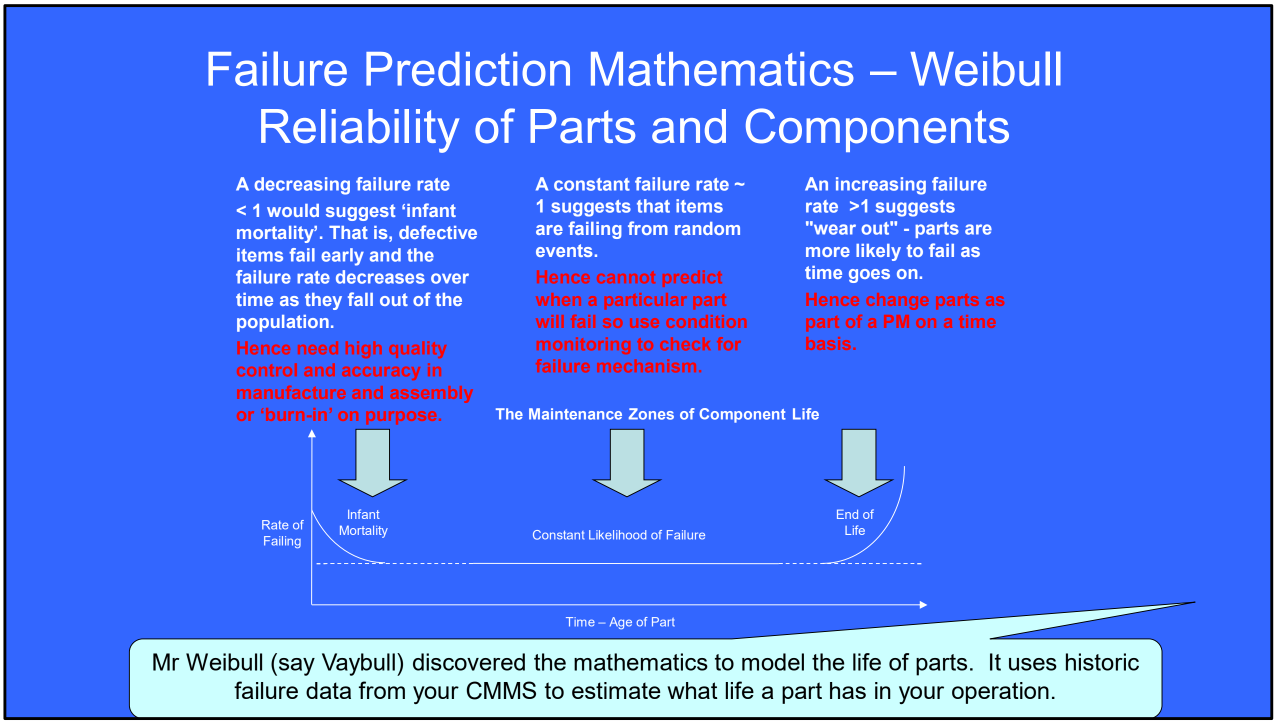
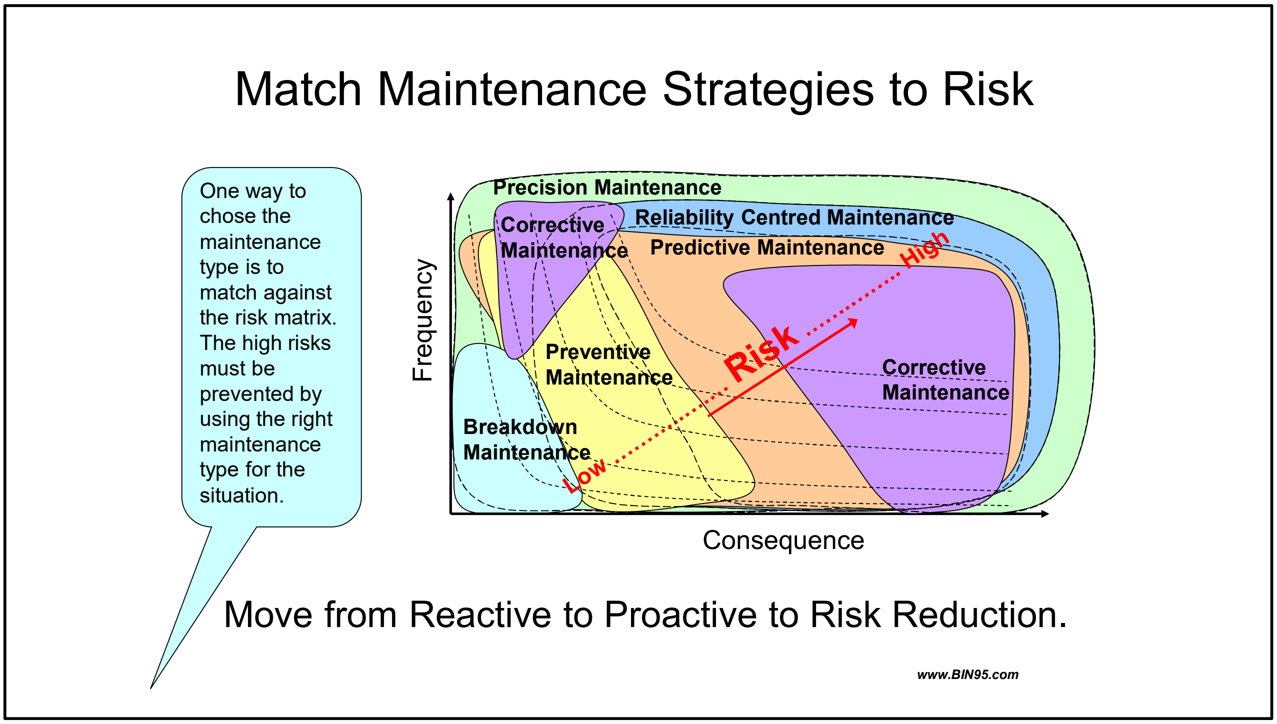
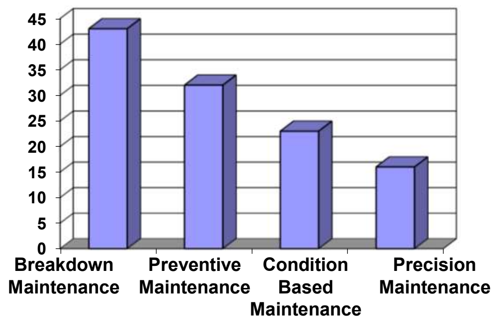


In 1939 Waloddi Weibull developed a distribution curve that has come to be used for modelling the reliability (i.e. failure rate) of parts and components. The Weibull distribution uses a part's failure history to identify its aging parameters. One of these is the beta parameter, which depending on its 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.



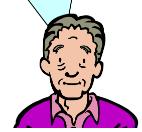
The maintenance strategies can be matched to operating risk. Where risk is high, proactive strategies reduce the chance of failure and so lower the maintenance costs. Where risk is low, consequence reduction strategies can be applied because cost of failure is low. Chance reduction strategies are viable 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 failure.

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 top-quality work in all that they do. The payoff for the organization is magnificent.



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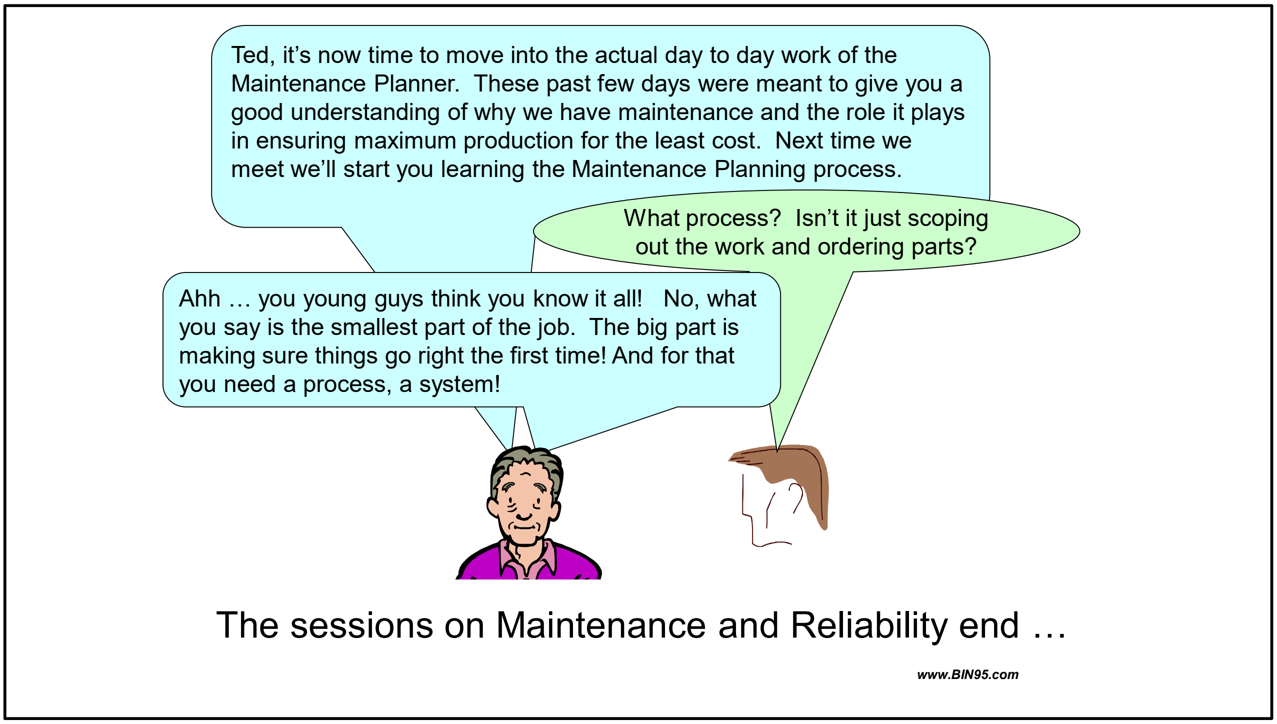

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