Glossary

Accounting Measures

These are summary statements containing key information covering the economic events affecting a business during a particular period, usually a month and the financial year.

Businesses use various forms of accounting for monitoring and trending. The methods usually used include financial accounting, cost accounting, managerial accounting and tax accounting. In all cases, they summarise and present business performance data that reflect the outcomes of decisions and actions taken in the past. The intention is to allow rapid detection and correction of poor performance and instigate continual improvement in future performance.

Data accuracy is critical to the proper use of accounting measures. The data needs to be timely, consistent in its gathering, of use to the user and understandable in order to make correct interpretations and decisions.

Benchmarking

This is a method for organisations to compare their processes, practices and performance with other organisations in the industry, sometimes even across industries, to encourage striving for improvement.

Performance benchmarking is the collection of (generally numerical) performance information for making comparisons with other compatible organisations. It identifies the important performance yardsticks and permits ranking and comparing with others in the industry and other analogous industries. Ideally, repeat performance benchmarking over two or three years to monitor progress. Performance benchmarking can lead directly to improvements, but often it is an ideal pointer to improve specific processes through in-depth study using process benchmarking.

Process benchmarking is the comparison of practices, procedures and performance, with specially selected benchmarking partners, studying one business or production process at a time. It identifies what is the best practice in a process, where the best practitioners are, and what to learn from them and put to use in our own organisation.

Common, Shared Goals

In order to produce alignment of effort and focus it is necessary to ensure diverse groups such as Operations, Maintenance and Engineering all work toward the same outcome. Giving each group the same goal insures that they work together to deliver the same result best. It minimises cross-purposes and helps focus the use of scarce resources.

An example would be that Operations, Maintenance and Engineering are each to ensure the plant and equipment has 98.5% availability in the next 12 months. Now that each group has the same target they will support each other's efforts and provide resources freely across departments. By so doing they move closer to their common goal.

Computerised Maintenance Management System (CMMS)

An on-line computer accessed data base containing all useful information needed to maintain a facility's assets. It permits the planning of work, ordering of parts and spares, reporting on costs, scheduling of manpower, investigation of equipment history and other functions that improve response time and efficiency of maintenance efforts.

Integrated CMMS is one where the maintenance module seamlessly interacts with other modules in the suite to exchange data and information between the accounting, stores, human resource and manufacturing functions.

Detailed Scope of Work

This is a written document describing the performance outcomes required from the person or organisation doing a task. The customer writes it to make clear to the provider exactly what outcome they want and the constraints to meet. It can include specific methods to apply in a situation, specific equipment and subcontractors to use, specific data to provide as part of the supply, specific tests to pass and standards to meet, etc.

Engineering Design Standards

The purpose of Engineering Design Standards and Specifications is to provide minimum standards for the design, methods of construction, kinds and uses of materials in the preparation of plans for construction, repair or alteration of business facilities. The standards cover the current proven body of knowledge applicable to a situation or engineering issue.

Engineering and Design Standards provide information and guidelines in designing facilities. These guidelines avoid confusion during construction, operation and maintenance.

The standards may indicate compliance with specific legal requirements. Standards quoted in statutory laws and regulations become Law themselves.

Standards provide proven systems and materials to efficiently build, operate and maintain facilities while satisfying the functional needs of the business. Update standards continually as new discoveries and technologies become normal practice in an industry.

Environmental Impact Statement

A detailed written statement required by Government Environmental Protection Authorities. Typically a detailed report analysing the environmental impacts of proposed plans and actions, any adverse effects that cannot be avoided and the alternative courses of action available. In the report are detailed the final decisions and actions that will be taken in the case. It can also cover short-term uses of the environment versus the maintenance and enhancement of long-term productivity, along with any irreversible and irretrievable use of environmental resources.

It should include a description of the project; a description of the environment affected; assessment of the important effects of the project on the environment; justification of the project from alternative views; and a non-technical summary of its findings.

The primary purpose of an Environmental Impact Statement is to suitably address the requirements of the statutory Environmental Act. It is to provide full and fair discussion of significant environmental impacts and inform decision-makers and the public of reasonable alternatives that would avoid or minimize adverse impacts, or enhance the quality of the human environment.

Equipment Criticality Analysis

A ranking technique used to order the functions of the manufacturing/production process and the equipment supporting them. It highlights their critical value to the business. Criticality analysis is divided into two segments – Functional and Equipment Criticality analysis. The purpose of the Functional and Equipment Criticality Analysis procedure is to segregate the Function as Most Critical, Critical and Less Critical and Equipment as Extreme Critical, High Critical, Medium Critical and Low Critical.

Each function is analysed and scored with respect to its failure effect on Production, Environment and Safety and criticality scores established for each effect to calculate functional criticality score.

Then equipment is analysed with respect to its effect on Production, Environment, Quality, Safety, Service level, Redundancy and Frequency of failure. Based on the score obtained the Equipment Criticality Score is calculated.

This analysis helps in fixing Operating and Maintenance policy and strategy for the equipment based on its importance to the operation.

Equipment Performance Standards

At one level, these standards establish rating criteria and procedures for measuring and certifying that product and equipment performance meet minimum requirements set by Government Agencies and Technical Committees. Typically the standards check equipment performance meets occupational health, employee welfare and environmental requirements, and to rate performance on a uniform basis so that buyers and users can make proper selections for specific applications.

A second and equally important use of equipment performance standards is to specify when the equipment is operating at design specifications. Operations and maintenance use the information to control the loading and stresses placed on plant and equipment in order to run plant within its capacity and be sure it can operate to design specifications all its life.

As new performance targets are developed the Standards are continually revised and updated. Third-party assessors monitor compliance to the minimum requirements of the standard. In statutory tests you present the results to the government agencies responsible for compliance. The standards can specify the testing methods and equipment to use to do the compliance check. For production equipment they define the lower limit of performance acceptable and let operators and managers determine what level of maintenance and monitoring are required for the plant and equipment to guarantee the minimum performance.

Failure Modes and Effects Analysis (FMEA)

This is a methodology for analysing potential reliability problems early in the development cycle where it is easier to take actions to overcome these issues, thereby enhancing reliability through design. FMEA identifies potential failure modes, determine their effect on the operation of the plant, and identify actions to mitigate the failures. A crucial step is anticipating what might go wrong with a process. While anticipating every failure mode is not possible, the development team should formulate as extensive a list of potential failure modes as possible.

The early and consistent use of FMEAs in the design process allows the design-out of failures and production of reliable, safe, and easily operable plant and equipment. FMEAs also capture historical information for use in future improvements.

Hazard Audits

The identification, assessment and control of hazards are a key business risk management and health and safety activity. The discovery and good management of hazards will significantly reduce the number and severity of workplace injuries and catastrophic incidents.

A hazard management system includes the following features.

- Identified and assessed hazards/injury factors. This includes when there are new or changed processes, machinery or equipment.
- Significant hazards identified and prioritised for control.
- There is an action plan to manage/control hazards and injury factors (particularly significant hazards that can take the business out of production).
- Remedial action identified in injury investigations is included in action/controls.
- Hazards/injury factors and their controls are recorded in a hazard register or similar.
- Actions put into motion to address the risks and dangers.
- Staffs know when and how to report hazards and injury factors.
- Regular updating of the list of hazards and injury factors.

To manage your hazards and injury factors you need to:

1. Identify the hazard and injury factors through reporting and auditing.
2. Assess the impact on the business and prioritise hazards and injury factors for resolution.
3. Control hazards and injury factors by developing and implementing actions to control them.
4. Regularly evaluate the effectiveness of the control actions.

All these steps need completion to create an effective hazard management system that will prevent injuries and business catastrophes from happening.

As with all health and safety activity, the hazard management process will be far more effective when employees are involved, and trained managers lead the process.

Hazard Identification Study (HAZID)

This is the first step in risk assessment and hazard management. The results input directly into planning and setting safety objectives. HAZID is a similar process to HAZOP, involving pre-work, a documented team exercise using tailored check-lists and prompt lists, and the subsequent tracking of actions through to close out. The process of hazard identification is relevant throughout the life-cycle of a project.

Several techniques of HAZID exist, including conceptual hazard analysis and layout assessment. All of which systematically evaluate a plant, process or system to determine the hazards present. These techniques ensure objectivity by including independent personnel on the review team and assist in the demonstration of hazard management by the use of formal records. Ranking of identified risks ensures efforts focus on areas of higher risk.

Hazard and Operability Review (HAZOP)

These are six systematic and integrated studies conducted to identify safety, health and environmental aspects and operability problems of processes through all stages of the project life cycle.

HAZOP 1 (Preliminary Hazard Review)

Perform it at the very early stage of any project or modification. It identifies the safety, heath & environmental aspects of the materials in the process that need further attention. Also, provide information for compiling the Environmental Impact Assessment.

HAZOP 2 (Plant and Equipment Major Hazard Review)

Carried out at the conceptual design stage on the feasibility phase plant and equipment to identify and assess hazards in terms of fire, explosion, and toxic release. This provides information for Major Hazard Installation Risk Assessments.

HAZOP 3 (Detailed Examination of the Design)

It identifies hazard and operability problems at the completion of the basic design, which could originate from deviations in the design.

HAZOP 4 (Plant Review)

After construction and before commissioning, this review ensures that all the provisions from the previous studies are incorporate in the built plant.

HAZOP 5 (Safety Health and Environmental Audit)

This review checks legal and organisational risk management programs for compliance before start-up.

HAZOP 6 (Operational Review)

This final review confirms that the operation meets all the Safety Health and Environmental requirements and is operable.

Installation Check Sheets (Also see Rotating Equipment Integrity)

Charts, tables, records that list the plant and equipment precision maintenance standards for construction and the actual site field measurements attained.

The acceptable tolerance ranges on the check sheets are from information provided by the OEM, and from the previously set precision maintenance standards specified for the equipment.

KAIZEN Continuous Improvement

It is a Japanese concept that encourages small continuous improvement daily. It focuses on doing things better without spending much money; involves everyone from managers to workers and uses simple common sense solutions. It is ongoing, never-ending progress where established practices are gradually improved.

Kaizen methods work in a number of ways. The most common is to change worker operations to make a job more productive, less tiring, more efficient and safer. To get buy-in, and gain significant improvement, invite workers to participate in the process. With the help of a supportive team, ask how to more efficiently and simply do the job. Gradually introduce the changes. A second way is to improve the equipment, like providing foolproof devices (poka-yoke) or changing the machine layout to speed up a process. A third outcome is to redesign the procedures.

Conduct a review first to identify areas and functions of potential benefits, or problem areas needing improvement. There are opportunities for improvement in every business function.

The Kaizen process needs to be controlled. Do not change designs, layouts or standards unless there is definite improvement. The control is normally through using improvement groups where rank or position is unimportant and where improvement suggestions from all are encouraged. An authoritative committee further discusses the suggestions to insure they have worth and gain to the business. It is normal to reward appropriately those suggestions that are valuable to the organisation.

The best success with Kaizen comes when it is applied to make improvements in the workplace ('gemba' is the word for workplace in Japanese). The workplace is where the actions taken, the procedures used and the decisions made will affect the profitability of the business. By asking people in the workplace to find better ways to do their work they gradually introduce changes and improvements that simplify and speed-up the outcomes they produce.

Key Performance Indicator (KPI)

This is where you evaluate and optimise the performance of the business using metrics. One of the greatest challenges faced by a company's executives is optimising the results of its business performance. Businesses can use metrics to generate and analyse key performance indicators (KPIs) to measure the success of its efforts and continuously improve so they can meet and exceed future expectations.

When you know what goals you should set for your business, specify and define a KPI to track their achievement, and performance. This helps the people involved in its achievement to succeed faster.

Leadership toward World Best Practices

Leadership is the ability of the leader to think, reason, calculate, inform and act so that a group of people produce performance and results beyond the sum of each individual's abilities. In particular the focus is on continually looking for better ways to deliver outcomes and drive the business toward world leading performance, through its people growing and developing in competence and self-esteem.

Lean Waste Reduction

Lean waste reduction is the concept of eliminating waste in production conversion and in process flows. The lean production philosophy emphasises maximising the effectiveness of production processes. At the same time the ratio of actual outputs to the inputs should also be maximised.

This approach involves the basic idea that activities other than pure conversion are non-value-adding tasks, thus generating waste. A working principle is to continually reduce the cost of non-value-adding activities. It becomes important to minimise flows that generate waste. In the lean thinking approach, management and optimisation of processes focus not only on the improvement of conversion activities but also concentrate the efforts at reducing inefficient flows. It provides a way to manage unnecessary work and uncertainties. These escape notice during common operating and production practice. To improve the operating systems you have to address both optimising conversion activities, and cut waste by reducing unnecessary flows.

Major principles of lean waste reduction for flow design and production improvement are:

a) The reduction of variability during production.

b) The continuous improvement of the processes to eliminate waste in all its forms.

c) Control over the whole process (conversion and flows).

The reduction of variability is one of the most important challenges in lean thinking. One way to reduce variability is to bring each process under control so you know what will happen. Another way to eliminate variation is by anticipating the variation root causes and addressing them in the equipment design, and in the future operating and maintenance practices.

Life-Cycle Cost Analysis (LCCA)

This is a method for assessing the total cost of facility ownership. It takes into account all costs of acquiring, owning, and disposing of a building or building system. LCCA is especially useful with project alternatives that fulfil the same performance requirements, but differ with respect to initial costs and operating costs. Select the one that maximises net life-time savings. LCCA will help determine the cost-effective alternatives that dramatically reduce operating and maintenance costs during the life of a project, even though they may increase initial capital cost. LCCA is not useful for annual budget allocation.

The LCCA estimates the overall costs of project alternatives to select the design that ensures the lowest overall cost of ownership consistent with necessary quality and function. Do the LCCA early in the design process while there is still a chance to refine the design to ensure a reduction in life-cycle costs.

Maintainability

Defined by the military as “The relative ease and economy of time and resources with which an item can be retained in, or restored to do its function. With maintenance performed by persons having specified skill levels, using set procedures and resources, at each prescribed level of maintenance and repair. In this context, it is a function of design.”

You design Maintainability into a plant. Designing for maintainability requires reducing the time equipment will be down and unavailable. It goes beyond reducing the time saved by having a highly trained workforce and a responsive supply system to achieve minimum downtimes. Designing for maintainability requires an item of plant to be serviceable (easily repaired) and supportable (cost-effectively kept in or restored to a usable condition).

Attempts to improve the inherent maintainability of an item after the design is finalised are usually expensive, inefficient and ineffective. With plant and equipment built and installed, its maintainability is set, and to improve it requires major changes later during operation. If the simplest maintenance efforts need a crane to extract an item from inaccessible areas of the plant, or a major shutdown of equipment to insure safety, it is clear that both maintenance costs and production downtime are greatly increased. If maintainability were part of the plant design, such equipment maintenance would be quick and simple to maintain.

Achieving excellent maintainability requires the use of sound planning, engineering, plant and equipment design, testing, excellent quality conformance, adequate supply and support systems for spare parts, competent and trained people, additional skills development, and the ability to incorporate lessons learned from past problems or previous similar equipment.

It is well worth spending a great amount of time in simplifying the maintenance requirements of plant and equipment, as over one third of all future maintenance costs and time losses are attributable to maintainability factors.

Maintenance Standards and Procedures

This collection of documents specifies the minimum level of performance functions and conditions for operating the facility and its equipment to deliver design output. It includes:

- defining what level of in service performance plant and equipment will operate at (typically an availability measure or a OEE target);
- the level of presentation and cleanliness needed in the facility, and its plant and equipment.

Setting standards and making them public knowledge will make the requirements of managing the facility, along with the proper operation of the equipment clear to everyone and easy to encourage and achieve.

Management Reporting

To insure the operation is running efficiently and troubling issues are being addressed it is important that people know how the business is performing, what the relevant issues are for the business and how they are being resolved. This necessitates using a method to capture and pass relevant information to the people that need it. Such a system is a management reporting system.

Typically, it allows the integration of operating processes with business systems to provide real-time business information across the operation. It reduces duplication of administrative activities; streamlines planning and budgeting processes; and uses both financial and non-financial performance measures to track performance throughout the operation.

The timeliness of information will make the management reporting system either a useful tool with which to manage the business, or a millstone that prevents rapid response to changed conditions and innovative opportunities. Its processes need to deliver timely, accurate, relevant, consistent, accessible management information useful to making the business successful.

A good management reporting system will allow:

- The frequency of information to be optimal to decision making.
- Whenever possible the original data is real-time input by users and be in a consistent format.
- Central systems to be sufficiently flexible to capture any data considered relevant by users.
- Users get direct access to data, and the tools to derive and analyse management information.
- The data and its conversion processes into useful information to facilitate and improve management decisions.
- Information is available to all units and managers to measure performance against quantifiable performance goals.
- Decision-making is on the substance of the decision rather than the quality or consistency of the data.
- Full financial impacts of decisions on cost and revenues to be analysed before making decisions.

Net Present Value (NPV)

An approach used in capital budgeting where the present value of cash inflow subtracts from the present value of cash outflows. If the resultant flow is positive then the investment should make money.

NPV compares the value of a dollar today versus the value of that same dollar in the future, after taking inflation and return into account. You should accept a prospective project if the NPV is positive. However, if it is negative, reject it because the money flows are negative.

The net present value method of evaluating a major project allows you to consider the time value of money. Essentially, it helps you find the present value in “today’s dollars” of the future net cash flows of a project. Then you can compare that amount with the amount of money needed to do the project. If the NPV is greater than the cost, the project will be profitable (assuming, of course, that assumptions made to estimate the cash flow are reasonably close to reality). If you have more than one project on the table, you can compute the NPV of both, and choose the one with the greatest difference between NPV and the cost to do.

Overall Equipment Effectiveness (OEE)

Thanks to Don Fitchett from www.bin95.com.

A metric used to save companies from making inappropriate purchases, and continue poor practices, so helping them focus on improving the performance of machinery and plant equipment they already own. It is a measure of the “effective” utilisation of equipment within its scheduled runtime.

Typically Operational personnel often have little control over the scheduled runtime of equipment (these often being determined by such factors as overall market demand, and senior management capital allocation decisions), and so OEE is an effective measure reflecting what factors they can control.

The overall performance of a single piece of equipment, or even an entire factory, results from the cumulative impact of the three factors that comprise the OEE figure – availability, quality and performance:

Availability is the measure of the percent of time that the equipment can be used (usually total hours of 24-7-365), divided by the equipment uptime (actual production) percent of scheduled production (reliability) or calendar 24-7-365 time (equipment utilisation), that the equipment is available for production.

Performance efficiency is the percentage of available time that the equipment is producing product at its theoretical speed for individual products. It measures speed losses (e.g., inefficient batching, machine jams). It is the percent of parts produced per time frame of maximum rate specified by the original equipment manufacturers (OEM) rated production speed. If the OEM’s specification is not available, use best-known production rate over a four-hour period.

Quality Rate is the percent of the total output (i.e. all production produced including rework and scrap/waste) that is good. It is the percent of good sellable parts out of total parts produced per time frame.

The OEE = (Availability % x Performance % x Quality rate %) and the result indicates how productive the plant has been during the period of time the measurements were made.

PM Optimisation

A shorter version of RCM used on existing plants with sufficient history of known failure modes. Instead of starting at the beginning and brainstorming possible failure modes, PM Optimisation starts with the known failure modes for the equipment in the plant. In plant and equipment operating for many years, the actual failure modes are in site-specific historical data. It greatly shortens the entire failure evaluation process and lets you set into place the right PM inspections for your plant.

Planning and Scheduling

Planning is a necessary function within any organisation that produces something. In the manufacturing and processing environments, this function is often complex because of the rate of change, range of production, and occurrences of unplanned events. There are several different methodologies to choose from depending on the demand for the product and the rate of change. Nevertheless, the objectives of efficiency (minimisation of waste) and effectiveness (supply to demand) remain the same for each.

Planning is used to co-ordinate activities and limited resources to achieve goals right-first-time. Planning must be done so that the progress of the plan can be monitored at regular intervals and control over is separate operations can be maintained. Planning involves five elements: definition, labour planning, scheduling, equipment planning and cost planning.

- Definition means specifying the scope and extent of the work performed.
- Scheduling involves specifying the start, duration, and end of the various activities,
- Labour planning involves allocation of personnel, distribution of responsibilities and resources,
- Equipment planning involves identification of types and need of equipment,
- Cost planning involves identifying costs and their occurrence.

Precision Maintenance Standards

This involves the installing, operating and maintaining of equipment to the running tolerances required by current best practices. Adopting a precision maintenance philosophy and setting high standards extends machinery life spans between failures (reliability) enormously and so increases profits.

To achieve this it is necessary to set-up equipment aligned to close tolerances, balanced so vibration is within acceptable low limits and operated stress-free and deformation-free so it can function exactly as designed.

Precision Operating Standards

These are similar to standard operating procedures (SOP) but with specified operating condition tolerances for plant and equipment. It involves defining the range of process variation considered to be acceptable for the plant and equipment to meet its planned operating life while delivering quality and throughput requirements.

The purpose is to remove stressful occurrences on equipment and materials of construction and extend the length of failure-free plant operation. The measures monitor the equipment loads and stresses on the materials of construction so to ensure original design specifications throughout the equipment's operating life. It uses visual management to display timely process performance data to the operations people so they can adjust conditions to keep equipment within design envelopes.

Predictive Maintenance (PdM)

This proactive approach to maintenance detects the onset of equipment degradation. This allows elimination or control prior to any significant deterioration in the physical state of the component or equipment. The benefits include improving both the current and future functional capabilities of the equipment and increasing its reliability.

Predictive maintenance differs from preventive maintenance by basing maintenance needs on the actual condition of the equipment, rather than on some predetermined schedule. Typically, preventive maintenance is time-based or throughput based. Activities such as changing lubricant are time dependent, like calendar time or equipment run time. For example, most people change the oil in their vehicles every 10,000 to 15,000 kilometres travelled. This is basing the oil change needs on equipment run time. There is no concern of the actual condition and performance capability of the oil. The schedule dictates the change, not because it needs to be changed.

This approach is equivalent to a preventive maintenance task. On the other hand, if the driver of the vehicle instead had the oil analysed to determine its actual condition and lubrication properties. Then he or she may be able to extend the oil change until the vehicle had travelled another 5,000 kilometres. This then is the fundamental difference between predictive maintenance and preventive maintenance. Predictive maintenance defines needed maintenance tasks based on inspection and measurement to quantify material and equipment condition against an acceptable standard. Until the standard is breached the equipment remains in service.

Advantages:

- Provides increased component operational life and availability since remaining life is monitored,
- Allows for pre-emptive corrective actions before failure,
- Results in decrease in equipment and/or process downtime, as rectification work can be planned,
- Lowers costs for parts and labour since only true problems are actioned,
- Provides better product quality as deterioration is monitored,
- Improves worker and environmental safety by proactive measurement,
- Raises worker morale because they see the true equipment condition,
- Increases energy savings,
- Results in an estimated 8% to 12% cost savings over a preventative maintenance program.

Disadvantages:

- Increases investment in diagnostic equipment so real-time measures are trended,
- Increases investment in staff training to build competency of analysis,
- Management may not readily see the savings potential without first doing a trial to prove its worth.

There are many advantages of using a predictive maintenance program. A well-orchestrated predictive maintenance program will all but eliminate catastrophic equipment failures. Use schedule maintenance activities to minimize or eliminate overtime costs. Inventory is minimised, as orders for parts go out when needed to support anticipated maintenance. Equipment will be operated at an optimal level, which will also save energy costs and increase plant reliability.

Depending on a facility's reliance on a reactive maintenance approach and material condition, savings opportunities of 30% to 40% are possible. In fact, independent surveys indicate the following industrial average savings resulted from initiation of a functional predictive maintenance program:

- Return on investment: 10 times
- Reduction in maintenance costs: 25% to 30%
- Elimination of breakdowns: 70% to 75%
- Reduction in downtime: 35% to 45%
- Increase in production: 20% to 25%

The down side of using a predictive maintenance approach is its initial costs. The up-front costs of starting this type of program can be expensive. Much of the equipment requires substantial expenditure, though low entry cost products are now available. Alternately, subcontract the program and service to a proficient provider who provides reports and advice. Training of in-plant personnel is necessary to effectively utilize predictive maintenance technologies and practices. That will require additional funding.

Beginning a predictive maintenance program requires an understanding of the opportunities available to the facility and the approaches to take to get those benefits. It is also essential to have a firm commitment by the organisation's management and staff to make it work. The safest approach is to appoint an able person to conduct trails in an area of plant with a bad maintenance history and monitor the improvements achieved.

Preventative (Preventive) Maintenance (PM)

Wear, tear, and ageing are normal in this maintenance program. It applies continuous corrective actions to ensure peak efficiency and correct deterioration in equipment.

PM involves a planned and controlled program of systematic inspection, adjustment, lubrication, and replacement of components along with in-service operational performance testing and analysis. The result of a successful PM program extends the life of the plant and equipment, and minimises unscheduled downtime that causes major problems. It ensures that equipment parts operate properly, and breakdowns minimised.

A PM system is time based or scheduled on unit of production. It reviews the condition of existing equipment listed in a CMMS database. PM work orders generate from the CMMS at designated frequencies for each piece of equipment.

There needs to be a proactive review and analysis of equipment to identify the most cost-effective service tasks and time cycles. Optimise the service tasks and time intervals for equipment in the PM system, as the understanding of maintenance requirements for a piece of plant improves.

As new equipment comes on line, a maintenance mechanic can gather nameplate data in the field. The data is reviewed with reference to the manufacturer's manuals, and assigned initial service tasks and intervals before the data input personnel enters it to the PM system. As the PM system runs, a service/failure history will develop for each piece of equipment, and data extracted by equipment type.

Equipment grows old, uses change, and techniques vary. Important elements to monitor closely include an assessment of appropriate PM tasks, as well as proper frequency. An effective preventive maintenance program is not static, but needs regular review and updating in order to remain viable and effective.

Project Management Indicators

A project comprises a set of measurable objectives aimed to achieve a desired outcome. The objectives are definitive, time specific and measurable by some metric. Accomplishing an objective can involve many people, require specific resources and involve an extensive series of process tasks.

The primary objectives of project management include time, resource, quality and risk management.

- Time management is concerned with accomplishing the project within a given timeframe.
- Resource management addresses labour, materials and equipment needed to accomplish the project.
- Quality management focuses on meeting the requirements for the project.
- Risk management is being aware of and responding to potential delays or impediments to accomplishing the project.

A project is a planned set of milestones to achieve within a set time and cost.

- A project plan communicates what work to do to those involved.
- Those involved with plan can anticipate their contribution to the project.
- Management has a means to monitor and measure progress and costs.
- Anticipate and manage unexpected events that may impact the project.

The primary objectives of project management are planning, scheduling monitoring and controlling.

- Planning determines what needs doing, who does it, and how to achieve the objective
- Scheduling when the work will occur.
- Monitoring involves tracking task accomplishment in relation to time, cost and resource use.
- Controlling is concerned with responding to unanticipated occurrences or circumstances.

The planning and scheduling functions are the key elements of the project management process. Together they involve six steps.

- Identify activities that must be performed to complete the project
- Estimate the time required to complete each task activities.
- Develop a project plan to sequence the task activities.
- Schedule task activities assigning a start and finish date to each one.
- Review the schedule to determine if it is reasonable and complete.
- Implement the schedule.

Applying project management techniques enhances the prospects for success by providing methods to control, co-ordinate and measure key factors affecting completion.

Quality Function Deployment (QFD)

Product users judge a product by the ways it is actually used, rather than the ways its designer imagined it used. Therefore, the procedure for developing new products and new production facilities starts with finding out what the (potential) customers want and how that can be technically achieved. QFD takes the quality characteristics specified by the customer and turns them into ‘engineer-able’ features. The purpose of QFD is to find out what the customers want or need, how much they will pay for it, what the competition is doing, and then translate that knowledge by logical stages into a competitive design, complete with manufacturing instructions. QFD is concerned with economic quality of design and ensuring satisfactory product service, without excessive maintenance needs or restrictions on its operation. The value of QFD lies in organising and correlating the marketing information into a form that is useful for production. It translates customer wishes, first into engineering features and then into detailed product designs that meet those wishes.

It is a formal technique that attempts to get “the voice of the customer” echoed into the design and manufacture of the product. The customer says, for instance, “What we really are worried about it the comfort of the ride.” The marketing group does some comparisons against competitive models. Then they go to the engineers, and the engineers say, “What does a comfortable ride translate into? It’s related to the thickness of the seat, and to the suspension system.” They break down the desired characteristic, a “comfortable ride,” into its subsidiary engineering design aspects. Once they get it fine-tuned enough -- it requires, say, a change in the amount of lubrication in the shock absorber -- they reflect those changes in the way they manufacture shock absorbers.

Quantitative Risk Assessment (QRA)

A Quantitative Risk Assessment is a credible scenario of analysing the risk for a specific project. The methodology is to identify, quantify and evaluate the risks to operations involving hazardous materials. The purpose of the assessment is to reduce risks to a level that are ‘as low as reasonably practicable’ (ALARP), which are acceptable to the community hosting the operation.

Third party persons assess the likelihood of danger. They calculate the consequences and severity should the danger arise. Preferably, design-out and eliminate the problem. If that is not possible methods of local containment within a set area are used. In addition, put management and control methods to continually monitor the danger and address any occurrence into place.

Records Management

The systematic gathering of key information into a catalogued database where it is accessible to help make better decisions in the future based on facts from the past. There is a need for good record management in an organisation. The control of records may be due to statutory/legal requirements to prove compliance, future purchasing of exact duplicate items for current operating plant and equipment and the future review of key decisions taken in the past to check their remaining validity for the organisation.

Records management is the application of systematic controls concerning the creation, maintenance and destruction of records required in conjunction with the operation of an organisation. File the records using a logical and defined scheme into a managed repository, available for retrieval by authorised principals. The records management system is foremost about storage and maintenance, and has responsibility for maintaining the integrity of the records, facilitating back-up, and assisting users in filing and retrieval.

The chief duties of a records management system are filing, searching, retrieval, creating retention schedules, transfer, destruction, etc. all are part of managing the life cycle of a record.

A record is a unit of recorded information, generated or received by an organisation, which acts as evidence of activities. Most records are in the form of a document, although records in other forms are possible. The notion of a record encompasses the roles the underlying document plays within an organisation over time. Including the relationship the participant in an organisation has to that record, and the relationship between the record and other records.

When the information in the record has declined in value, remove it from active accessibility. Depending on the nature of the record, destroy it immediately, or keep in archives for a set period. Preserve records that have a sustaining utility exceeding storage costs permanently in an archive.

Redundancy and Duplication

This controls risk in key production systems by intentionally duplicating equipment that has poor mean time between failures, or where the consequence of failure is too catastrophic.

Regulations, Laws and Standards

The requirements put into place by government decree to continue operation of the project, operation or business.

The regulations, laws and standards require all persons to read them and to understand their obligations. Where necessary ask the regulatory bodies responsible for policing the upholding of the requirements to provide additional information and guidance in interpreting the requirements.

Reliability Centred Maintenance (RCM)

RCM is a structured and formulaic process used to decide what to do to ensure that any physical asset, system or process continues to operate as its users want.

Users define what they expect from their assets in terms of primary performance parameters such as output, throughput, speed, range and carrying capacity. Where relevant, the RCM process also defines what users want in terms of risk (safety and environmental integrity), quality (precision, accuracy, consistency and stability), control, comfort, containment, economy, customer service and so on.

The next step in the RCM process is to identify ways in which the system can fail to live up to these expectations (failed states), followed by an FMEA (failure modes and effects analysis), to identify all the events which are reasonably likely to cause each failed state.

Finally, the RCM process seeks to identify a suitable failure management policy for dealing with each failure mode in the light of its consequences and technical characteristics. Failure management policy include: – predictive maintenance – preventive maintenance – failure-finding – change the design or configuration of the system – change the way to operate the system – run-to-failure.

The RCM process provides powerful rules for deciding whether any failure management policy is technically appropriate. It also provides precise criteria for deciding which and how often to do routine tasks.

Risk Based Inspection (RBI)

Risk based inspection considers the probability of failure and its consequences. The technique aims to bring better value for money from inspection.

It is now widely accepted that the traditional time-based approach to planned plant inspection by a competent person has a number of shortcomings. In particular, the use of fixed intervals between inspections may be too conservative and lacks the freedom to benefit from good operating experience. The introduction of goal setting legislation has facilitated a move towards risk based strategies, which focus inspection resources on parts of the plant that carry greater risks where preventing failure will have the greatest benefit.

RBI is a technique to underpin and direct planned plant inspection. It claims to offer the prospect of cost savings resulting from the better targeting of resources. RBI recognises that there is little point to spending good money, for example, on very frequent inspection of something that is very unlikely to fail, or if it did fail would have little financial or safety consequence. In line with the principles of ALARP (as low as reasonably practicable) the money saved may be better spent elsewhere. Savings can also arise from reduced direct inspection costs.

Root Cause Analysis (RCA)

The method brings a team of 3 to 6 knowledgeable people together to investigate a failure using evidence left behind from the fault. The team brainstorms to find as many causes of the fault as possible. They construct a fault tree starting with the final failure and progressively tracing each cause that led to the previous cause. By using what evidence remains after the fault and from discussions with people involved in the incident, dismiss all non-contributing causes from consideration and retain the contributing causes.

This continues until the trail can be traced back no further. Each result of a cause must clearly flow from its predecessor (the one before it). If it is plain that a step is missing between causes, add it in and look for evidence to support its presence.

Once the fault tree is completed and checked for logical flow the team then determines the changes to make to prevent the sequence of causes and consequences from again occurring.

It is not necessary to prevent the first, or root cause, from happening. It is merely necessary to break the chain of events at any point and the final failure cannot occur. Often the fault tree leads to an initial design problem. In such a case, redesign is necessary. Where the fault tree leads back to a failure of procedures, address the procedural weakness or to install a method to protect against the damage caused by the procedural failure.

The cause tree explains step-by-step how the events leading to the incident unfolded. It is necessary to prevent one failure cause and there would be no failure.

Rotating Equipment Integrity

This method aims to ensure process equipment safety and reliability. Because of the many factors that can affect the reliability of rotating equipment. Guidance notes and checklists for inspections are developed. They contain sufficient detail to make informed and rational judgements during inspection visits, on the state and general health of safety critical areas of machinery and rotating equipment. It covers the development of inspection notes on major safety issues for process machinery and rotating equipment used on offshore and onshore installations. It focuses on the equipment included within commonly applied machinery and rotating packages. It contains a review process used to assess a complete installation, in order to help an inspector understand the impact of operating culture, and context on the safe operation of machinery and rotating equipment installations.

Six Sigma Quality

'Six Sigma' focuses on preventing problems by building quality into processes – by not having problems in the first place. The Six Sigma methods utilizes full-time dedicated project managers (Green and Black Belts) who receive formal classroom training in process analysis and statistical methods as well as mentoring by Six Sigma experts. The Black Belts then work within the company as "problem-solvers for hire." They lead process improvement projects, and focus on areas that will have the highest impact on the bottom line.

Six Sigma stands for 3.4 defects per one million opportunities.

- 3 Sigma – 66,800 defects per one million opportunities.
- 4 Sigma – 6,210 defects per one million opportunities.
- 5 Sigma – 233 defects per one million opportunities.
- 6 Sigma – 3.4 defects per one million opportunities.

The Six Sigma methods start by asking the fundamental question: What is critical to the customers? All processes in the business get rigorous analysis to assess whether they are delivering what customers require. Each time processes don't deliver what the customer wants it is a defect.

Six Sigma is rooted in fundamental statistical and business theory; consequently, the concepts and philosophy are very mature. Applications of Six Sigma methods in manufacturing are common and the process well understood. It follows on the heels of many quality improvement programs.

Six Sigma is passionate about using data to uncover the root causes of those defects and eliminating them from the processes. It used data to understand the process variability and drive process improvement decisions. The ultimate objective is to deliver to customers what is critical to them each and every time – to produce "virtual perfection" from the customer's perspective.

A Six Sigma improvement team is responsible for identifying relevant metrics based on engineering principles and models. With data/information in hand, the team then proceeds to evaluate the data/information for trends, patterns, causal relationships and "root cause," etc. If needed, conduct special experiments and modelling to test hypothesised relationships or to understand the extent of leverage of factors. You can accomplish most improvement projects with the basic statistical and non-statistical tools. On achieving the target level of performance, put control measures in place to sustain it.

Common sense and force of personality are not means to reach dramatic improvements. The only way is to ask the tough questions and to use rigorous statistical and financial analysis. When problems reduce, costs decline and customer satisfaction improves. Six Sigma delivers business results that can accelerate growth, reduce costs and ultimately deliver excellent profits.

Supply Chain Management (Logistics)

It is about getting a smooth and efficient flow from raw material to finished goods in your customer's hands. It is a concept that is increasingly replacing traditional fragmented management approaches to buying, storing and moving goods.

Traditionally, the management of material flows centred on stocks of product: on the movement of trains, and boats and trucks, and in the contents of warehouses and stores and factory-floor queues. Managing those stocks meant buying enough goods far enough in advance to ensure that long, steady production runs were seldom jeopardised by shortages of components. Tougher competition has brought shorter product life-cycles and made the old stocking approach increasingly expensive. Now replacing these ‘inventory-driven systems’ are the ‘service-driven systems’. This type of system, which is ‘pulled’ by customer demand rather than ‘pushed’ by a supply system, has become a necessity in many manufacturing sectors.

In the past, companies have dealt with moving and storing goods in unrelated ways, and under a number of different managers. In manufacturing, transport from supplier to plant was handled by suppliers themselves or by a purchasing department. The stores department handled transport and storage of stores within the plant, and manufacturing or maintenance operations handled movements within the plant. Transport from plant to customer was handled by transport or distribution departments; buying was handled by purchasing; sales forecasts by marketing and communicated to manufacturing and procurement in a generally one-way information flow.

This approach splits functional departments into watertight compartments when, as every manager knows, business is not like that. Particularly in this area, where the essence of supply chain management is managing flows across departments, sites and – often – companies. This approach takes a high degree of management integration.

Logistics deals with geography, time and value. Many of its concerns are with things in places and transport between the places. In this view, logistics deals with everything from raw materials, through their movement into and between various stores, and the processes to the customer. It looks at material flows within sites as much as between sites.

Shewhart Control Charts

Control charts were developed in the 1920s by W. A. Shewhart as a means to monitor variation in production processes. Shewhart observed production supervisors reacting to common cause production problems and instead of reducing variation they made production performance worst. To help identify when a problem was caused by the process itself or by an external factor, he devised control charts based on three sigma limits that assumed normal distribution of events. The presumption was that a process would of itself produce random variation. Provided the variation was within the behaviour of random chance, then it was caused by the process and thus was uncontrollable without changing the process. If an event was beyond the three sigma upper or lower limit, it was an outlier that very likely had a special cause which had to be addressed to ensure it would not again impact process performance.

The obvious problem with control charts is that a special cause problem ‘hides’ within the three sigma limits and appears to be a process issue because it does not produce outlier effects. The way to find such problems is to first solve the identifiable special cause problems you can and stabilise the process so it runs for a long time within its three sigma limits. Then you improve the process performance so the spread of process results tightens closer to the required target. This will expose more special causes to address until the process is again producing only its own random variation. You then repeat process improvement in the same way until it becomes uneconomic to do more.

Total Effective Equipment Productivity (TEEP)

It is a percentage figure that represents the portion of good quality production versus total time during the period being measured. Typically used as a measure of the “effective” utilisation of equipment assuming continuous 24 hour/day, 365 day/year operation. Useful to senior management who should be concerned more with total return on assets employed, and is a more effective performance measure at this level.

Total Productive Manufacturing (TPM)

This is a methodology that can slash unit costs in manufacturing and process industries by ensuring that plant and equipment are used to their maximum effectiveness. It can bring significant competitive advantage. TPM promotes best of breed practices and is used to secure:

- Business performance improvement.
- Cultural change and people benefits.
- Competitive advantage in the market place.

Company-wide TPM recognises that it is customers who drive the business. It aims to provide the necessary responses to not only satisfy, but also to exceed the expectations of customers. The goal is to maximise added value by eliminating waste in all that is done, right across the supply/value chain.

TPM is a Continuous Improvement process that strives to maximise equipment efficiency by creating the perfect relationship between people, their processes and equipment. It has five founding principles:

- Increase the Overall Equipment Effectiveness (OEE) through focused improvement.
- Make front-line Asset Care part of the job.
- Improve existing planned maintenance systems and the quality of maintenance.
- Increase hand/operational skills and team working and problem solving skills.
- Early Equipment Management: Involve operators and maintainers in the next generation of equipment design (TPM for Design).

TPM is both practical and results driven. Applied to the shop floor, it is a common sense approach that provides visibility to all the six major losses that are a result of poor equipment performance. The resultant Business Performance Measure is called the Overall Equipment Effectiveness (OEE).

The TPM process must be led by manufacturing and encourages production and maintenance departments to work in harmony as a team, with the goal of increasing equipment effectiveness and in turn the organisation's profitability.

It also involves other departments, such as supply chain administration, sales and marketing, warehousing and distribution, as well as the more direct manufacturing support functions of design, quality, production control, finance and purchasing which are concerned with equipment and process effectiveness. This of course includes management and supervision. TPM makes extensive use of waste elimination, standardisation, workplace organisation, visual management and problem solving.

Like all good business improvement tools TPM must be tailored to suit the specific organisation and plant.

Total Quality Management (TQM)

Thanks to Ron Kurtus of Kurtus Technologies for this information.

The basic principles for the Total Quality Management (TQM) philosophy of doing business are to satisfy the customer, satisfy the supplier, and continuously improve the business processes.

The first and major TQM principle is to satisfy the customer--the person who pays for the product or service. Customers want to get their money's worth from a product or service they purchase. If the user of the product is different than the purchaser, then both the user and customer must be satisfied, although the person who pays gets priority.

A Company that seeks to satisfy the customer by providing them value for what they buy and the quality they expect will get more repeat business, referral business, and reduced complaints and service expenses. Some top companies not only provide quality products, but they also give extra service to make their customers feel important and valued.

Within a company, a worker provides a product or service to his or her supervisors. If the person has any influence on the wages the worker receives, that person can be thought of as an internal customer. A worker should have the mind-set of satisfying internal customers in order to keep his or her job and to get a raise or promotion. Often in a company, there is a chain of customers, – each improving a product and passing it along until it is finally sold to the external customer. Each worker must not only seek to satisfy the immediate internal customer, but he or she must look up the chain to try to satisfy the ultimate customer.

A second TQM principle is to satisfy the supplier, which is the person or organisation from which you are purchasing goods or services.

A Company must look to satisfy their external suppliers by providing them with clear instructions and requirements, and then paying them fairly and on time. It is only in the company's best interest that its suppliers provide it with quality goods or services, if the company hopes to provide quality goods or services to its own external customers.

A supervisor must try to keep his or her workers happy and productive by providing good task instructions, the tools they need to do their job and good working conditions. The supervisor must also reward the workers with praise and good pay. The reason to do this is to get more productivity out of the workers, as well as to keep the good workers. An effective supervisor with a good team of workers will certainly satisfy his or her internal customers.

One area of satisfying the internal suppler is by empowering the workers. This means to allow them to make decisions on things that they can control. This not only takes the burden off the supervisor, but it also motivates these internal suppliers to do better work.

The third principle of TQM is continuous improvement. You can never be satisfied with the method used, because there always can be improvements. Certainly, the competition is improving, so it is very necessary to strive to keep ahead of the game. Some companies have tried to improve by making employees work harder. This may be counter-productive, especially if the process itself is flawed. For example, trying to increase worker output on a defective machine may result in more parts that are defective.

Examining the source of problems and delays and then improving them is necessary. Often the process has bottlenecks that are the real cause of the problem. You must remove these. Workers are often a source of continuous improvements. They can provide suggestions on how to improve a process and eliminate waste or unnecessary work.

There are also many quality methods, such as just-in-time production, variability reduction and poka-yoke (mistake proofing), that can improve processes and reduce waste.

The principles of Total Quality Management are to seek to satisfy the external customer with quality goods and services, as well as your company internal customers; to satisfy your external and internal suppliers; and to improve processes continuously by working smarter and using special quality methods.