

Enterprise Asset Management Stops Production Failure and Loss

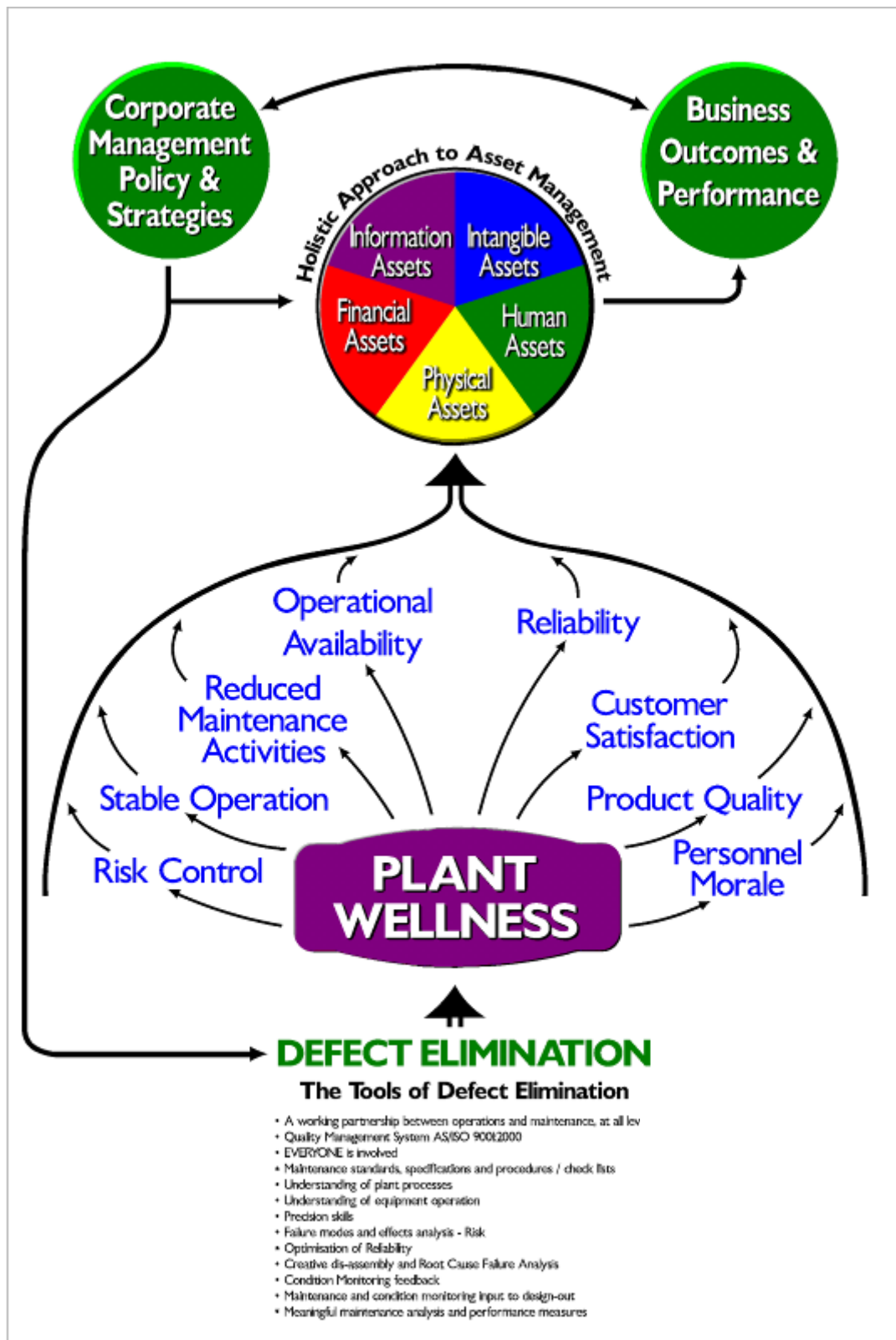
Let a Plant Wellness Way EAM System-of-Reliability End Your Business Risks Forever

No longer can administration, marketing, finance and operations be treated as ‘silos’ that operate separate to each other. Each affects the others in subtle ways that can either improve overall corporate performance or degrade it. To be sure the influenced of each on the others, and on the whole organisation, is productive, positive and profit-boosting learn to apply Enterprise Asset Management and build the right system, processes, procedures, principles, and philosophies into your business.

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1. A System to Solve Production and Maintenance Worries



- A system of looking after physical assets that maximises their lifetime profitability
- Provides for maximum use of plant and equipment with all operating risks addressed

- No specifications or limitations on how to comply
- Requires introduction of systems to create work processes that can then be optimised by use of a Quality Control System
- Requires setting condition and performance targets for assets
- Necessitates maintaining capability of assets
- Suitable support systems, skills and equipment necessary

Asset Management System Elements

- Asset Management Policy
- Asset Management Strategy
- Asset Management Information System
- Risk Identification, Assessment and Control
- Legal, Regulatory, Statutory and Other Asset Management Requirements
- Asset Management Objectives
- Asset Performance and Condition Targets
- Asset Management Plans
- Structure, Authority and Responsibilities for Asset Management
- Training, Awareness and Competence
- Consultation and Communication
- Documentation
- Document, Date, and Information Control
- Operational Control
- Emergency Preparedness and Response
- Performance and Condition Measuring and Monitoring
- Asset-related Failures, Incidents, Non-conformances and Corrective and Preventative Action
- Records and Records Management
- Audit
- Management Review and Continual Improvement

2. Supply Chain Management for Maximum Performance

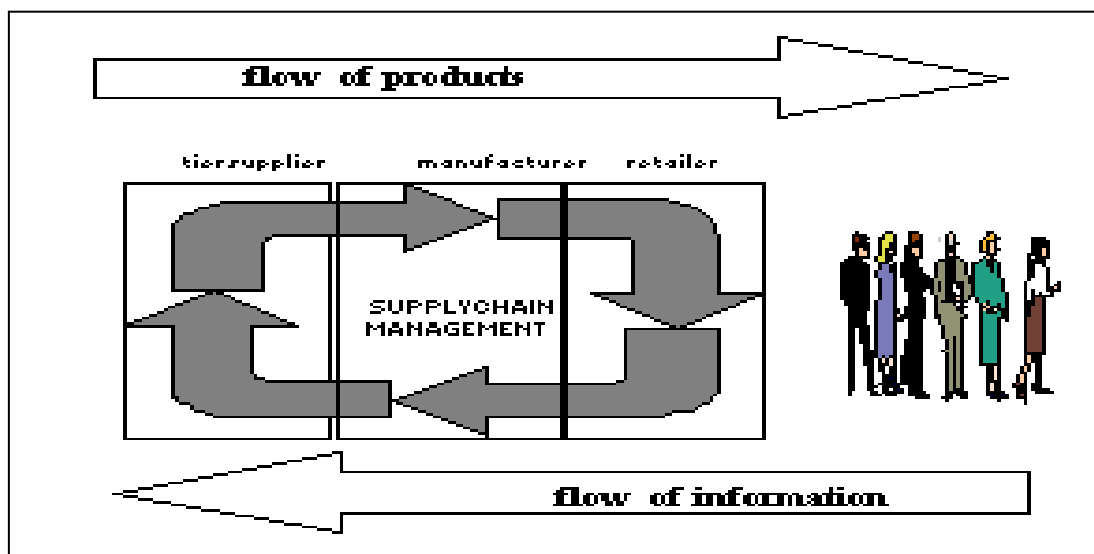
Delve into the four universal factors for supply chain management success: Managed customer service; Optimised logistics costs and investment; Logistics management information systems; Logistics organisations' structure.

Supply chain management (SCM) consists of specific tools and techniques that deal with forecasting, inventory management, and supplier evaluation.

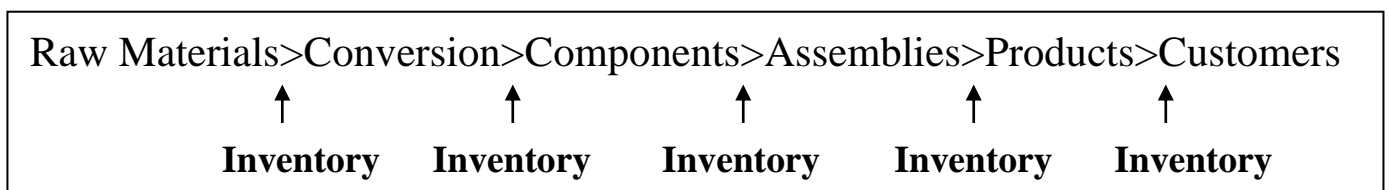
SCM stands for a management concept which tries to integrate the activities of an entire set of organizations from procurement of material and product components to deliver completed products to the final customer.

In domestic and international markets is increasingly becoming 'chain versus chain' rather than 'company versus company'. Often smarter to cooperate rather than compete so becoming more competitive against other chains.

Basic Supply Chain Management Model



The Supply Chain.



Inventory is money tied-up in-process. Here are huge opportunities for inefficiencies and waste to develop along the chain!

Management Concerns

Supply chain management/logistics issues managers need to address:

- Logistics Strategy Development and Implementation
- Logistics Network Optimisation
- Logistics Performance Measurement
- Competitive Logistics Capabilities i.e. using logistics to gain competitive advantage
- Sales Forecasting
- Logistics Support for Marketing Activities
- Setting Competitive Customer Service Levels
- Logistics Outsourcing Options e.g. warehousing, materials management
- Purchasing and Procurement Strategies
- Materials Management Optimisation
- Inventory Levels and Deployment
- Warehouse/ Facility Location
- Warehouse Productivity
- Transport Costs
- Fleet Sizing
- Logistics Organisation Structure
- Logistics Management Information Systems
- Warehouse Management Systems
- Vehicle Scheduling
- Stock Control Systems
- Logistics Skills Shortages

Four universal logistics success factors in addressing supply chain management (SCM) issues are:

1. Managed Customer Service.

Customer service is where supply chain management/logistics starts. Customer service sets the specification for logistics system design. What do we mean by customer service? To some organisations it means dealing with customer complaints, to others it is about after-sales service, and to others it is to have a customer. Generally, it includes all the service factors involved in doing business with your customers.

Customer Service Elements

- Product Availability (Order Fill)
- Length of Order Cycle Time
- Consistency of Order Cycle Time
- Invoice / Billing Procedures / Accuracy
- Information Request Responsiveness
- Flexibility in Resolving Problems

- Distance to Suppliers Warehouse
- Special Customer Requests
- Frequency of Damaged Goods
- Quality of Order Department
- Emergency Coverage
- On-time Delivery

If you surveyed your customers about how they rank the reasons they do business with you, you might be surprised to find customer service coming second only to product quality and usually more important than price. Customer service is very important factor in your customer's decision to do business with you.

If you asked your customers to rank the customer service elements above, in order of importance to them, the results might also be interesting. For example, it is quite common to find companies incurring significant costs to provide a speedy response to customers. Surveys often indicate that speed is not the issue, but consistency of order cycle time is. Customers can plan knowing that you will consistently deliver say 10 days after receipt of order. That is more important to them than some times getting it in 24 hours and at other times 72 hours.

If you also asked your customers to rate your performance in relation to the customer service elements, and also the performance of your leading competitor or competitors, you would be able to identify those elements where you are strong (and weak) and your competitors' strengths (and weaknesses). Then you can start to develop strategies which deliver the level of service your customers actually want and exploit your strengths and your competitors' weaknesses.

In this way, your customer service strategy can become part of your marketing mix. You will be developing a market driven customer service strategy.

Once you have done this, you can design the logistics system necessary to deliver the required level of service. This is what we mean when we say customer service sets the specification for logistics system design.

For example, if order fill rates are important to your customers, then you can plan inventory policies to satisfy this requirement.

If a fast response time to orders is critical, then you can plan your inventory levels, warehouse locations, modes of transport etc to deliver the required level of service.

2. Optimised Logistics Costs and Investment.

Having developed the specification for the logistics system, the second universal logistics success factor is optimising logistics costs and investment.

An analysis of the typical profit and loss statement for a company will show logistics related costs accounting for 20 - 25% of the cost of sales when you consider transport, warehousing, stock holding, systems, materials and people. In the typical balance sheet logistics will probably account for 35 - 40%

of the assets when you include inventory, investment in warehousing, transport and handling equipment, and production capacity.

With these sorts of figures, optimising logistics costs and investment is a major opportunity for improving the bottom line. Add to this the potential impact on competitive advantage of the development of a market-driven customer service strategy, then logistics is a must for management attention.

Deciding on the number, location and size of distribution centres and warehouses - Deciding the location and mission of manufacturing facilities i.e. what manufacturing locations should make what products and service what markets. Developing a cost-effective logistics operating strategy e.g. inventory deployment, intra company and customer transport, size and number of vehicles, Cost savings in freight, warehousing, inventory levels, materials handling, order processing etc.

3. Logistics Management Information Systems.

Supply chain management or logistics is about managing the flow of the right materials through an organisation and the flow of information to facilitate the flow of the right materials. The sort of decisions referred to above cannot be made without having the appropriate information.

Designing and implementing information systems to support the logistics network is critical. These systems will include order-processing, warehouse management, inventory and materials management, procurement as well as various logistics planning tools.

4. Manage Logistics Organisation Structure.

The traditional approach to managing a company was to take each functional area in isolation. So, if you were the production manager you managed your function to achieve your objective which was probably achieving the lowest unit cost of production. You did this by producing long runs of the same product. This invariably meant you built up stocks of each product with resulting inventory carrying costs and loss of customer service.

If you were the transport manager you would optimise your function by achieving the lowest transport cost. This might mean using the cheapest mode of transport and inevitably this would be at the cost of service levels.

The procurement manager would buy the cheapest which would usually mean buying large quantities which would impact investment in inventory and the potential risk of damage or obsolete materials. Etc.

The principle of supply chain management is that the flow of materials of materials needs to be managed as a whole. This means that you can make the right trade-offs and avoid the problems described above.

To achieve this you need to have an organisation structure to facilitate it. This involves having all logistics related functions under the same management control.

Key element of SCM is the integration of activities in response to customer requirements. Solution is integration from start to delivery insuring inventory movement is 1) coordinated 2) minimised 3) on time 4) not wasted.

SCM Principle	Principle's Framework
Compress:	(1) Reducing the number of nodes, members, or actors in the chain, (2) or by reducing the physical distance between any two nodes. Compression primarily applies to structure and aims at costs.
Speed up:	Reducing the amount of time necessary to move between any two nodes in a chain or network or between any two stages in a process. "Speed Up" could be reframed as well as a specific form of "Compression" but is treated separately to ease argumentation below. Speed up primarily applies to processes and aims at time.
Collaborate, cooperate:	Increasing the intensity and scope of cooperative behaviour between two or more independent decision-making units. Collaboration primarily applies to relationships, planning, scheduling, and execution. It aims at cost and service.
Integrate:	Reducing the penalty in time, effort, cost or performance to move between any two activities in a process or between processes. Integration can be applied sequentially (activity A to activity B), vertically (generic process A to generic process B) or horizontally (activity A is pooled for products X and Y). Integration primarily applies to processes and aims at time and cost.
Optimize:	Maximizing the value of a target function through the use of quantitative models. Optimization primarily applies to planning and scheduling and aims at time and cost.
Differentiate, customize:	Increasing the specificity and thus the effectiveness of a subject towards a given purpose. Differentiation primarily applies to structure, processes, and planning and aims at cost and service.
Modularize:	Reducing the penalty in time, effort, cost or performance to replace a particular segment of the chain. Modularization primarily applies to products and processes and aims at cost and time.
Level:	Reducing the magnitude of variation of a certain parameter of an object over time. Levelling may apply to material flows and order flows. Levelling primarily applies to goods and order flows and aims at cost.
Postpone:	Move the product differentiation closer to the time and locus of consumption.

3. Identifying True Downtime Costs So You Can Rid Yourself of Them

True Downtime Cost (TDC) is a method of recording and analyzing all the costs associated with equipment downtime in a production, processing or manufacturing facility. It provides a way to assign time and/or monetary value to stoppages in a complete, thorough and true way that reflects the direct costs, indirect costs and opportunity costs lost because of plant and equipment outages.

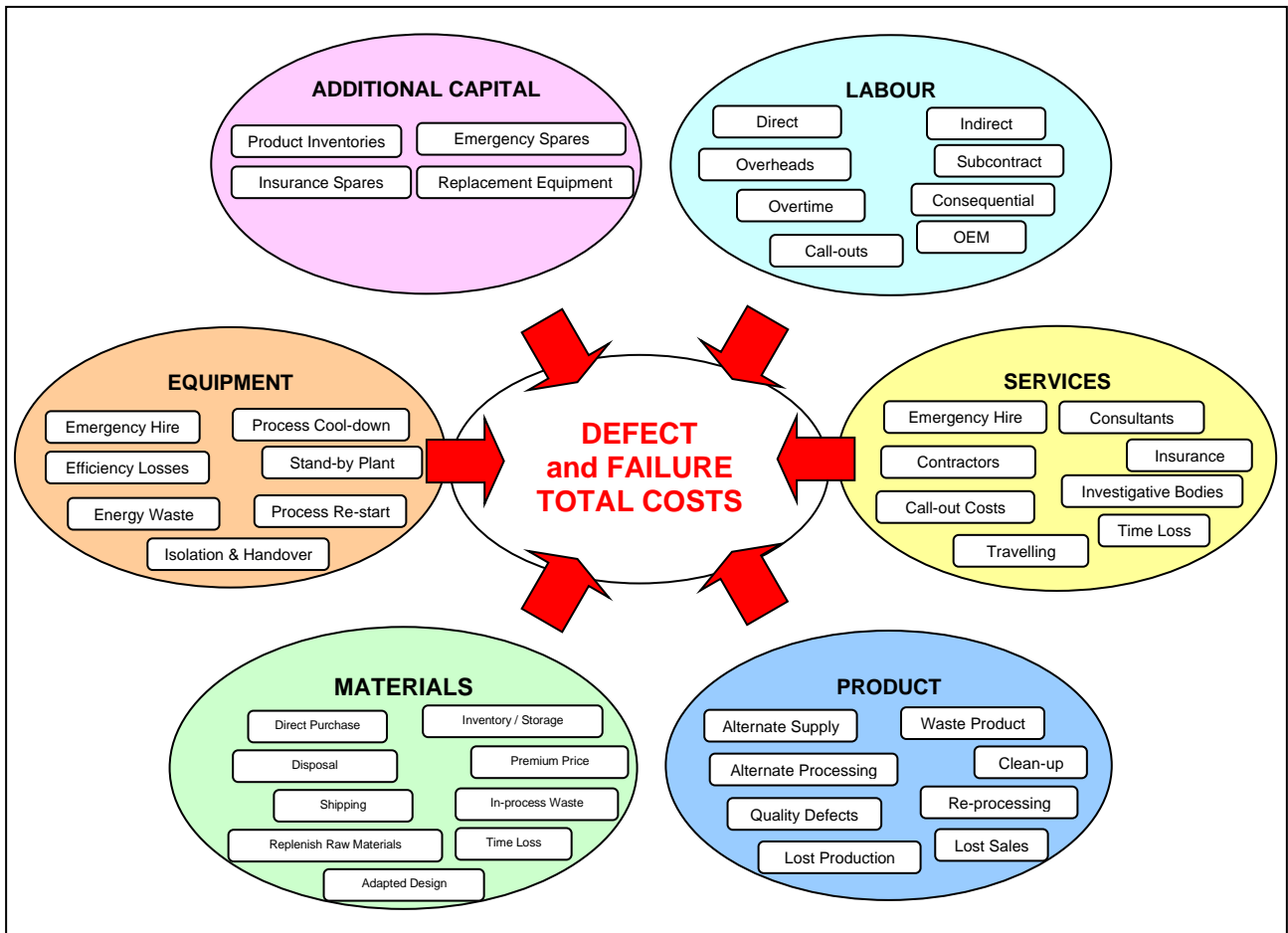


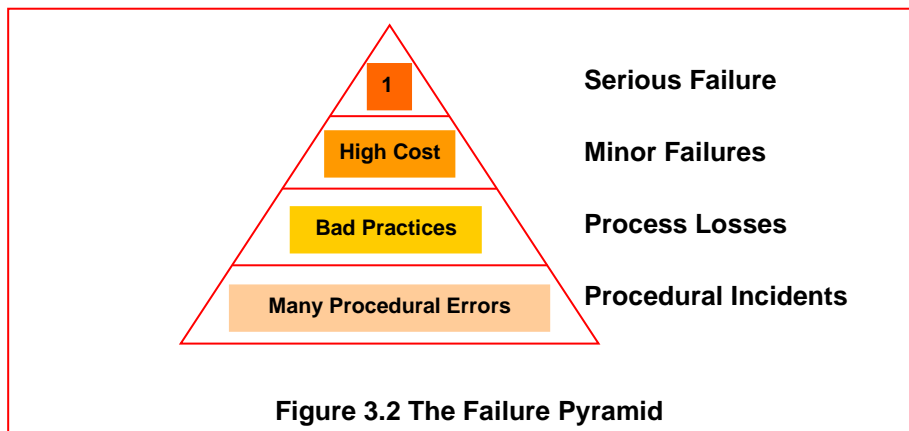
Figure 3.1 A Multitude of Costs Arise Due to Defects and Failures

A failure has consequences. Some consequences will be negligible and perhaps only an inconvenience at worst. Others will be severe; some catastrophic.

Though there is no data for the number of error incidents before there is a serious failure, the implication of a failure pyramid, with many small errors at the bottom for each catastrophe, is conceptually applicable. A simple representation is shown in Figure 3.2.

Those failures that result in loss of life, equipment or materials will incur a financial cost. There will be costs for rectification and restitution, for manpower, for subcontracted services, for repairs and for many other requirements that were not needed before the failure happened. The costs to address a failure are all unexpected costs and draw money away from elsewhere. Failures cause direct and obvious losses but there are also opportunity loss costs. All these costs are additional to the normal

costs of running an operation and must be carried by the business. They are in reality lost profits that could have been made and put in the bank!



Incident costs can be divided into two types:

Financial costs/losses: those additional costs incurred to return to the desired situation. For example:

- overtime payments
- cost of repairs
- Cost of replacement parts
- cost of extra materials
- fines and penalties

Opportunity costs/losses: the costs paid because of no production. For example:

- salary costs of people waiting to work on an idle machine
- people at home unable to work through injury
- costs for machinery running idle
- lost profits on sales that could have been made

As part of conducting a thorough analysis into a failure, the total and complete financial cost of the incident needs to be compiled. The process of collecting, analysing and reporting all costs due to the failure is known as the ‘Defect and Failure True Cost’ (DAFT Cost) method.

The acronym ‘DAFT Cost’ was intentionally chosen to reflect the senselessness of these unnecessary costs being allowed to happen in a business, organisation or operation.

The Components of DAFT Costs

Collating all the costs associated with a failure requires the development of a list of all possible cost categories, cost sub-categories and cost sub-sub-categories so that every charge, fee, penalty, payment and loss is identified. The potential number of cost allocations can be numerous. An example of categories where costs can be incurred is shown in the list below.

- Labour : both direct and indirect
 - operators
 - repairers
 - supervisory
 - management
 - engineering
- overtime/penalty rates
- Product waste
 - scrap
 - replacement production
 - clean-up
 - reprocessing

- handover/hand-back
- lost production
- lost spot sales
- off-site storage
- environmental rectification
- Services required
 - emergency hire
 - sub-contractors
 - travelling
 - consultants
 - utility repairs
 - temporary accommodation
- Materials used in repair
 - replacement parts
 - fabricated parts
 - materials
 - welding consumables
 - workshop hire
 - shipping
 - storage
 - space
 - handling
 - disposal
 - design changes
 - inventory replenishment
 - quality control
- Equipment costs
 - OEM
 - energy waste
 - shutdown
 - handover
 - start-up
- inefficiencies
- emergency hire
- damaged items
- Extra capital expenditure
 - replacement equipment
 - new insurance spares
 - buildings and storage
 - asset write-off
- Consequential impacts
 - penalty payments
 - lost future sales
 - litigation and legal fees
 - loss of future contracts
 - environmental clean-up
 - death and injury
 - safety rectification
 - product recalls
- Administration activities
 - documents and reports
 - purchase orders
 - meetings
 - meeting rooms
 - stationary
 - planning, schedule changes
 - investigations and audits
 - invoicing and matching
- Lost Value from Curtailed Lives
 - lost equipment/materials life
 - labour/resources wasted
 - outsourced services value lost

Each cost category and sub-category may receive several charges against them over the period of time being analysed. All of these charges need to be captured in the analysis.

To assist in compiling the DAFT Cost list it is useful to use the company's Chart of Accounts, as it contains all the accounting cost codes that would typically be used to allocate costs and charge payments in the organisation. If new cost codes are developed because of the failure these also must be included in the cost list.

4. Equipment Profit Contribution

This is an introduction and explanation of why and how to measure equipment efficiency and identify the profit created by each piece of equipment in your operation. Monitoring your plant and machinery's contribution to business profits lets you spot problems and rate their importance and urgency for correction.

Value Stream Mapping – Remove the Unnecessary; Support the Value Streams

Only do what brings value to the operation. Everything else is a non-value activity, a waste, which costs money ... and must be eliminated. You will learn how to spot value and non-value so you can remove the waste and leave the profit.

- All functions are involved in a transformation process
- Develop a time-scale block diagram chart of the process including all the steps capture process flows, material flows, information flows, decision points, feedback loops, review events
- Develop standard work sheets – Written list of tasks in actual sequence; all movements; all times; all distances; all use of tools, jibs or fixtures; inventories; locations of stock
- Measure time and distance moved by people, machines, inventory and 'product' in the process; complete the standard worksheets
- Calculate ratios – cycle time, job time, time in system, value ratio
- Draw a macro-overview current state map
- Identify the wastes and the value-adds
- What does the customer want?
- Reorganise around the core value streams – all support services support the value streams
- Draw a macro-overview future state map
- Complete the future standard worksheets
- Calculate future ratios
- Develop a one-page implementation plan including roles and responsibilities
- Track progress visually
- Focus on continuously improving the process

- **Overall Equipment Effectiveness**

- Measures Maintenance input, Production input, Quality input

The overall performance of a single piece of equipment, or even an entire factory, will always be governed by the cumulative impact of the three OEE factors:

Availability - Percent of (scheduled production - *reliability*) or (calendar 24/7/365 - *equipment utilization*), that equipment is available for production.

Performance Rate - Percent of parts produced per time frame, at maximum rate OEM rated production speed. If OEM specification is not available, use the best known production rate.

Quality Rate - Percent of good saleable parts out of total parts produced per time frame.

$$\text{OEE} = \text{Availability} \times \text{Performance Rate} \times \text{Quality Rate}$$

Example: 50% Availability (0.5) x 70% Performance Rate (0.7) x 20% Quality Reject Rate (results in 80% (0.8) acceptable) = 30% OEE

OEE reveals the six major losses occurring and identifies hidden production plant capacity. The six common losses and their typical causes are:

1. **Equipment Breakdowns and Failures** – The loss of equipment function needed to perform an operation.
 - a. Overloading the machine
 - b. Loose bolts and nuts
 - c. Excessive wear
 - d. Lack of oil
 - e. Contamination
2. **Set-up and Adjustment** – Time lost during changeover from current product to the next product, or changing the settings during a run.
 - a. Removing tools
 - b. Finding tools
 - c. Attaching new tools
 - d. Adjusting new settings
3. **Idling and Minor Stops** – brief stoppages due to ‘insignificant’ problems.
 - a. Parts stuck in a chute
 - b. Removing chips
 - c. Malfunctioning sensors
 - d. Program error
4. **Reduced Speed** – Loss when equipment operates below standard speed.
 - a. Machine Wear
 - b. Human intervention
 - c. Tool war
 - d. Overloading machines

5. **Defects** – Time lost to making scrap, doing rework, or managing defective parts.
 - a. Manual error
 - b. Bad material
 - c. Tool breakage
 - d. Program error
6. **Start-up and Yield** – Time it takes a machine to ‘warm-up’ to full production after a period of downtime
 - a. Slowly bringing a machine up to speed
 - b. Raising environments to set temperature
 - c. Running-off excess material
 - d. Process related material losses

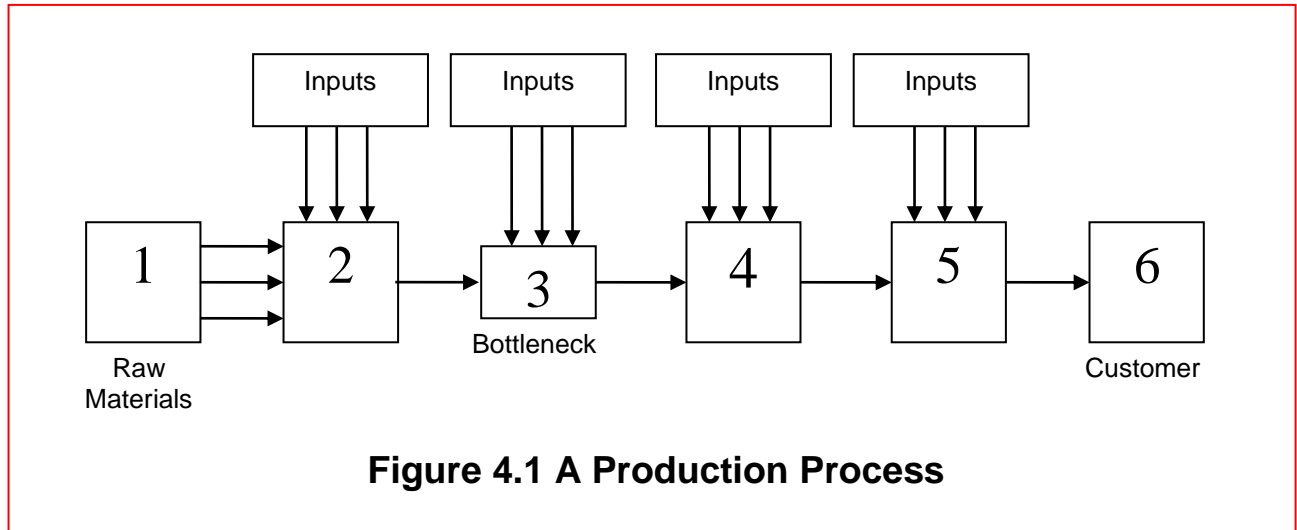
- **Modified Value Stream Mapping using Profit Contribution and Input Costs**

Being busy is not what production is about. It’s about making the most profit as efficiently and effectively as possible while making the product that the customer wants. It’s about producing effectively at the ‘global’ level and efficiently at the ‘local’ level! Discover how to trend your costs and profits to manage production at the optimal output for the least cost and make the most profit.

A production process must be viewed as a system for supplying the customer’s requirements, when they want them at the maximum sustainable profit to the producer.

Here is a simple model of how to maximise the production and profit from your production process.

- Identify customer’s requirements and takt timing.
- Build your production system with components that produce the customer requirements and schedule.
- Maximise the system output to increase production.
 - Map your process to identify constrictions to production flow.
 - The constrictions control the system output rate.
 - Expand the constriction capacity to increase the production flow.
 - Only put enough production through the rest of the process to keep the bottleneck at 100% capacity.
- Optimise local process steps to increase profits.
 - Measure the input costs
 - Measure the profit contribution from the process step.
 - Measure the waste costs from the process step.
- Analyse the bottleneck(s) to increase its throughput capacity.
- Analyse the wastes in each process step looking for ways to reduce them.
- Teach the better ways to everyone
 - Up-skill the competence of people.
- Apply the better ways and continuously improve them.
 - Remove root causes.
 - Use next generation equipment improvements.



To make the product the customer requires from the production process of Figure 4.1, it is necessary that 1) the process be designed to make it, 2) the process be managed to produce the product 3) the company is, and remains, profitable.

The process design establishes the process quality. The efficiency of operating each process steps determines the profit. The bottleneck sets the process rate.

Once a process is designed people's concerns naturally turn to how to make the product as timely as possible. What most people forget to do is to also make it as cheaply as possible while meeting the customer's requirements. This confusion between making product for the customer on-time and also making it for the least cost leads to the situation where everyone is busy making product, but no one is busy making money!

Not shown in the process design is the other output which is produced – waste. This waste includes waste product, which is a commonly appreciated term, but there are many other types of waste made as well. The other wastes most people miss include such things as excess movement, lost, heat, lost water, lost energy, excess storage space, excess time, excess forklift pallet hire, excess equipment, excess paperwork, excess manning, and many, many more. These wastes take-away money from potential profits that could have been made.

Figure 4.2 shows you the same process as before but now we have added the waste produced throughout the process. To determine effectiveness and efficiency we need to have a measure. The best measure to use, which everyone understands is money.

Trending Profit Contribution

Figure 4.2 shows the importance of cost control in each process conversion step. If the customer will not pay what it costs to make the product, plus a margin, then there will be no sales and the organisation goes out of business.

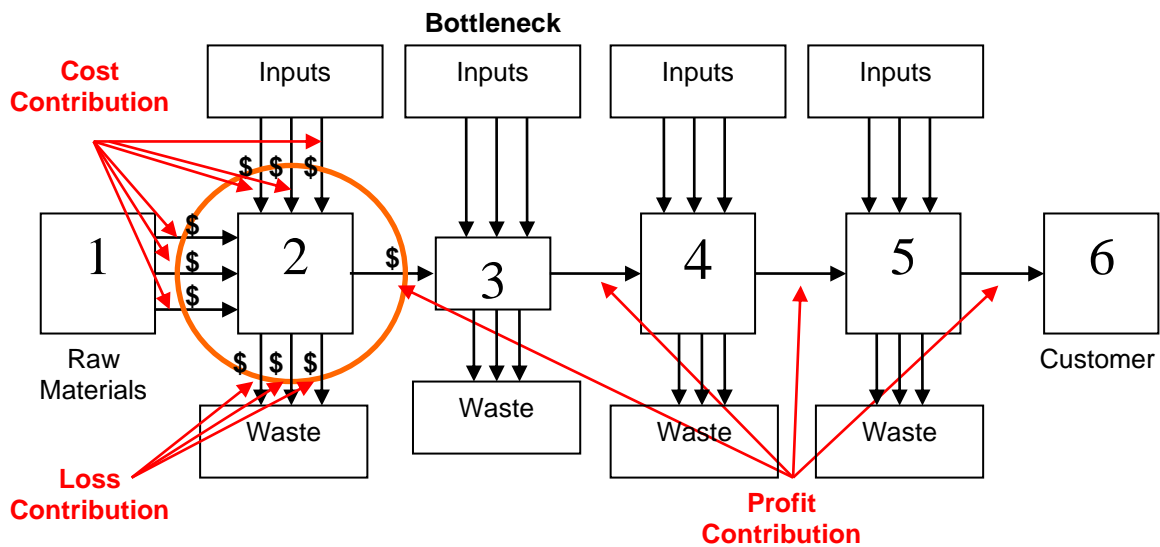


Figure 4.2 Maximising Profit Contribution

Figure 4.3 indicates that each process step has process products coming into it, plus additional inputs required to make the process conversion. Each process step also produces its process ‘product’ along with other waste outputs.

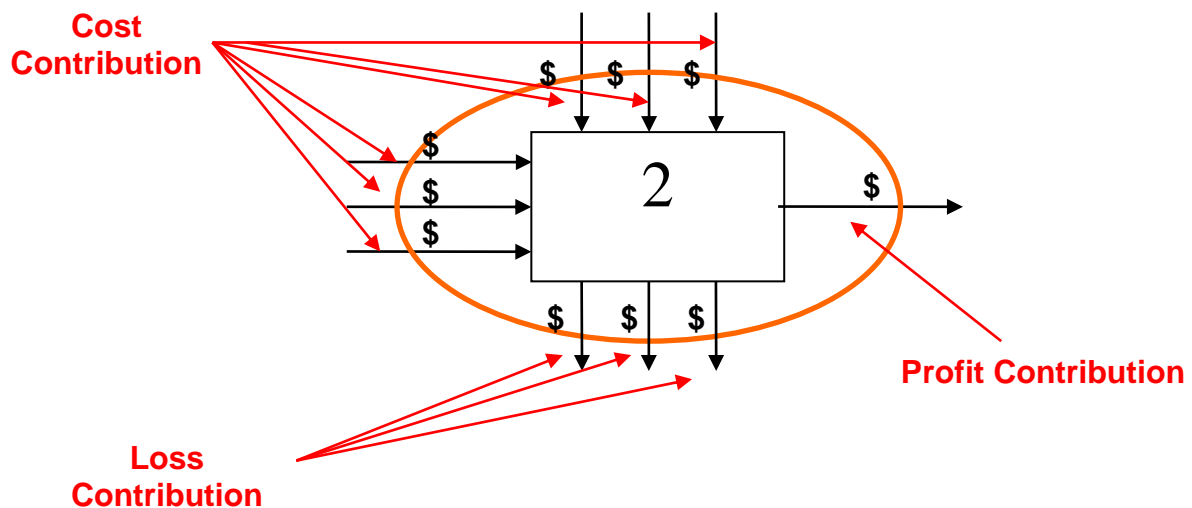


Figure 4.3 Local Profit Contribution

Figure 4.4 shows the importance of maximising bottleneck throughput. The greater the throughput, the more customers that can be serviced with falling marginal operating costs.

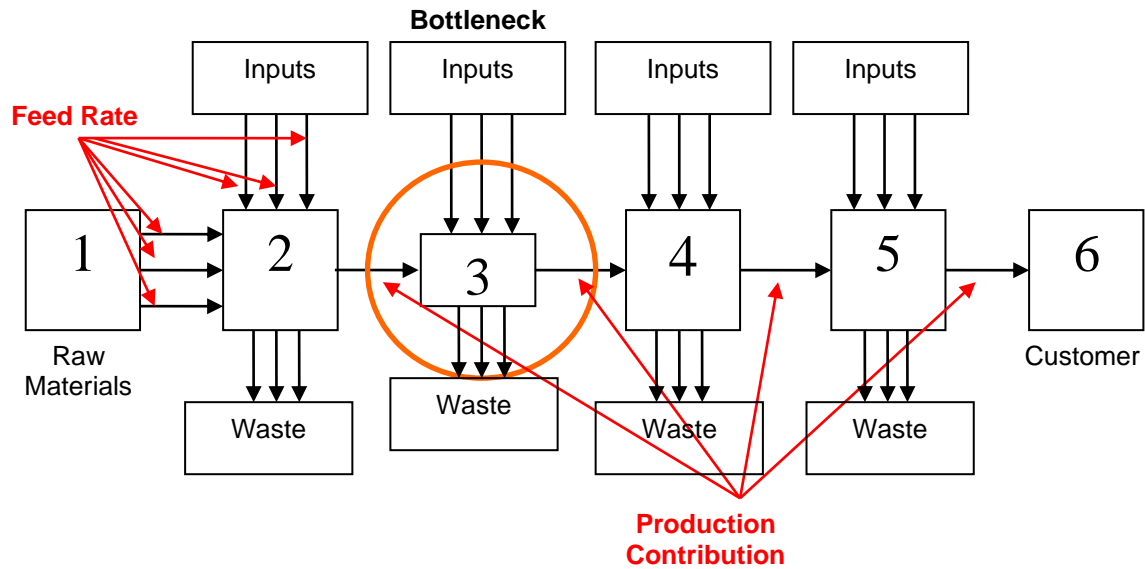


Figure 4.4 Optimising Process Output

5. Operations and Maintenance Defect Elimination and Failure Prevention

Your operation is a bucket collecting defects brought in from outside. Management systems and maintenance help you to handle the failures and problems. But the best long-term answer is to stop the defects and so reduce the need for managing failures and problems!

The world-leading companies don't let things go wrong. They proactively focus on stopping problems from entering their business. They set control mechanisms and checkpoints in place to spot and stop the defects that turn into future failures. They look for what can go wrong before it does and prevent it happening. Now you can discover what they do ... and how to do it too!

- **Assumptions Made When Designing Business Processes, Plant and Equipment**
 - People do their work consistently and reliably
 - People are fully conversant and competent in their duties
 - People are 'expert' at their duties
 - All necessary maintenance and up-keep will be provided
 - No unforeseen external forces will arise
 - There will be no change to the design specification throughout operating life
 - There is a ready supply of inputs, raw materials, parts and people
 - There will be no defects introduced into the system
- **What is a Defect, Failure or Error?**
- **From where do Defects Come?**
- **Measure the Financial Cost to the Business of Defects and Failures**
- **Preventing Defects and Failures**

Defect Elimination Strategy. To reduce maintenance costs and production downtime it is necessary to reduce the causes of the maintenance and downtime. Both maintenance and downtime are an effect and not a cause. The causes can be traced back to defects and errors from a variety of sources. Knowing that defects eventually lead to future equipment failures, production downtime and lost profits, it is necessary put strategies into place to purposely prevent them occurring in the first place and to eliminate them if they are present.

All equipment starts life new. If you do nothing about controlling them, it also comes with future failures built into it. The Japanese say that new equipment is in its worst condition and the longer you have it the better you improve it!

These future failures are the design errors, the materials selection errors, the fabrication errors, the assembly errors and any transportation damage. When installed, further causes of future failures arise from incorrect installation, incorrect site assembly, incorrect mounting practices, inadequate environmental protection and deficient foundations/supports.

Some of these errors, along with commissioning errors and operating errors, cause failures early in the equipment's operating life and explain early-life or 'infant mortality' failures. The errors that do not appear early in equipment infant-life will eventually surface and cause failures sometime later during its operating life.

The preferred terminology is to call the errors 'defects', because that is what you see as a consequence of the mistake.

Defect Elimination

Starting from new, a part properly built and installed, without any errors, will operate at a particular level of performance. If looked after properly it should, ideally, deliver its design requirements all its operating life.

As its operating life progresses any of those previously hidden manufacturer's and installer's errors noted above starting to make their effects shown. For some reason the equipment starts to fail. Failure causes can be introduced at anytime. They can appear during operation from management decision errors, operating errors, repair errors, abuse and even acts of Mother Nature.

If you want superbly reliable equipment you must prevent the introduction of defects and errors at all stages of equipment life and also act to remove the defects and errors already present in it. By getting rid of the defects that generate failure modes you will not reduce your future maintenance requirements.

An average item of equipment has several dozen direct and consequential failure modes.

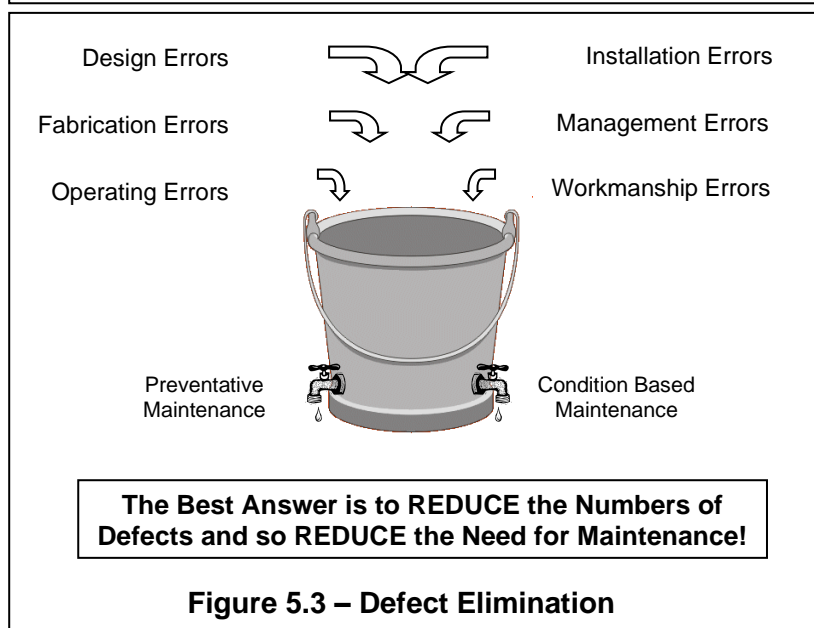
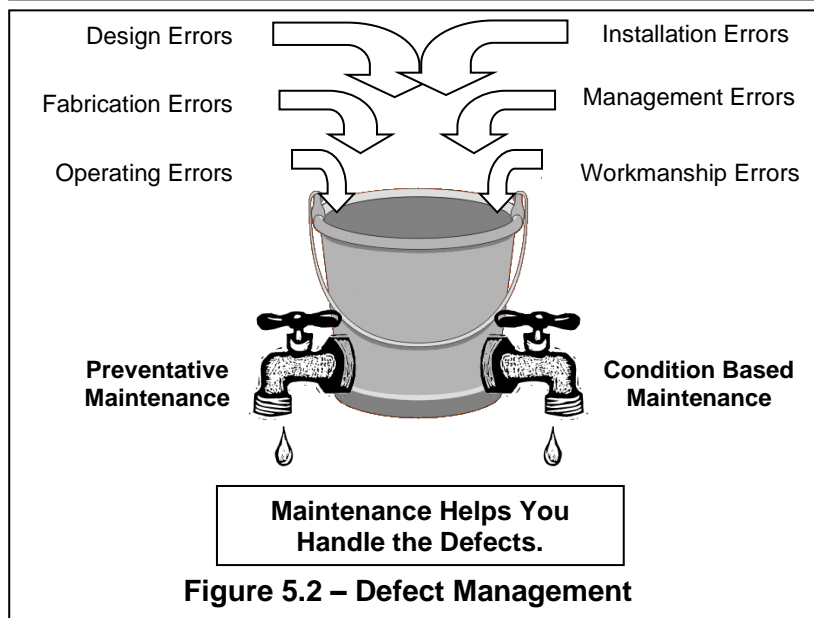
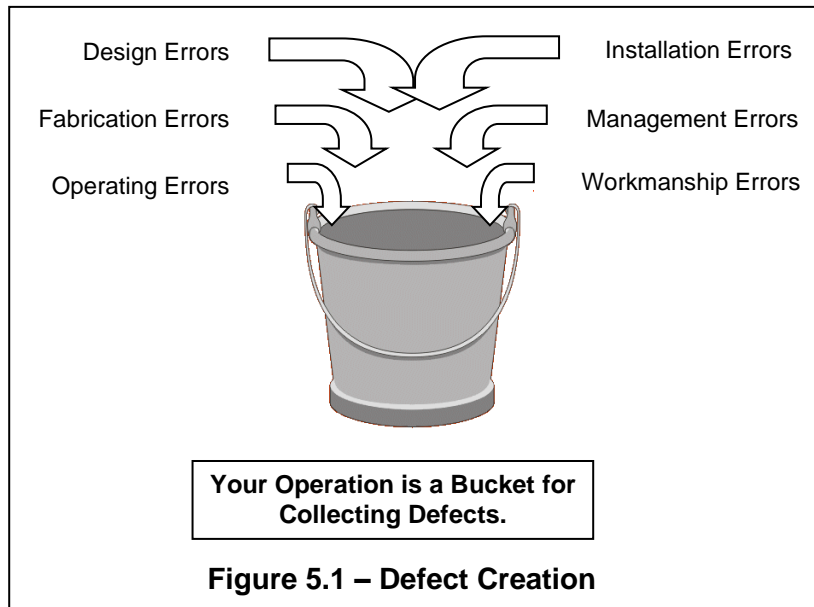
The best maintenance strategy to adopt is to not allow failure modes into the equipment from the start. Such strategies require that you put in place management controls and quality standards that must be followed to detect, control and stop the introduction of errors and defects into the equipment.

For example a wise strategy at the design stage is to look for every failure mode possible and remove it while on the drawing board. You can take each part of the equipment and list its possible defects and errors and then introduced strategies and plans to address every one of those failure paths.

Figures 5.1, 5.2 and 5.3 highlight where your failure casing defects and errors come from and what you need to do to get rid of them and reduce your maintenance costs and production downtime.

Each of the defect categories need to be addressed systematically. Effective mechanisms must be introduced by you to combat and defeat the cause of the defects. Unless the causes are controlled and stopped you will be continually battling failures.

They will never stop because they are forever being introduced and perpetuated by poor procedures and practices, poor quality control and poor management systems. Every new piece of equipment, every new part, every new person that joins your company will bring defects and errors with them to one day cause future failures. How catastrophic those failures will be will depend on the internal controls you have in place in your organisation to prevent and control them.



A Simple Defect Elimination Process

An easy, simple and powerful model to guide you in removing equipment defects from your operation is:

- 1) Select one failure and identify where defects and errors were first introduced through the use of root cause failure analysis.
- 2) Use resources skilled at eliminating the root cause and action a plan to engineer-out the causes forever. (I implore you not to use work procedures to control engineering failures. If you do that you will soon run out of people in the company to make responsible for controlling the causes you will find. They will also consider it an impost on their job and sub-consciously lower its importance so they do nothing about it and the failure will repeat. Use work procedures to direct people's attention, not to compensate for equipment defects.)
- 3) Introduce clear, written quality production and engineering standards into the appropriate levels and locations in the organisation that contain checks and tests to prevent the defects from again entering into your company.
- 4) Train and re-train your people to meet the new standards.
- 5) Measure their performance against the new standards.
- 6) Repeat the above until the defects are so few that your operation is the world-class leader in your industry.

It is necessary to use a quality system because a quality system is self-improving, self-correcting and self-developing. With a quality system properly applied, your company will continuously improve because continuous improvement is built into the way you do business. Without a working quality system you require individuals to remember to do the right things every time. This means you are now counting on good luck for things to go right!

You can remove defects and stop failures by taking a personal stand and start introducing the right quality management practices into your operation. Start with your own projects. Only by adopting better systems and methods, and causing the introduction of better practices and standards at every stage of the production, engineering and maintenance process, will you ever reduce the equipment failures in your operation.

If you want to master equipment maintenance and have outstandingly reliable production, stop the introduction of defects and errors into your operation! If you want to seriously reduce maintenance costs then reduce the number of ways your equipment can randomly fail.

6. Low Cost Preventative and Predictive Maintenance

If you use a contracted condition monitoring service, or you have dedicated people doing your condition monitoring, you are paying far too much money for it and missing too many problems. Predictive maintenance is a job best done by the operators. There are simple, low-cost equipment that every operator should be using to spot problems without needing specialists.

Successful maintenance involves having ownership of equipment problems with the operators and maintainers. Their greatest fear in taking on ownership is their ignorance of where that will take them and the extra workload that it will impose on them. They will not accept responsibility if they feel that it will simply increase their stress levels.

The experience from Total Productive Maintenance is that the least cost maintenance and fastest operational response is attained when the operators do as much of the maintenance as possible. As they gain more confidence and experience looking after the equipment their level of ownership grows. They start doing all their own predictive and preventative maintenance and their machines run better. When they have problems with their equipment they know what to do about it without additional help.

In order to help operators better understand the operation of their equipment they need to develop an affinity with it. Working with the equipment will not greatly help them to understand how it works. If you provide them with some simple predictive tools they will begin to analyse its operation. They will begin to associate equipment operation with production rate and product quality. These predictive tools used by the operators involve no great technical sophistication. They are simply a temperature test pen or laser gun, an automotive stethoscope and their own bodies.



7. A New Technique Controls Accuracy and Stops Failure

You will be introduced to a new technique developed to address repetitive failure in the workplace. It produces consistent focus and attention to detail. There is little time and cost required in its introduction, yet the results it produces are astounding and rapid.

Abstract

Moving from Quality Conscious to Accuracy Controlled Production and Maintenance. Highly reliable equipment is necessary to reduce production costs and maximise production throughput. High reliability from operating equipment requires high quality reassembly, coupled with the correct operating practices. You can guarantee correct maintenance and proper plant operation by specifying a target and tolerance in maintenance and operating procedures. Having a target and tolerance sets the recognised acceptance criterion. A simple proof-test will confirm if it has been met. Specifying a mark and tolerance range changes the focus from one of simply doing the job; to now doing the job accurately. This results in high quality trades' workmanship and sound equipment operator practices that deliver reliable equipment performance. Those organisations that use 'target, tolerance, proof-test' methodology in their procedural tasks move from being a quality-conscious operation to being an Accuracy-Controlled Enterprise (ACE).

Do you know that your workforce can prevent nearly all plant and equipment breakdowns! If your maintenance people do their work accurately to design specification, and your operators run the equipment precisely as intended, they can make the equipment work so well that it becomes superbly reliable.

There is no need to be doing repairs sooner than required by the design if the equipment is rebuilt accurately and run correctly. Accuracy is defined as "the degree of conformity of a measured or calculated value to its actual or specified value." To have accuracy you need a target value and a tolerance of what is acceptably close to the target to be called accurate.

How many defects, errors and failures can your operation afford to have each day? Does your maintenance crew have the time to go back and do a job twice or three times because it was done wrong the first time? Are people happy to regularly accept wasted production and lost time due to stopped equipment? If not, then do your internal work procedures support doing the job right the first time?

Highly reliable production equipment running at 100% design capacity should be normal and natural. Your plant and equipment was designed to work reliably. Its maintenance was intended to sustain the design reliability. Its operation should be as the designer anticipated. The designer wanted reliable 100%-rate production.

If under operation you are not getting the reliability designed into the equipment, then something is amiss. The challenge becomes to identify what is preventing the equipment from delivering the performance it was designed to give.

Very occasionally the fault lies with the design itself. Typically the wrong material was selected for the job. Either it was not strong enough for the stresses induced in it or it was incompatible with materials coming in contact with it. Once a design problem is identified the necessary change is made to enable the equipment reliability to rise to the design intent.

Much more often the reason equipment does not meet its designed reliability is because it is installed wrongly, it is built or rebuilt poorly and it is operated not as designed. Usually this happens because people involved in its installation, care and running do not know the right ways.

Though most operators and maintainers have some recognised training it can never be enough to competently handle all situations. In those situations where they have not been trained they are forced to use what knowledge they do know to make a decision. If it's the wrong choice and no one corrects them, it becomes the way they solve that problem again in future.

The Start of Defects, Failures and Errors in Your Business

Unfortunately many decisions of this type do not have an immediate bad impact. If they did it would be good, because the worker would instantly self-correct and get it right. No, most errors of choice or ignorance do not impact until well into the future. The chosen action was taken and nothing bad occurred. Which meant the operator or tradesman thought it was the right decision, since things still ran fine. That is how bad practices become set-in-place in your operation.

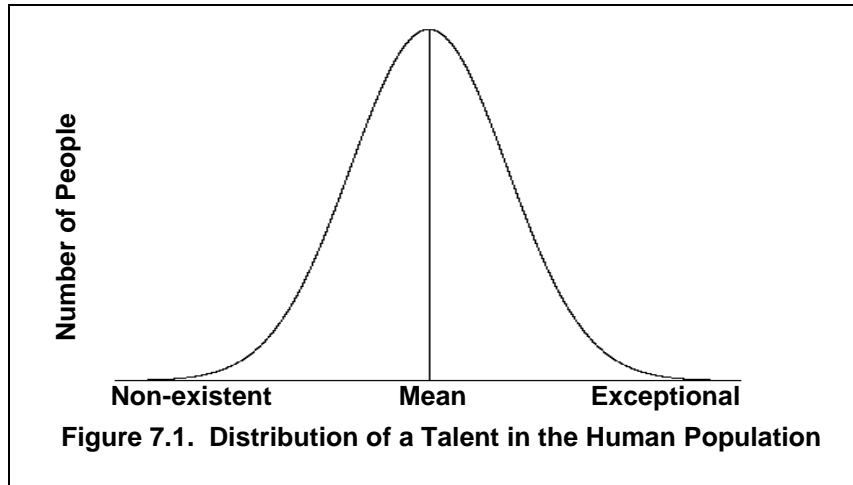
There is nothing wrong with making a wrong decision. Provided it is corrected immediately and nothing bad happens, there was no harm done. Bad things happen when bad decisions are allowed to progress through time to their natural and final sad conclusion. Regrettably there are very few decisions that will give you instant replay options.

If it is important in your company to have low maintenance cost, highly-reliable production equipment, then your internal work systems must support that outcome. All work done by operators, maintainers, engineers and managers need to go right the first time.

Why We Have Standard Operating Procedures

Companies have long recognised that if you want consistent, reproducible, correct results from your workforce they need to work to a proven and endorsed procedure. The procedure provides clear guidance, sets the required standard and stops variations in work performance.

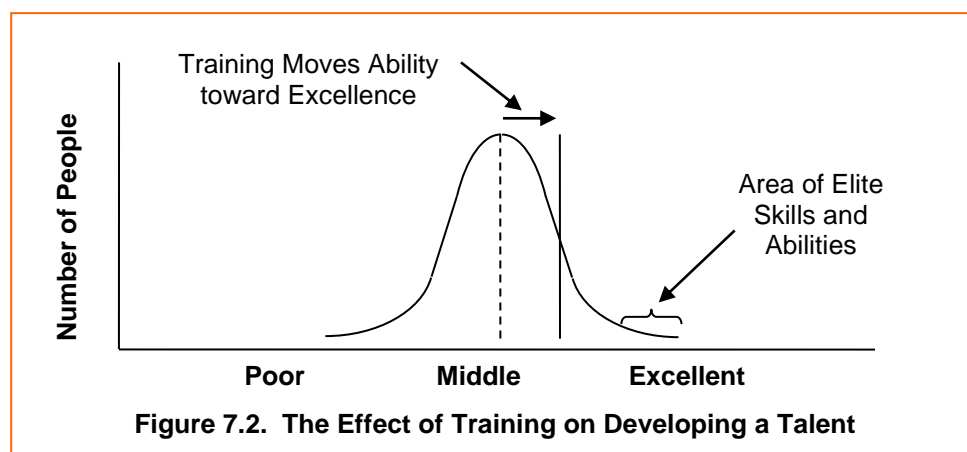
Variations in work performance arise because human skills, talents and abilities are typically normally distributed. If we were to gauge the abilities of a wide cross-section of humanity to do a task, we would end up with a normal distribution bell curve. Secondary and tertiary learning institutions are well aware that student results follow a normal distribution curve. A normal Gaussian distribution bell curve of a talent in a large human population is shown in Figure 7.1.



The implication of such a distribution is that for most human skills and talents there are a few exceptionally able people, a few with astoundingly poor ability and lots of people in-between clustered around the middle or mean.

If your workplace requires highly able people to make your products and do your maintenance, then from the distribution curve of human talent you are going to find it hard to get many people who are that good. The ones you do get will cost you a lot of money because they are the elite in the industry. Hence standard operating procedures were created to use people from the around the middle and below ability levels to do higher standard work than they naturally could do unassisted.

The talent distribution curve also explains why the continual training of your people is so important to your company's long term success. If the available labour pool is clustered around the mean performance level of a skill, then a good way to improve the population's ability to do the skill is to teach them how to do it better. Training has the effect of moving average performers toward the elite portion of the population. This is shown in Figure 7.2.



The Cost of Poorly Written Standard Operating Procedures

Since standard operating procedures (SOPs) control the quality of the work performed by people not expert in a task, they are clearly absolutely critical to the proper running of a business. It is also critically important that they are written in ways to promote maximum efficiency (make use of the least resources) and effectiveness (done in the fastest correct way).

It has been my experience that very few companies use their SOPs to control outcomes. When they are available they are not self-checking and do not promote good practice. They offer little practical assistance to the user. Typically they are glanced over when operators and maintainers start a new job and then thrown to the back of the shelf to never be seen again. That is a pity because they are one of the most powerful learning tools ever developed. At least they could be if their supervisors and managers knew what could be done with an SOP.

Of the companies that have SOPs, most were written by their resident expert in the job. They wrote the procedure already knowing all the answers. So tasks were described with words and statements that assumed prior knowledge. You will often see in SOPs statements such as - “Inspect lights, check switch, check fuse, and test circuit”. And “Inspect steering wheel linkage”. Or in the case of a machine operator - “Test the vehicle and report its condition”.

The problem with the use of procedures containing such descriptions is that you must first be an expert to know whether there is anything wrong with what you are looking at. They require you to hire trained and qualified people in order to do what is maybe a very simple job.

The Best SOPs Can Be Done By The Least Skilled People.

There is a better way to write SOPs that still maintain the work quality but do not need only qualified people to do them. They can be written with more detail and guidance and include a target to hit, a tolerance on accuracy and regular proof-tests of compliance so that job quality is guaranteed.

Standard operating procedures are a quality and accuracy control device which has the power to deliver a specific level of excellence every time they are used. Few companies understand the true power of an SOP. Typically they are written because the company's quality system demands it. People mistakenly write them as fast as they can, with the least details and content necessary.

In reality SOPs should be written to save organisations time, money, people and effort because they can make plant and equipment outstandingly reliable so production can maximise productivity!

For a standard operating procedure to have positively powerful effects on a company and its people there must be clear and precise measures, which if faithfully met, will produce the required quality to deliver the designed equipment performance. Great production plant reliability and production performance will naturally follow!

If we take the “Inspect steering wheel linkage” example from above and apply the ‘target, tolerance, proof’ method, a resulting description might be:

“With a sharp, pointed scribe mark a straight line directly in-line on both shafts of the linkage as shown in the accompanying drawing/photo (A drawing or photo would be provided. If necessary you also describe how to mark a straight scribe mark in-line on both shafts). Grab both sides of the steering linkage and firmly twist in opposite directions. Observe the scribe marks as you twist. If they go out of alignment more than the thickness of the scribe mark replace the linkage (a sketch would be included showing when the movement is out of tolerance).” The procedure would then continue to list and specify any other necessary tests and resulting repairs.

With such detail you no longer need a highly qualified person to do the inspection. Anyone with mechanical aptitude can do a reliable inspection. This method of writing procedures is the same as

used by writers of motor car manuals for novice car mechanics. Car manuals are full of procedures containing highly detailed descriptions and plentiful descriptive images. With them in-hand novice car mechanics can do a lot of their own maintenance with certainty of job quality.

The very same logic and method used to write car manuals also applies to industrial production and maintenance procedures. If you put in your procedures all the information that is necessary to rebuild an item of equipment, or to run a piece of plant accurately, you do not need people from the exceptional end of the population to do the job well.

Train and Retrain Your People to Your Standard Operating Procedures

Having a procedure full of best content and excellent explanations for your workforce is not by itself enough to guarantee accuracy. How can you be sure that your people comprehend what they read? Many tradesmen and plant operators are not literate in English, nor do they understand the true meaning of all the terms used in a procedure.

To be sure your people know what to do and can do it right, they need to be trained in the procedure and be tested. Training is needed before they do the task alone, without supervision, and later they need refresher and reinforcement training. The amount and extent of training varies depending on the frequency a procedure is done, the skill level of the persons involved and their past practical experience in successfully doing the work.

Procedures done annually or more often by the same people will not need retraining. Because people forget, those procedures on longer cycles than annually will need refreshment training before they are next done. Training and retraining often seems such an unnecessary impost on an organisation. You will hear managers say “If the work is done by qualified people why do I need to train them? They have already been trained.” The answer to that question is “How many mistakes are you willing to accept?”

For example, if you have had flange leaks soon after a piece of equipment was rebuilt, it is a sign that you may need to retrain you people in the correct bolting of flanges. Flanges do not leak if they were done right. When a repair re-occurs too often, it is a signal that the SOP does not contain targets, tolerances and proof-tests or that training is needed to teach people the procedure.

Taking Your Organisation to an Accuracy Controlled Enterprise

A classic example of what great value an accuracy-focused SOP can bring is in this story of a forced draft fan bearing failure. The rear roller bearing on this fan never lasted more than about two months after a repair. The downtime was an expensive and great inconvenience. To take it out of the realm of a breakdown, the bearing was replaced every six weeks as planned maintenance.

The bearing was also put on vibration analysis condition monitoring observation. After several replacements enough vibration data was collected to diagnose a pinched outer bearing race. The rear bearing housing had been machined oval in shape when manufactured and it squeezed the new bearing out-of-round every time it was bolted up.

You could say that vibration analysis was applied wonderfully well. But the truth is the repair procedure failed badly. If there had been a task in the procedure to measure the bolted bearing housing roundness and compare the dimensions to allowable target measurements, it would have been instantly noticed as having an oval shaped hole at the first rebuild.

There was no need for the bearing to fail after the first time! A badly written procedure had let bad things happen! Whereas an accuracy-controlled procedure with targets, tolerances and proof-tests would have found the problem on the first repair and it would have been fixed permanently.

You can convert existing ISO 9000 quality procedures to accuracy-controlled operating procedures with little development cost. The only extra requirement is that you include a target with tolerances and a proof-test in each procedural task to give feedback and confirmation the task is done right.

The problem with targets is that they are not easy to hit dead-centre. It is not humanly possible to be exact. If a procedural task states an exact result must be achieved, then it has asked for an unrealistic and virtually impossible outcome. A target must be accompanied with a tolerance range within which a result is acceptable. There must be upper and lower limits on the required result.

Even the bulls-eye in an archery target is not a dot; it is a circle with a sizable diameter. You can see the bulls-eye in Figure 7.3 is not a pin prick in size. Anywhere within the bulls-eye gets full marks. So must be the target for each task in an accuracy-controlled procedure.

A well written accuracy-controlled procedure contains clear individual tasks; each task has a measurable result observable by the user and a range within which the result is acceptable. If you do this to your procedures you build-in accuracy control. With each new task only allowed to start once the previous one is within target, you can guarantee a top quality result if the procedure is followed as written.

With targets set in the procedure, its user is obliged to perform the work so that they hit the required target. Having a target and tolerance forces the user to become significantly more accurate than without them. When all the task targets are hit accurately, you know the procedure was done accurately!



Figure 7.3. Targets Have Tolerances

Once a procedure always delivers its intended purpose you have developed a failure control system. No longer will unexpected events happen with work performed accurately to the procedure.

Conclusion

Procedures need in-built accuracy to prevent failure and stop the introduction of defects. To ensure each task is correctly completed the worker is given a measurable target and tolerance to work to. The procedure is done correctly when its individual tasks are all done to within their target limits. Using this methodology in standard operation procedures makes them quality control and training documents of outstandingly high value and accuracy.

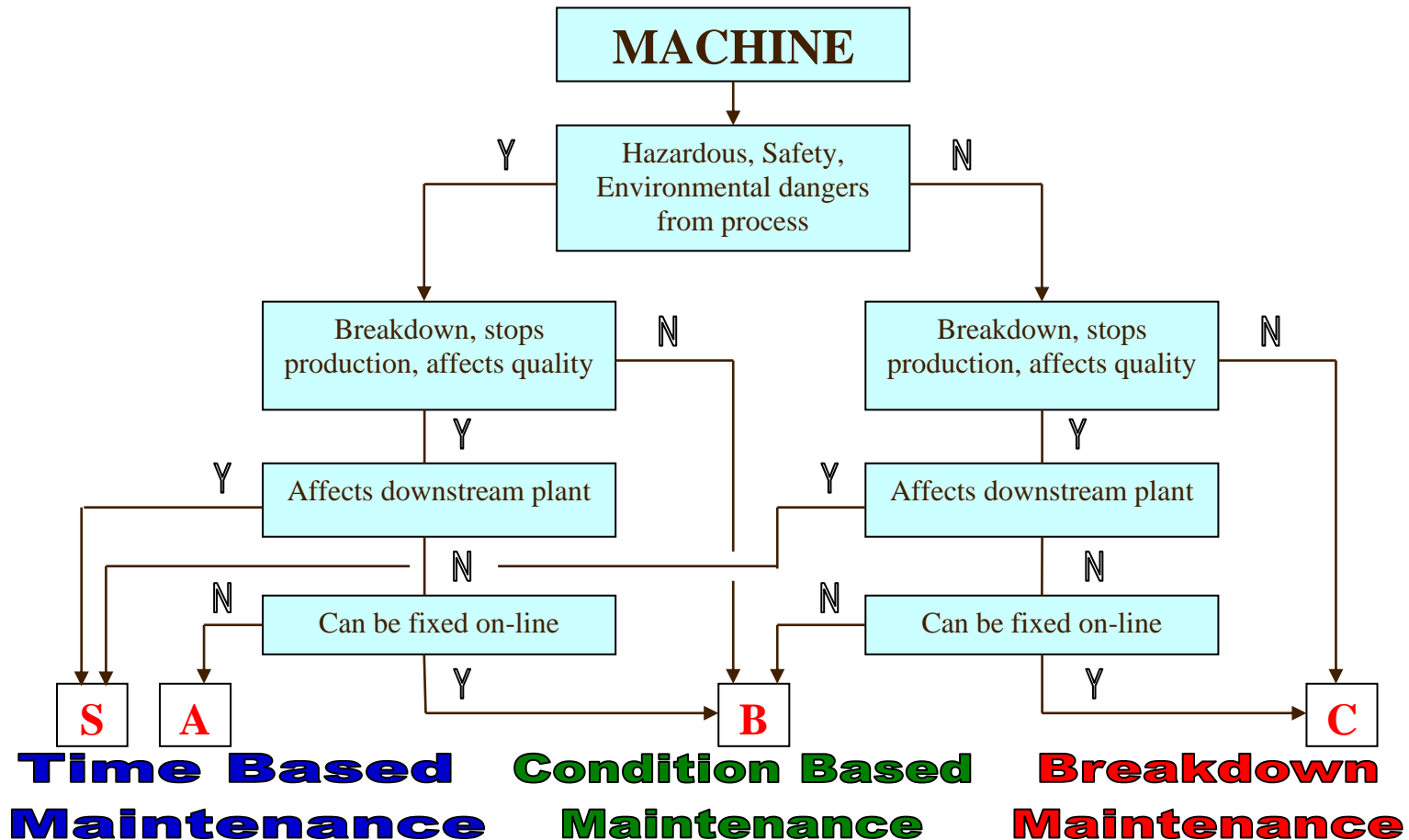
The organisations that use sound failure control and defect prevention systems based on proof-tested, accurate work, move from being a quality conscious organisation to being an accuracy-controlled enterprise; an ACE organisation.

With that level of accuracy in maintenance, operation and engineering tasks you will naturally get outstanding equipment reliability and consistently high production performance.

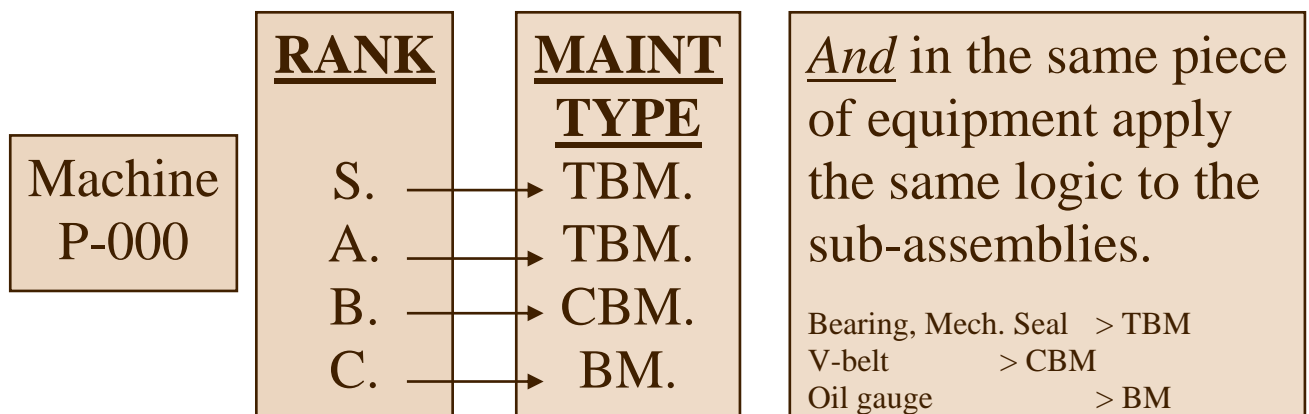
8. A Japanese Equipment Criticality Method to Manage Risk

Risk control starts with recognising the size and consequence of the risk. This simple methodology used by a Japanese industrial giant will let you both identify the risk level and select the risk mitigation method best suited to it.

Equipment Criticality Rankings



Sub Assembly Rankings



9. The Incredible Power of Visual Management

Human beings love a challenge. You can use visual management ‘tools’ to turn work into a ‘game’ that they will love to master. This little understood psychological ‘trick’ is a powerful way to get people to enjoy their work and become inspired to improve their performance!

A key condition of accuracy controlled procedures is to provide a means to physically confirm a test measure is definitely within the target tolerance range. To pass the acceptance test the operator must have sensory confirmation of the result. It is not sufficient that a procedure is accepted as completed correctly simply because the tasks in the procedure have been followed from start to end. One must be sure that what is written in a procedure produced the right result.

It is only when the result of the proof-tests confirm that all procedural tasks have been done right that you can be sure the whole procedure has been completed correctly. The best and most acceptable way to know a test is within its limits is for the person performing it to note the results with one of their body’s senses. This can be visually, through sound, by taste, using touch or with smell.

The most common way to confirm a test result is by use of sight. This preferred technique of seeing if a variable is in control has become known as the ‘visual control’ method. Some common visual controls seen around us everyday are shown in the pictures in Figure 9.1.



Traffic Lights



Airport Runway Lines and Lights



Goal Post

Figure 9.1 – Visual Control Measures in Everyday Life

Visual control measures give immediate feedback on whether we are getting the right result. At the traffic lights we know if we are going to make the lights in time or not. The pilot landing a plane can line-up with the centre line and know the plane is in the middle of the runway. The kick for goal either went between the posts or it missed, there is no question about it. That degree of certainty is what is needed in ACE procedures.

By converting task proof-tests into visual control measures it becomes possible for anyone and everyone to know if the procedure is being done right. It means a manager or supervisor can immediately see for themselves how well the work is being done. It lets the worker check themselves with certainty that they are meeting the procedural requirements. Visual controls clearly indicate whether the proof-test made the target or not.

Visual Control Measures for Continuous Processes

Often it is not possible to stop a production procedure to do a proof-test because it is not practical. The alternative is to take test samples from the process and trend them. To monitor the whole process the samples can be taken from selected representative points in the production cycle.

The test samples are measured and the results graphed. The results of the tests are compared to the desired target result and if within tolerance they are passed and production can continue. If the results are not within specification the production process is adjusted and retested. Adjustment continues until the test values indicate the process is running correctly.

Typically the results of testing are put on statistical control charts and the charts become the visual control measure. An example of a statistical process control chart from a continuous process operation is shown in Figure 9.2.

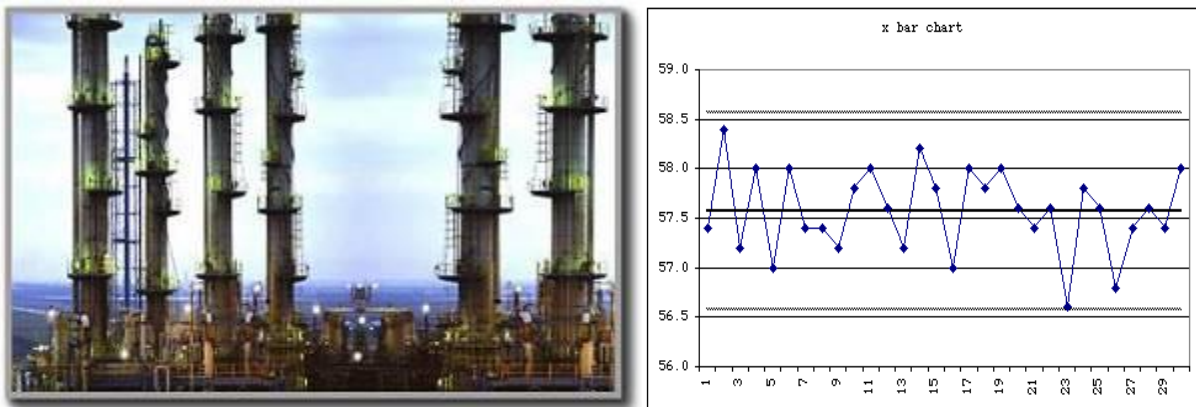


Figure 9.2 Statistical Process Control Chart Used to Monitor Continuous Processes

10. 5 Ways to Miss-Out on World-Class Operating Performance

World-class operations performers do five things exceptionally well. If you want to be like them you need only do the same! But not doing one of the five exceptionally well will stop you getting there. Learn what the 5 key factors are and how the world-class operators do them.

The biggest and richest car company in the world has discovered many successful production practices and methods. Learn what they are and how they can be used in your operation to make quick and lasting improvements.

- Continuous One-Piece Process Flow
- ‘Pull’ Systems to Avoid Inventory (JIT)
- Level-Out the Workload to the Bottleneck
- **Get Quality Right the First Time (1)**
- **Standardise to Maximise Simplicity (2)**
- Use Visual Controls
- Use Tested and Proven Technology
- **Develop People and Teams To Support Your Culture (3)**
- Work With Your Suppliers and Partners To Improve Together
- **Go and See for Yourself to Gain Thorough Understanding (4)**
- Make Decisions Slowly, Considering All Options. Implement Rapidly
- **Become a Learning Organism Continuously Improving (5)**

11. Optimising Whole of Life Profitability

The profitability of a business is determined before a shovel of dirt has been turned! If the concept and design is flawed nothing can fix it when it is operating. You need to have a profitable operation before it starts! Now a new method to test and prove your plant and equipment investments will make good profits, not just average profits, is yours to use!

Life Cycle Profit Optimisation – Design-in Reliability and Lower Costs

If maintenance is done poorly production costs rise fast. But maintenance done well delivers higher profits. ‘Repairs and Maintenance’ is classified as a cost by accountants but is an enabler for improving production and lifting profits. Learn how to use maintenance to drive profits!

- **Reliability is Where the Profit Is**

- *Reliability is long-term.* It is the probability a product will function correctly when needed, for the period required, in the specified environment. In manufactured products the reliability comes from its design, materials, manufacture and use in service.
- *Reliability is customer satisfaction driven.*
- *Reliability is measured at end of life* – probability of functioning to design for a set period.
- *Reliability is observable* - number of returns and service call-outs from customers

- **Reliability is Designed-in – Request It.**

- Reliability is designed-in using **failure reduction techniques** such as Failure Mode and Effects Analysis (FMEA), Design Options and Cost Total Optimisation Review (DOCTOR) and as predicted based on test results and models.
- Forecast problems and unlikely ways to fail.
- Prototype and make the item fail; then design-out problems.

- **Life-Cycle Profitability is Culture Critical**

- Master plan for reliability improvement and a written company policy.
- Company-wide buy-in – ‘common-mindset’ throughout/across organisation.
- Make the improvement process visible – goals, targets, charts, deeds done.

- **‘Customer’ Communication**

- User feedbacks captured and root cause failure analysis applied.
- Competitor’s products examined for weaknesses and strengths.

- **Equipment Failure Database and Analysis**

- Detailed equipment and component failure database developed.
- Discover the actual root cause and identify clearly.
- Analyse database for specific changes to include in next generation of items.

- **Product And Design Development**

- Reliability is ‘designed in’ with appropriate engineering decisions.
- Reliability level and matching project goals set with design team for each ‘project’.
- Formal methodology of design, development and testing process developed and followed.
- Project management applied to control reliability requirement during development.

- **Supply System Alignment**

- The supplier’s components are the components your company will build its business on.
- The supplier’s processes must deliver the required reliability.
- Open, honest communication focused on mutual improvement needed.

- **Production and Maintenance Systems**

- Need the processes, equipment, tools and techniques to control variation.
- Production/Manufacturing is part of the design and development process so that production/manufacturing limitations are recognised and appropriate choices made.

- **Design Options & Cost Total Optimisation of Risk (DOCTOR):**

Analyses the operating costs of available solutions based on Net Present Value. The costs of the consequences of future failures are used to proactively address issues at the decision and selection stages of improvement projects. It is a Life-Cycle Profit (LCP) methodology of great value because of its simplicity to understand and to use. Appropriate measures are put in place to track and control the solution’s performance.

- **Defect and Failure True Cost (DAFT Cost):**

Identify the full and true costs of potential failures in real money. Typically, the total true defect cost is many times the obvious costs of rectification. When failures occur, their costs reverberate across the entire organisation. Production, Maintenance, Stores, Administration, Finance, Sales and Despatch are all impacted. Those seemingly small failures snowball into substantial amounts of money that could have been profits! DAFT Costing highlights to everyone the tremendous expense and waste caused by failure and spurs change the way things are done so that defects, failures and errors are reduced.

- **Examples of the Techniques**

See the ‘Plant and Equipment Wellness’ eBook free from the website.

12. Standard Costs Improve Results in 30 Minutes

Every dollar used in an operation needs to add value to the product. Standard costs are a means to spot changing business inputs and outputs before they spiral out of control. You will discover how to easily set what your costs should be and quickly detect negative changes so you can act in good time to turn them around in a controlled fashion.

- **What is a Standard Cost**

- A very carefully prepared estimate of the cost of performing a given operation under specific conditions
- If conditions change, or operation changes, or costs change the standard costs change
- Based on process design performance

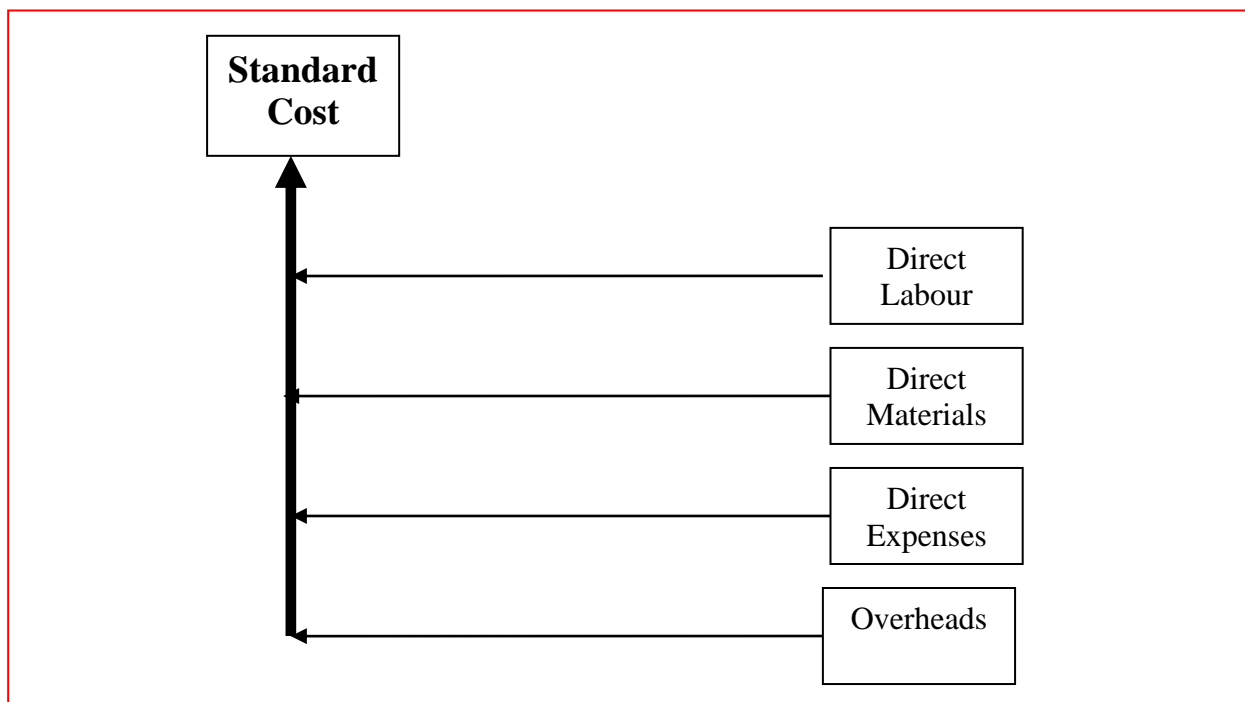
- **Why Have Standard Costs?**

- To know the expected cost under expected conditions
- For the budget
- To identify variations quickly
- To provide factual proof that operation is properly managed
- To allow accurate costing of new proposals
- To identify improvement opportunities

- **Developing Standard Costs**

- **Using Standard Costs to Manage the Operation**

- Variance analysis
- Performance reports



Standard Costs

A standard cost is a very carefully prepared estimate of the cost of performing a given operation under specific conditions.

Used in budgets, quotations and to allow monitoring and control of actual costs.

Cost = Quantity x Price (to that point in the production/supply chain). Require standards for both Quantity and Price to have a standard cost.

Developing the Standards

Historical Standards

- *Average of Past Performance*
 - Simplest and quickest
 - But will include all extraordinary/abnormal occurrences
 - But may not reflect actual normal cost
 - But does not allow for production scale variations (small run vs. large run)
 - Can apply statistical techniques to help refine (mode – most common performance, median – mid result of a range of performances, inter-quartile – middle of range of performances)
- *Best of Past Performance*
 - Based on real historical evidence
 - Sets realistic beneficial goals to reach
 - But may not be best possible performance
 - But best performance may not be consistently reproducible
 - But may have been an error made in recording/analysing

Forecast Standards

Standards represent not what costs are, or have been, but what they should be! So Standard Cost ...

- Is estimated and prepared in advance of production or supply
- Correlates technical specification of material/labour to prices/wages
- Includes apportionment of overhead expenses
- Related to a selected period of time
- Related to a set of prescribed working conditions

Ideal Standards

- The **highest performance attainable** at the most ideal conditions
- No allowance for defects, operator fatigue, accidents, price movements, or any undesirable and avoidable condition
- Purpose is to **identify the upper limit of efficiency** and perfection within the conditions existing
- Unachievable and so can be demoralising to workforce if used.

Normal Standards

- Average **activity over a full business cycle** including boom and bust
- Used to **prove and check overhead absorption** throughout the business cycle is attainable
- Not used for monitoring, as activity is seldom consistently at normal capacity and results in continually changing variances

Expected Standards

- **What costs should be** within the context of the real conditions
- Assumes inefficiencies in conditions will gradually be addressed and improved – expected standards become an attainable goal!
- **Variances** from the standard highlight system and management performance and provide recognition of successful and not successful strategies, practices and methods.
- Most commonly used standard.

Revision of Standards

Input costs change over time and the standard costs need to change to reflect the current situation. However there are benefits in comparing changes in standards over time and in revising the ‘ideal’ standards.

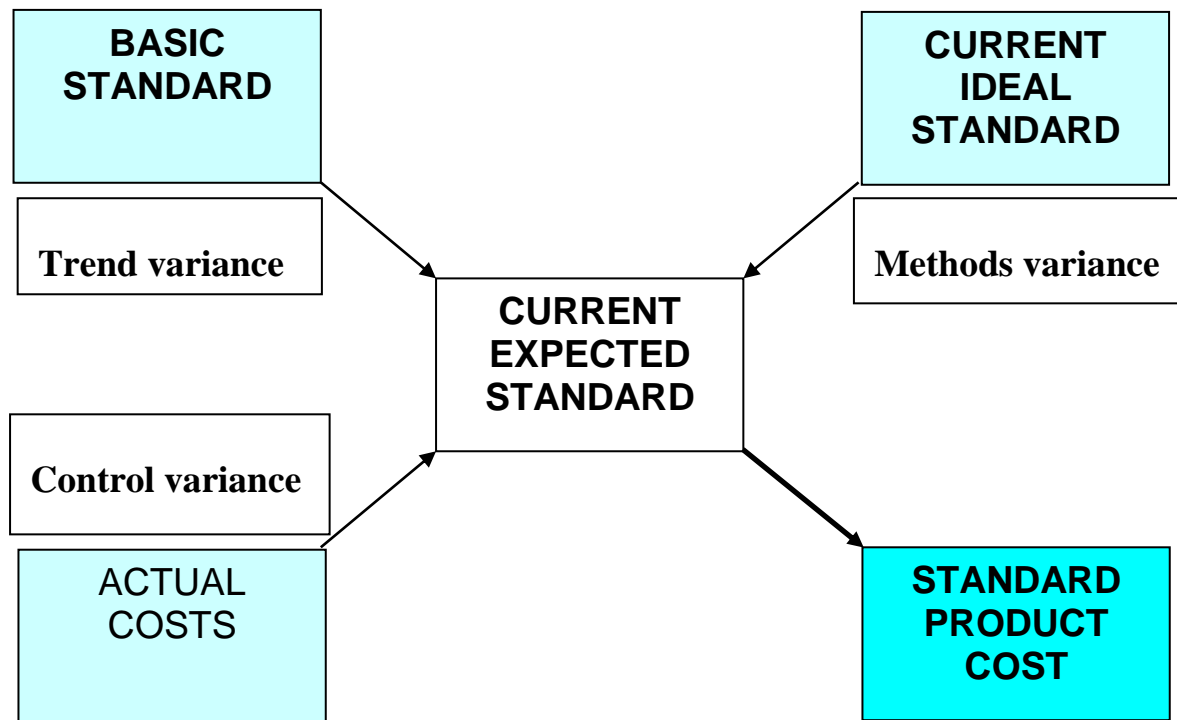
Basic Standard – the initial standard. It remains in force for long periods and is used to **monitor trends** – original standard is retained as set. Eventually it becomes unusable for managing variances as conditions become too different.

Year	1	2	3	4	5
Price	\$80	\$84	\$78	\$86	\$92
Ratio	100	105	97.5	107.5	115

Ratio of Actual Prices to the Basic Standard

Current Standard – expected performance under current conditions. Changes as current conditions change. Best approach for controlling costs as they are most realistic of prevailing conditions.

Dual standards – Two standards are used. One is current expected standard while the other is either basic or ideal standard.



Comparison against the basic indicates changing trends. Comparison against the ideal indicates where to improve methods and efficiencies. Comparison against actual costs indicates where control is required.

Motivational Aspects of Standards

- Humans in a control system – forced, coerced, or willing achievers?
- Conflicting goals of participants – imposed or joint goals?
- Behaviour improvement or behaviour standardisation?

Setting Cost Standards

Cost is product of quality and price; hence both need to be incorporated in each standard cost. Need both the technical performance standard and the price standard.

Physical Standards for Direct Materials

The engineering or design standards set the material specifications from which material standard costs are determined.

- Bill of materials
- Fabrication and assembly drawings
- Manufacturing methods and process used
- Material losses expected during manufacture
- Direct materials purchased from outside the operation

Include benefits (trade discounts, cash discounts, refund on returns, full credit on returnable items) and adverse effects (disposal, cartage, damage, handling) in standard costs where intended.

Provides chance to use 'value analysis' to interrogate the function of materials' selection and identify least expensive purchase to meet function.

Standard Operations for Direct Labour

Setting labour performance requires specifying how the operation is performed with the equipment involved and the estimated time for each operation.

Operation Times are based on the standard hour – 'a hypothetical unit pre-established to represent the amount of work that should be performed in one hour at standard performance'. It represents the average time for the average worker to perform a given task under standard conditions.

- Time and method studies.
- Average past performance
- Test runs factoring in learning curve
- Forecast estimates (particularly when tendering)

Standard Wage Rates

Setting standard wages depend on the type/grade of labour (trade, manual, technician, engineer, etc) and the payment for that type of work including method of remuneration (wages, salary, incentives)

Hourly wages - Time rate usually reflects one grade of labour in any given cost centre for all operations in that cost centre. Unless there is a clear need for a range of rates in the cost centre (some tasks need higher skills).

Incentive plans – in piecework the standard rate is the price paid to operators and incurs no variance. Under a bonus system the rate includes time wages and bonus earned under standard conditions.

Teamwork – where process requires a team to accomplish it may be better to aggregate all wages into a standard team hour.

Factory Overhead Standards

Overheads are the additional costs incurred in running a business, which are not directly related to making the saleable product – manufacturing, engineering, administration, selling, distribution, research.

Absorption rates are established for each cost centre to enable an equitable charge for overheads to be made against each product.

Can be based in a time rate where overhead costs are allocated based on passage of time, e.g. monthly, or use a pre-determined rate based on production volume or throughput.

Methods of absorption relate to where overhead cost is incurred –

- Percentage of direct wages
- Rate per direct labour hour
- Rate per machine hour
- Rate per departmental production hour

Variance Analysis

Purpose is to identify difference from the standard by causes.

Classification of Variance

- *Materials Usage Variance* – Materials costs differ because more or less was used

Example: 55 tonnes of material was issued from store at \$960/t. Standard price was \$1000/t. The material was used to produce 4000 articles. Standard specifies 80 units per tonne of material; hence 50 tonne produces 4000 standard items.

Standard cost (50t x \$1000)	= \$50000
Actual cost (55t at \$1000)	= <u>\$55000</u>
Price variance <i>adverse</i>	= (\$ 5000)

- *Materials Price Variance* – Materials costs differ because a higher or lower price was paid

Standard cost (55t x \$1000)	= \$55000
Actual cost (55t at \$960)	= <u>\$52800</u>
Price variance <i>favourable</i>	= \$ 2200

- *Labour Efficiency Variance* – Labour costs differ because more or less hours were needed

Example: The 4000 articles were made in 280 hours for which wages paid were \$18,200 and the standard wage rate for the job is \$60 per hour. The standard time for 4000 units is 340 hours.

Standard cost (340 hours at \$60)	= \$20400
Actual cost (280 hours at \$65)	= <u>\$16800</u>
Efficiency variance <i>favourable</i>	= \$ 3600

- *Labour Rate Variance* – Labour costs differ because higher or lower wages rates were paid.

Standard cost (280 hours at \$60)	= \$16800
Actual cost (280 hours at \$65)	= <u>\$18200</u>
Labour Rate variance <i>adverse</i>	= (\$ 1400)

- *Overhead Volume Variance* – Overhead costs differs because more or less overhead absorption was needed for the volume of activity

The overhead for the period was \$37000. The budgeted overhead expenditure was \$35000 for an output of 3500 units, or \$10 per unit.

Absorbed expenditure (4000 at \$10) = \$40000

Budgeted expenditure (3500 at \$10) = \$35000
Volume variance *favourable* = \$ 5000

- *Overhead Expenditure Variance* – Overhead costs differ because expenditure on services was higher or lower for the level of activity

Budgeted expenditure = \$35000
Actual expenditure = \$37000
Expenditure variance *adverse* = (\$ 2000)

Performance Reports

Two aims 1) to measure actual performance against the standard and identify
variances
 2) Use the variance as the stimulus to generate corrective action and
improve performance if adverse and encourage if favourable

Principles of Variance Reporting

Used by the manager responsible and containing only those items for which they can be expected to control.

The variance report should be issued regularly (daily, weekly, monthly according to needs) and always punctually.

Use comparative figures and ratios to highlight significances. All known reasons for variances should be stated, e.g. poor quality material, machine breakdowns.

Regular Reporting

Daily reports to functional managers provide leading indicator information for early intervention to correct adverse performance.

The two significant reports for monitoring operating department effectiveness are daily materials usage and daily labour efficiency. Develop simple charts and tables to collect data and correlate it into meaningful performance indicators.

Daily Materials Usage Report									
Dept _____				Supervisor _____				Date _____	
Day	Daily Usage				7 days to date		4 weeks to date		Year to Date
	Actual Qty	Std Qty	Variance Qty	Variance %	Std Qty	Variance %	Std Qty	Variance %	Variance %
Sun									
Mon									
Tue									
Wed									
Thu									
Fri									
Sat									
Total									
Mean wkly variance for year to-date						Man mthly variance for year to-date			

Daily Labour Efficiency Report								
Dept _____				Supervisor _____				Date _____
Cost Centre		This Day (Hours)			Efficiency Ratio			
Code	Name	Actual	Standard	Variance	Today	Previous Week	Previous Month	Year to Date
Dept Totals								

Where daily reports are not possible or practical, weekly reports are used. Weekly reports should report daily performance and include costs along with actual quantities.

Divisional Managers normally receive a weekly report on performance showing departmental variances.

General Managers receive monthly reports of variance particularly the profit and loss statement of the company's monthly performance and the reasons for the variances.

Divisional Operating Summary					Week Ended _____				
Department	Materials		Labour		Variable OHD		Fixed OHD		Total
	Mix	Yield	Rate	Eff'cy	Expend	Volume	Expend	Volume	
Totals									

13. Workplace Failure and Defect Elimination

Here are two simple equations that are very important to your future. These two equations can make you very successful in your career. The first equation shows how you make money in business. The second equation shows you how you lose it!

$$\begin{array}{rcccl} \text{Profit} & = & \text{Sales Revenue} & - & \text{Costs} \\ \$ & = & \$ & - & \$ \end{array} \quad \text{Eq. 13.1}$$

$$\begin{array}{rcccl} \text{Cost of Loss} & = & \text{Frequency} & \times & \text{Cost of} \\ \$ & = & \text{Of Occurrence} & \times & \text{Occurrence} \\ & & \text{N} & & \$ \end{array} \quad \text{Eq. 13.2}$$

Equation 13.1 is what doing business is all about. If you want to be profitable you must make more money from selling your product or service than it costs to make it. If in your market you cannot raise your price, then you can only become more profitable by lowering your costs. Keeping your costs down means you must do two things well:

1. get things right the first time so there are no wasted resources, effort or money.
2. keep improving and finding ways to lower your costs further.

In business we expect things to go right, just as we planned them to go. But continually we find that they do not. This means that each time something goes wrong your costs automatically go up because the job was not done right the first time and you now have to expend extra resources and spend more money to fix it.

Equation 13.2 explains why when things go wrong your company loses money. A mistake, (often called a failure) costs money to fix. It is money lost that can never return. How much money you loose each year from failures depends on how big the failures are and how often they happen. How often a failure happens is known as the 'frequency of occurrence'. The more often a failure occurs, the more money lost. Even if a failure happens very occasionally, but when it does it is a catastrophe, you will still lose a lot of money.

All failures must be addressed and the extra costs to fix them are paid for from profits. This explains how failures and mistakes in a business cause it to become unprofitable.

Risk Based Maintenance

With equation 13.2 you can see that to reduce the losses from failures you must do one of two things:

1. reduce the number of failures.
2. reduce the cost impact of the failures.

Identify what your failures are costing you so that you can get support from the people in your company to fix them. Otherwise the cumulative cost of the losses could put you all out of business.

Risk-based maintenance (RBM) revolves around minimising both the frequency of failure and the cost consequences of failure. One of the best ways to minimise risk is to be accurate when you do maintenance.

Precision Maintenance – An Accuracy Mind-Set

This is a philosophy created by Ralph Buscurello from the USA-based Uptime International in the late 1980's. Time and again it has saved companies fortunes in maintenance costs. Now it's fully explained so you can use it too.

Accuracy is Critical

- Shaft parallel alignment to under a hair's width.
- Machine vibration to below standard – balance, transfer isolation
- No soft-foot, no body distortion, no pinched parts on assembly
- Master craftsmanship work quality
- Proof test that quality and accuracy is achieved before doing the next task

Keep Healthy Machine Condition

- Vibration
- Oil
- Wear
- Stresses
- Fatigue
- High temperature
- Identify and use measurable parameters

Assembly, Disassembly and Re-assembly is to Specification

- Develop procedures and check sheets with target, tolerance, proof-test; keep assembly records
- Tolerance standards
- Check and prove all is correct prior assembly
- Test run, check and observe under operating conditions – base level machine condition values are where they should be

Creative Disassembly

- Know what is right to expect – drawings, specifications, component materials
- Measure and record wear; record operating life effects for comparison training and reference
- Identify root cause of the issue