

# Justifying Predictive Maintenance

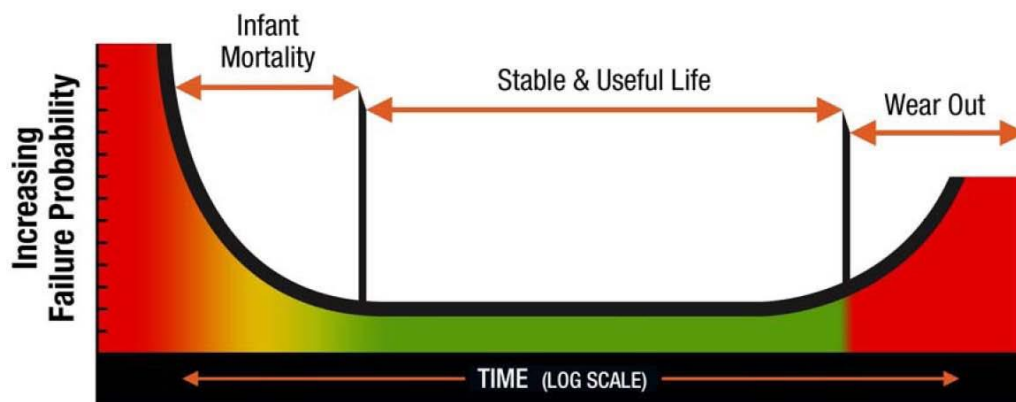
This paper describes, in brief, the issues involved in justifying a computer-based predictive maintenance program. A general formula for cost-benefit analysis is proposed, which can be tailored to your particular process. There are many issues involved in deciding whether to initiate a predictive maintenance program. Even if a program is already in place, it is often difficult to quantify the benefits of implementing a computer based system. The intention is to clarify the extent to which these types of programs can have your process running more safely and efficiently, and is to be used as a rough guide only.

## Preventative Maintenance

Preventative maintenance schedules regular machine/plant shutdowns, irrespective of whether repairs are required. There are many problems associated with this maintenance strategy including:

- Increased maintenance costs as parts are replaced when they are not necessarily required.
- Risk of infant mortality due, for example, to human error during dismantling work.

The component life cycle chart shown here identifies that, by far, the greatest probability of assembly failure is at start-up.



## Predictive Maintenance

The basic principle of predictive maintenance is to take such measurements that allow your organization to predict when plant machinery will break down. These measurements include machine vibration and plant operating data such as temperature, pressure and oil metal concentrations.

## The Benefits of Predictive Maintenance

Predictive maintenance determines when the machine REQUIRES repair. Plant machinery is therefore only repaired WHEN REQUIRED. The benefits of predictive maintenance carry over into multiple categories but two main categories are:

### Increased Safety

Predictive maintenance provides the reassurance of safe, continued plant operation. By reducing the likelihood of unexpected equipment breakdown, the safety of employees is improved. Although difficult to quantify, there is a definite economic benefit in improved employee and union relationships.

### Improved Operating Efficiency

There are many areas in which a predictive maintenance program can increase the efficiency of your process. Please see chart below.

How an Effective Predictive Maintenance Strategy Can Improve Plant Efficiency	
<b>Reduction in Lost Production</b>	Predictive maintenance aims to identify problems in equipment so that necessary downtime can be scheduled. By identifying problems in their initial stages, the predictive maintenance system gives notice of impending failure, so downtime can be scheduled for the most convenient and inexpensive time. Predictive maintenance minimizes the probability of unexpected failures, which would result in lost production. This is always important, particularly so if your plant uses 'just in-time' manufacturing techniques, as the lost production and credibility to the customer may NEVER be regained.
<b>Reduced Cost of Maintenance</b>	As equipment is only repaired when needed (as opposed to routine disassembly), maintenance staff have more satisfying and worthwhile work and the costs of maintaining the machinery are reduced as resources (labor, equipment and parts) are only used when needed.
<b>Less Likelihood of Secondary Damage</b>	By identifying potential failures in advance, the severity of these failures can be substantially diminished by reducing or preventing secondary damage. For example, a failing bearing in a motor can be identified and replaced before the winding and shaft are also damaged.
<b>Reduced Inventory</b>	Predictive maintenance reduces inventory costs because, as substantial warning of impending failures is provided, parts can be ordered as required, rather than keeping a large backup inventory.
<b>Extending the Life of Plant Equipment</b>	Using a predictive maintenance program, machines are only dismantled when necessary, so the frequency of equipment disassembly is minimized, and thus the probability of 'infant mortality' is reduced.
<b>Improved Product Quality</b>	Predictive maintenance requires data to be taken from the plant. That process, coupled with the collection of additional plant performance data (performed by many predictive maintenance groups), means that the efficiency of plant equipment is scrutinized constantly. By increasing the efficiency of your process, the quality of your product will be improved. With an improved product, and a renewed confidence in product supply, customer relations will also be improved.

## Determining the Benefits/Costs of Predictive Maintenance in Your Plant

Benefits	
<b>Reduced Forced Outage Time</b>	<p>Annual Benefits (\$ per unit per year), can be estimated as:</p> <div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: fit-content;"> <p style="text-align: center;"> <b>Probability of successful early detection</b>      <b>X</b>      <b>Benefit due to decrease in forced outage time</b>  <b>+</b>  <b>Benefit due to some forced outage time becoming scheduled outage time</b> </p> </div>
<b>Secondary Damage</b>	<p>It is difficult to develop a general rule for the savings due to reduced secondary damage. An estimate of a factor of ten has been suggested in related research. That is, the repair bill will be 10X higher if a machine is allowed to fail, rather than repairing it before failure.</p>
<b>Other Benefits</b>	<p>The benefits of increased product quality, improved employee relationships due to increased safety and job satisfaction, reduced inventory and extended plant life can only be assessed in your plant.</p>



## Considering the Costs

Costs											
<b>Devices, Software and Instrumentation</b>	The equipment necessary will depend on your requirements, but can range from \$10,000 to \$40,000, including instrumentation. Annual equipment cost in depreciation and interest on capital can be conservatively estimated of 30% of its capital cost. Maintenance cost can be estimated as 10%-15% of the capital cost. An additional benefit is that the cost of the software is can be tax deductible.										
<b>Staffing (Rough Guide)</b>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="background-color: #4F81BD; color: white;"># points measured and analyzed per month</th> <th style="background-color: #4F81BD; color: white;">Staff required</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">0-50 points</td> <td>Readily done by maintenance engineer along with other work</td> </tr> <tr> <td style="text-align: center;">50-1500 points</td> <td>One technician doing field work, sharing with one engineer</td> </tr> <tr> <td style="text-align: center;">1500—3000 points</td> <td>One technician doing field work, one engineer to analyze, one to evaluate, depending on the degree of automated analysis equipment used</td> </tr> <tr> <td style="text-align: center;">Over 3000 points</td> <td>More technicians for field measurements, again varying with automation, but keeping engineer staffing at two</td> </tr> </tbody> </table>	# points measured and analyzed per month	Staff required	0-50 points	Readily done by maintenance engineer along with other work	50-1500 points	One technician doing field work, sharing with one engineer	1500—3000 points	One technician doing field work, one engineer to analyze, one to evaluate, depending on the degree of automated analysis equipment used	Over 3000 points	More technicians for field measurements, again varying with automation, but keeping engineer staffing at two
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As you can see, the more automation features available, the fewer people will be required to implement your predictive maintenance program. This highlights the need for computer based automated features.

It is possible, therefore, to determine a rough estimate as to the savings this can provide your plant. We are confident that, even using this conservative analysis, the payback period you determine for the investment in our system will be minimal.

### About Azima DLI

Azima DLI is the leader and premier provider of predictive maintenance analytical services and products that align with customers' high standards for reliability, availability and uptime. Azima DLI's WATCHMAN™ Reliability Services utilize flexible deployment models, proven diagnostic software and unmatched analytical expertise to deliver sustainable, scalable and cost-effective condition-based maintenance programs. The company delivers machine health reliability solutions with global reach that reduce risk, improve safety, increase production and optimize efficiency.

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