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The Lifetime Reliability Solutions
Certificate Course in Maintenance and Reliability
Module 4 – Precision Maintenance Techniques for Machinery

Session 14
The Justification for a Precision Maintenance Programme

1. Introduction

There are companies who have very effective maintenance operations, they appear to achieve all the desirable outcomes most of us would subscribe to

- improved plant reliability and meeting availability targets,
- reduced maintenance costs,
- extended mean time between failures.

Conversely there are numerous companies still searching for whatever it is that will give them a successful maintenance operation. They still get breakdowns, maintenance is expensive.

What is the elusive element that brings success?

Research and exploration of original ideas by Ralph Buscarello of Update International, Inc. of Denver, U.S.A. has identified that element to be **Precision Skills** applied in the workshop. Much of the material and case studies in this work have come from this.

Precision Skills are additional to other concepts and methods that are embraced – be they TPM, TQM, RCM2, or whatever. No matter what philosophies may be applied by management, no matter what software packages at great expense, no matter what changes or guru's exhortations – if it does not reach and motivate the workforce to do their work at the "coal face" with greater diligence and skill on a plant-wide basis – **nothing will have changed.**

At the workshop level, if they do what they always did, you will get what you always got.

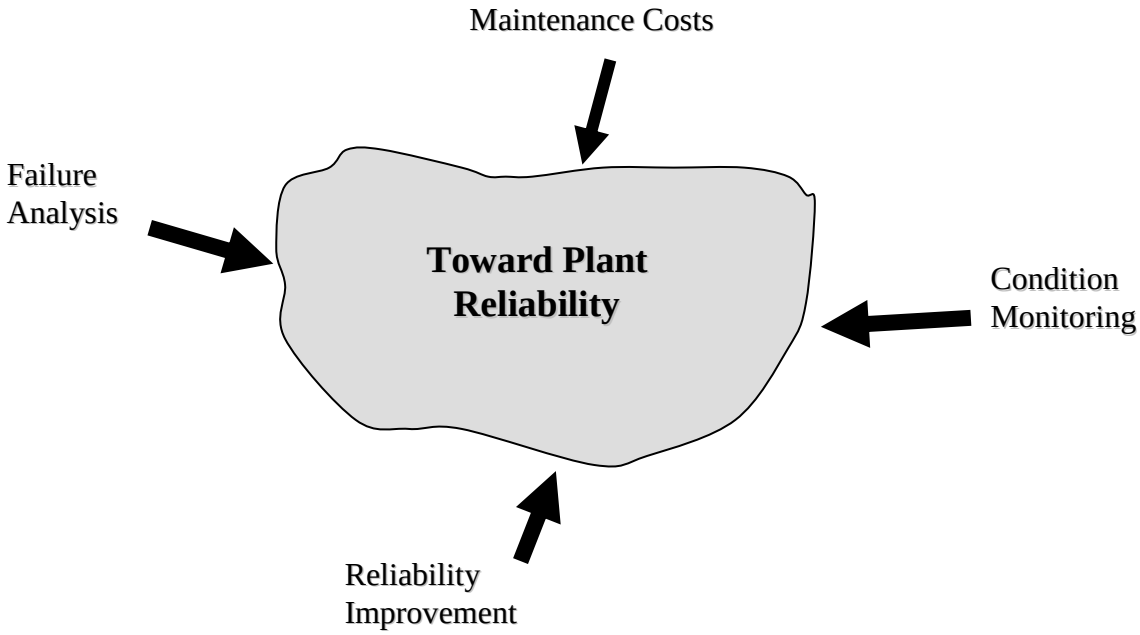
This session provides an overview of the concept of Precision Skills and their application to achieve reliability. It sets the context for the remaining sessions in this course.

2. Reliability in the Real World

Module 1 focussed upon the resources needed for a successful condition monitoring programme. It is appropriate to come back to these and examine them a little further.

The figure below seems to be all the required ingredients for success in Reliability but Premature Failures still happen.

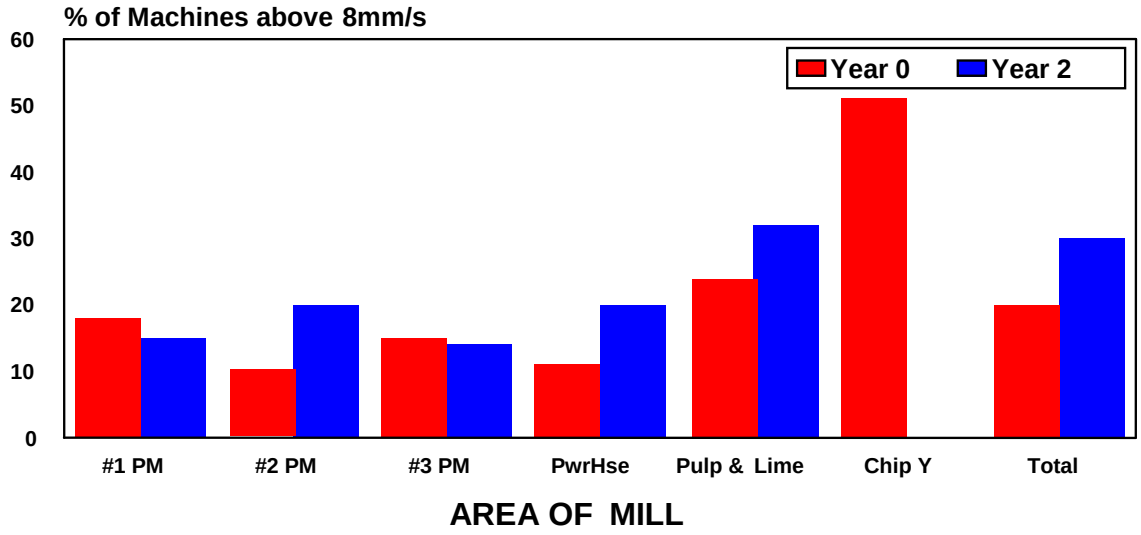
- Truly effective maintenance operations are few and far between
- Consideration needs to be given to the factors that inhibit the effective application of these various inputs



There is a wide acceptance of Condition Based Maintenance, but there are a number of limiting factors, most coming from a historical context of the application being seen as the answer to all of maintenance's needs;

- CBM is often used as a 'stand alone' maintenance concept
- Frequently CBM is simply used for Failure Prediction, little else is asked for or expected
- Too often CBM has been driven from the bottom upward
- CBM alone does not provide for reliability

The following graph is a vibration history from a 'successful' (successful from a failure prediction perspective) condition monitoring programme and shows that some 50% more machines are running roughly after 2 years.



This not not good from a maintenance costs and reliability perspective.

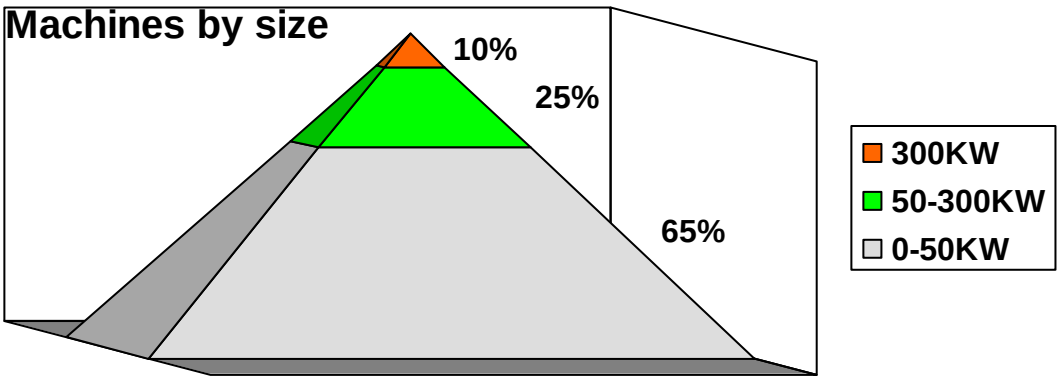
Some of the limitations of Condition Based Maintenance are quite reasonable and must be accepted as such;

- It can be expensive to apply,
- It is normally applied only where Risk justifies it,
- It tends to be used on expensive and large plant

This leaves a lot of plant to be 'covered' by Breakdown or Planned Preventative maintenance;

- we know that Breakdown Maintenance is expensive to apply, can be dangerous and contributes little to Reliability,
- we know that Planned Preventative Maintenance can be intrusive, can greatly increase the risk of failure to otherwise stable systems, and does not maximise potential operational life,
- we may be covering 70%, or more, of our plant with these techniques - or perhaps, no technique at all, just letting it care for itself.

Current Application of CBM



How Much of Your Plant Relies on Other Than CBM ?

As discussed in Module 1, Condition Based Maintenance placed in a **Reliability** context offers;

- diagnostics
- information and data for Root Cause Analysis and redesign
- verification of defect or design correction
- a context embracing all maintenance concepts

and our '70%' of plant is denied many of these benefits in the search for a balance against costs.

Truly effective maintenance operations are few and far between. What is it that separates those organisations with truly effective maintenance operations with those who do not?

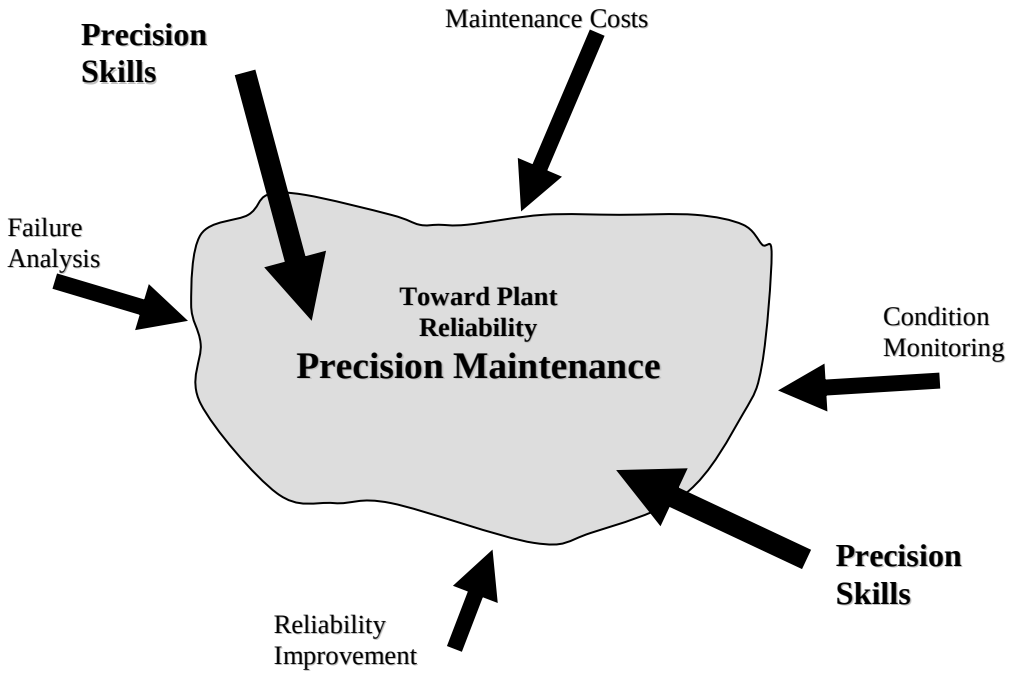
Regardless of the policies and programmes put forward from 'the top', plant reliability will always be linked to the effectiveness of operators and trades who work on the plant.

It is this effective involvement of trades staff and their plant wide application of precision focussed workplace skills which has been identified by Ralph Buscarello as the significant factor in producing a truly effective maintenance operation.

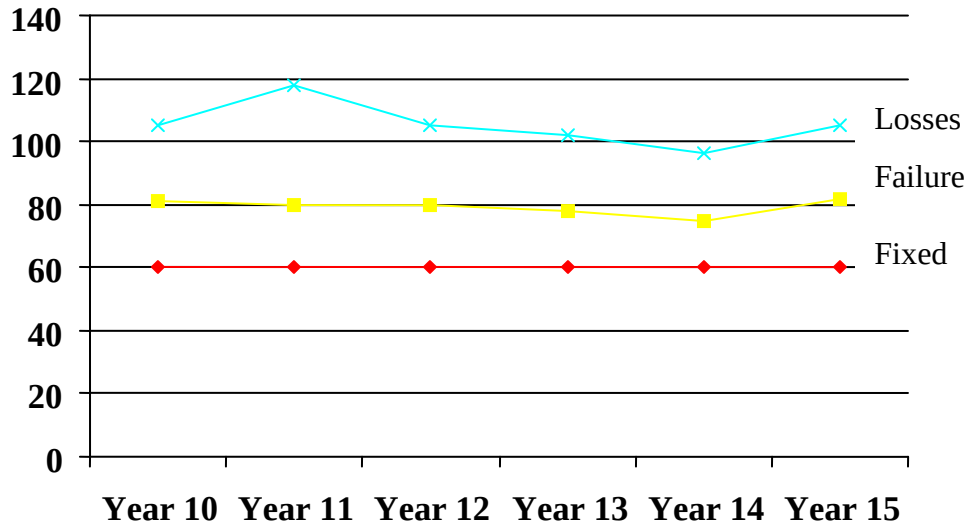
There are a number of case studies which have validated this.

3. Moving Toward Precision Skills

The PRECISION SKILLS input is the (largely) missing element which can make effective the move **Toward Plant Reliability.**
If it isn't in the plant then it needs to be; if it is only with the "top 30%" then it needs to be with 100%.



Returning to the Maintenance Costs model from Unit 1,

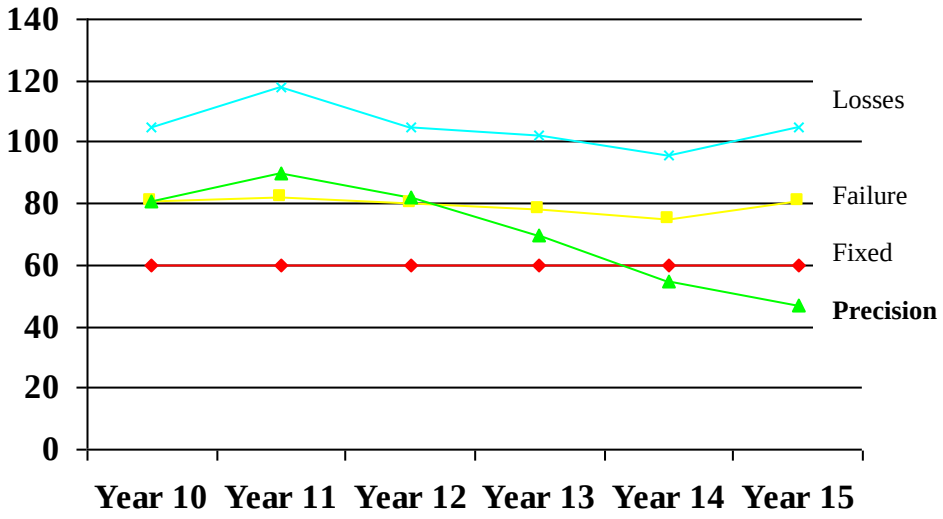


and acknowledging that Premature Equipment Failures may be reduced, or eliminated, by

- using high quality & diligent management with precision skills
- working to precision specifications and standards
- correcting design deficiencies
- appropriate maintenance methods

there arises the potential to operate at less than the Designed Fixed Cost.

Some may suggest this can be interpreted as operating maintenance at a Profit. Others will argue it is a reduction in Costs – either way, we are looking at saving money.



The new line represents what can be with the application of Precision Skills – and in many cases documented the results have been in a much shorter time scale than that illustrated. In some cases 3 months to 6 months has been quoted as showing significant and lasting changes.

The 'Profit' is in three parts;

- the reduction, or removal, of losses consequential to premature failure
- the reduction, or removal, of Failure Costs (repairs), back to the Fixed Costs
- achieving better than the Fixed Costs – this perhaps may be a true profit.

The essential elements of this transformation from 'cost' to 'profit' are

- Quality of the initial system
- Redesign to remove potential areas of failure
- Use of appropriate maintenance methods
- High quality Management, Standards and PRECISION SKILLS in the operation of the system maintenance.

Consider the costs in overhauling a 150kW Pump, against a 50kW or 15kW – the costs are not greatly different per machine, but they are on a per kW basis.
Look at the large number of smaller machines (70%) that may be getting indifferent skills applied to their upkeep. It is here that there is enormous potential to have an impact on the maintenance budget and on overall plant reliability by applying the same quality skills on all plant as would otherwise be applied only to the top (30%) group of important machines.

Appropriate use of CBM in a Reliability Context (30% ?)
+
Precision Focussed Workplace Skills Plant Wide (100%)
=

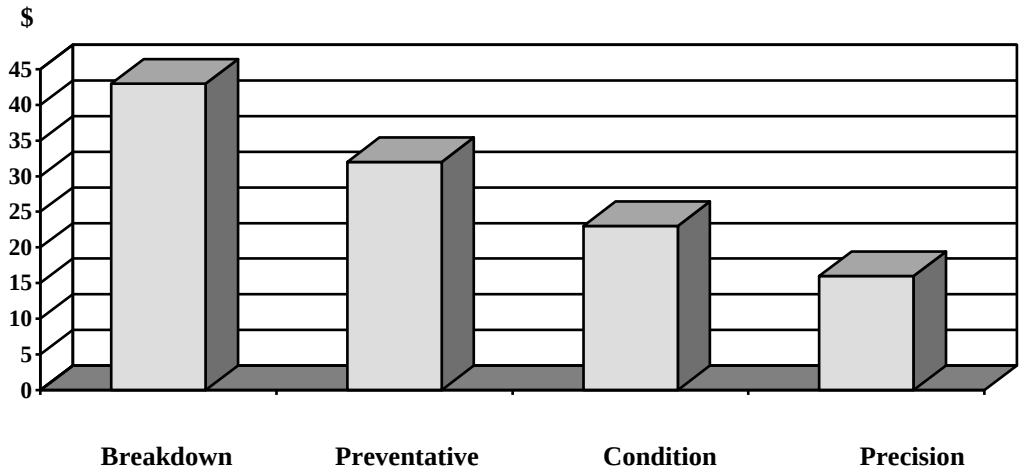
Optimal Plant Reliability & Maintenance Costs

The process of moving **Toward Plant Reliability** through **Precision Skills** requires a significant change in attitude and thinking at all levels in the maintenance organisation.

- A Change in Philosophy
  FROM detecting problems and fixing them
  TO preventing failures from happening in the first place
  REACTIVE → PROACTIVE
- Good is no longer good enough
- Most machinery problems are preventable
- Everyone in the organization has a role

4. What Are the Benefits of Precision Maintenance?

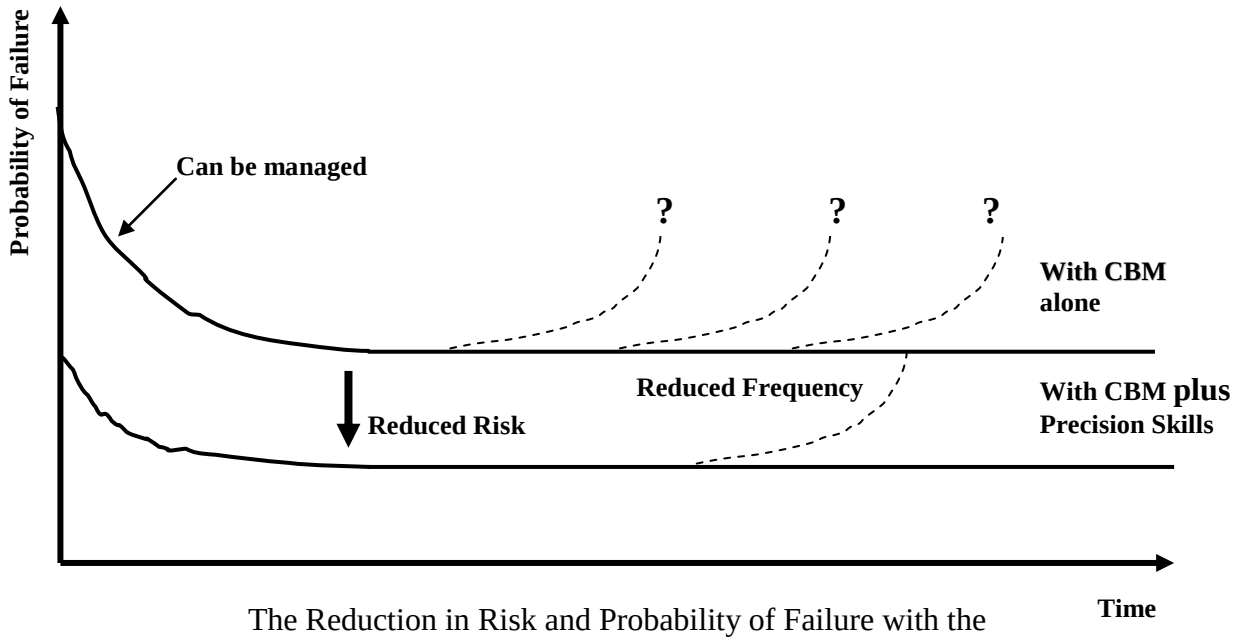
The most meaningful measure of benefit in today's environment is Dollars
The figures below have been gleaned from best available information from sources in the UK and USA. They will of course vary considerably between industries and it is up to each to find their own. Indeed, it is very important for each organisation to identify their own maintenance costs to identify the success or otherwise of any programme they may embark upon. This information is very readily available in today's computerised maintenance management systems but for whatever reasons few engineers take the trouble to obtain it and use it.



Typical Maintenance Cost $/kW/Year

The Benefits include

- Greater Safety
- Greater Reliability & Extended MTBF
- Reduced Production Losses
- Reduced Maintenance Costs
- Probability of a True Maintenance Profit
- Improved Product Quality
- Potential of Power Savings
- Greater Staff Motivation



The Reduction in Risk and Probability of Failure with the Implementation of Precision Maintenance

Some of the benefits listed above may visualised in this model developed from the Failure model shown in Module 1 Session 2.

5. How Are These Benefits to be Realised?

To achieve a successful precision focussed maintenance programme there must be

- a good working partnership between management, trades, condition monitoring and specialist providers
- a good appreciation of the need for precision trade skills
- achievement of agreed maintenance standards
- appropriate training and resourcing for Precision Skills

Additionally, there must be an appreciation of the assets within the maintenance organisation that represent significant value

- good engineering & maintenance experience
- staff's accumulated plant knowledge
- proven technologies, systems & services

6. Assessing the Potential for Improvement and Measuring the Benefits

Update International carried out research on various machines to identify and substantiate the value in Dollar terms of smoother running machinery. Shown below are the records taken for a number of 1800rpm and 3600rpm pumps, showing trends of Maintenance (US) Dollars against Vibration Levels.

There is a quite clear trend showing the higher maintenance costs for rougher machines; but there is also more. This is the focus in Session 15 of this course.

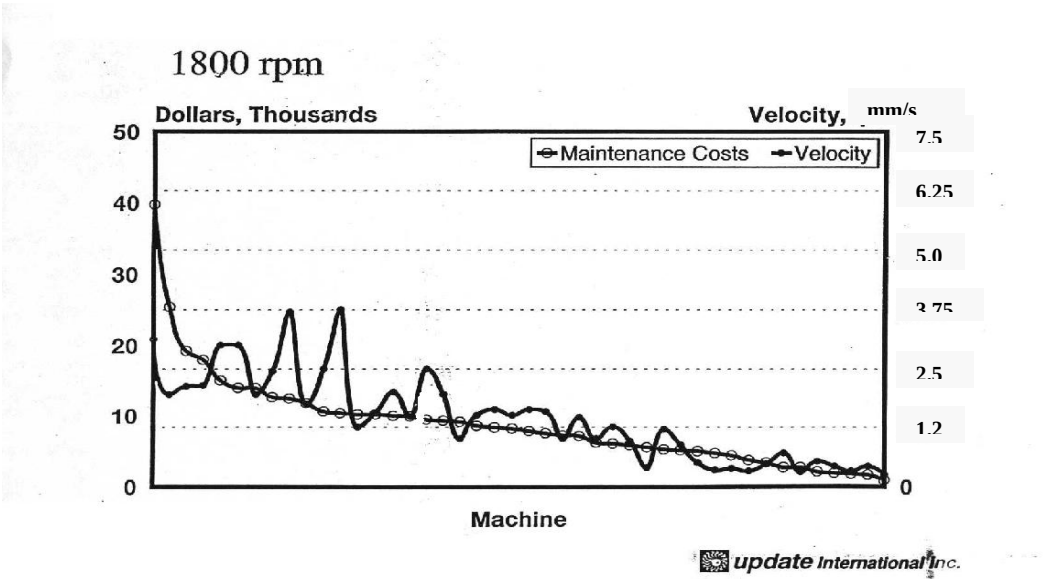


Figure 1: Comparison of previous year's maintenance cost vs. vibration amplitude for 1800-rpm pumps, in one department of a papermill.

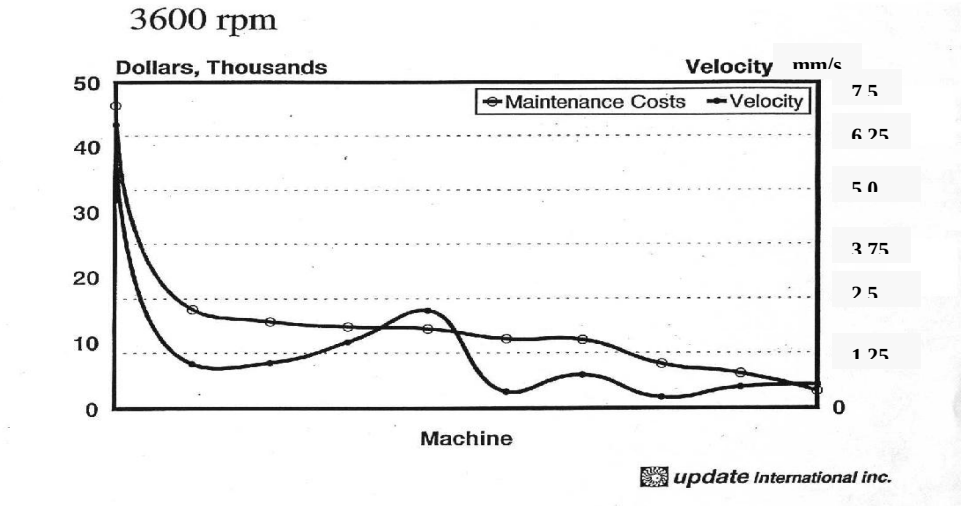


Figure 2: Comparison of previous year's maintenance cost vs. vibration amplitude for 3600-rpm pumps, in one department of a papermill

The table below gives an idea of the potential savings for a selection of machine types in achieving smoother running machinery.

Note that it is inappropriate to apply this kind of analysis to more complex or unique machines.

Machine Type	Highest Velocity	Dollars Spent Last Year	Lowest Velocity	Dollars Spent Last Year
Single Stage Pumps	**5.6**	**$3,200**	**2.0**	**$650**
Multi Stage Pumps	**4.8**	**$6,100**	**1.5**	**$1,100**
Major Fans & Blowers	**9.0**	**$900**	**2.8**	**0**
Single Stage Turbines	**3.8**	**$8200**	**1.0**	**$2,000**
Other Machines	**7.8**	**$11,850**	**3.0**	**$3,700**