Total Productive Maintenance

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1. Introduction to TPM:

In today's global economy, the survival of companies depends on their ability to rapidly innovate and improve. As a result, an increasing search is on for methods and processes that drive improvements in quality, costs and productivity. In today's fast changing marketplace, slow, steady improvements in manufacturing operations will not guarantee profitability or survival. Companies must improve at a faster rate than their competition if they are to become or remain leaders in their industry.

Western products, practices and methods were long considered the best in the world. This perception is constantly changing as a result of new competition and economic pressures. Arrogance or self assurance has devastated specific sectors of our manufacturing base. For example, the Japanese now own the consumer electronics industry. Changes in the automotive industry are well documented, and for the first time Western dominated industry such as computers and aviation are facing serious challenges by foreign competitors. Other companies and cultures have proven they can compete successfully in the world marketplace with western manufacturing. To confront this challenge, enlightened company leaders are benchmarking their organizations' performance and improvement processes against domestic and international competitors. They are adopting and adapting best in class: manufacturing practices and improvement processes. As part of these benchmarking efforts Total Productive Maintenance (TPM) has been identified as a best in class manufacturing improvement process.

Moreover cultural differences in both Japanese and Western countries can alter implementation strategies. TPM is a complex. Long term process which must be sold to the workforce as a legitimate improvement methodology. A sales pitch is created is created more easily for single homogeneous market segment than for a large diversified audience. For TPM to succeed in any industry, both management and the workforce must address issues strategically while operating in an environment of trust and organization. The improvement process must be recognized as benefiting both the company and the workers. The ultimate responsibility for success or failure of the TPM process rest more with management than the plant floor employees.

2. History of TPM:

The term "Total Productive Maintenance" was first used in the late 1960's by Nipponese, a supplier of electrical parts to Toyota. At the Time it was a slogan for their plant improvement theme "Productivity Maintenance with total employee participation. In 1971, Nipponese received the Distinguished Plant Award (The PM Prize) from Japan Institute of Plant Maintenance (JIPM). Nipponese was the first plant to receive the award as a result of implementing TPM and this marked the beginning of Jim's association with the improvement methodology. Eventually, Seiichi Nakajima, a vice chairman of JIOPM, became known as the father of TPM, since he provided implementation support to hundreds of plants, mostly in Japan.

Nakajima describes TPM as "Productive Maintenance" carried out by all employees through small group activities. He considers it an equal partner to Total Quality Management in the attainment of world class manufacturing. According to TPM principles, the responsibility for optimizing equipment lies not just with the maintenance department but with all plant personnel. Although many definitions for TPM had been gathered, for the purpose of this report, we shall define TPM as follows

TPM is a plant improvement methodology which enables continuous and rapid improvement of the manufacturing process through the use of employee involvement, employee empowerment and closed looped measurements of results.


Figure 1: Seiichi Nakajima, Founder of TPM

TPM is a method for bringing about change. It is a set of structured activities that can lead to improved management of plant assets when properly performed by individuals and teams. The culture of a plant does not evolved solely from TPM but may also be a reflection of other improvement processes that are underway such as TQM, Six Sigma, Lean, Kaizen, Root Cause Analysis etc., A critical aspect of TPM is that improvements should be rapid as well as continuous. Today's marketplace requires new paradigms. The story between the race of the hare and tortoise had to be modified. Current and future winners in industry will combine the quickness and speed of the rabbit with the perseverance of the tortoise. To attain or maintain a leadership at a rate that is much faster than their competition.

Performance target must be always be dynamic, not static. If a company sets goals and measures to reach performance levels of their best in class competitor in two years, they will lag behind, since their competition will have improved over that same period of time. To be the best in class, a company must leap-frog its competition by setting goals beyond where their competition is projected to be.

Likewise, in TPM, employee involvement is a necessary part of the TPM process. The goal is to tap into the expertise and creative capabilities of the entire plant or facility through the use of small group activities. The total involvement of plant personnel generates pride and job satisfaction as well as financial gains for the organization. Despite the advent of self managing teams employee involvement is still new and starting in most western countries. TPM requires employees to take a more active role in decision making and to accept responsibility for the plant and its physical condition. They have a heightened role in defining their job content, along with work systems and procedures. The intent of TPM is that each employee must takes pride in their equipment and all efforts must be directed the plant's objectives. For example, JIPM recommends that management adopt the theme of "My Plant" to increase the level of autonomous maintenance.

Western plants typically emphasize performance measures that are related to production and financial results. Numbers are tracked, reported by accountants and made available to selected members of the organization. There are two problems associated with classical results measurements. First, the results are not reported to all involved parties and secondly, results that are reported do not effectively measure performance. In TPM, the plant establishes the key performance indicators that measure performance relative to plant goals and objectives. These key performance indicators measure results in areas over which the plant has control. Typically, they include availability, quality, productivity and cost efficiency as well as measures of the effectiveness of the improvement process itself. The indicators are reported in a closed-loop manner back to the individuals who have the power to impact them. Hence, information is passed on to everyone including the shop floor people.

Figure 2: TPM is people involvement

Employee involvement does not mean that all decisions are made by individual workers or small group of employees; certainly it will lead to chaos. Historically, upper management has played the key role in the decision making process. TPM increases workers roles in the decision making process. TPM increases roles in providing input and in making tactical decisions. The most difficult aspect of empowering employees is determining which decisions should be made by management and their workers. Empowering the workforce is the main goal of TPM, a workforce which is enthusiastic and motivated will definitely improve the plants goals and targets.

2.1 The Spread of TPM

As said that TPM took root in the automobile industry and rapidly became part of the corporate culture in companies such as Toyota, Nissan and Mazda as well as their suppliers such as Nippondenso. It has also been introduced by other industries such as consumers, appliances, microelectronics, machine tools, plastics and many others.

Having introduced Preventive Maintenance, the process industries then began to implement TPM. An increasing number of process plants have introduced TPM over the past few years in industries such as food, rubber, oil refining, chemical, pharmaceuticals, gas, cement, papermaking, iron, steel and printing.

Initially, corporate TPM activities were limited to departments directly involved with equipment such as production, however administrative and support departments while actively supporting TPM in production are now applying TPM to enhance the effectiveness of their own activities. TPM improvement methods and activities are also being adopted in product development and sales department.

This last trend underlines the increasing tendency to consider production processes and equipment at the product development stage in an effort to simplify production, improve quality assurance and enhance and reduce the start-up period for new production. These issues are of particular concern most especially in the process industries today as product diversification continuous and product life cycle shortens. Interest in TPM outside Japan has also expanded throughout the recent years. Many companies in the United States, Europe, Asia and South America are planning to or are now actively pursuing TPM.

2.2 Why TPM is so popular?

There are three main reasons why TPM has spread so rapidly throughout Japanese industry and why companies outside Japan are becoming interested. It guarantees dramatic results, visibly transforms the work place and raises the level of knowledge and skill in production and maintenance workers.

Companies practicing TPM invariably achieve startling results, particularly in reducing equipment break downs, minimizing idling and minor stoppages (chokotei in Japanese), and lessening quality defects and claims boost in productivity, trimming labor costs, shrinking inventory, cutting accidents and promoting employees morale as shown by the increase in improvement suggestions

Through TPM, a filthy, rusty plant covered with oil, mist and grease, leaking fluids and silt powders can be reborn as a pleasant, safe working environment. Customers and other visitors are impressed by these changes and their confidence in their products increases.

As TPM activities begin to yield concrete results which is improving the working environment, minimizing breakdowns, improving quality, reducing set-up and change over times and so on, workers become motivated, involvement increases and improvement suggestions proliferate. People began to think TPM as part of their day to day jobs making TPM a way of life for all people.

TPM helps operators understand their equipment and widens the range of maintenance and other tasks they can handle. It enables them to make new discoveries, acquire fresh knowledge and enjoy new experiences. It strengthens motivation, engenders interest in their work and concern for equipment and fosters the desire to maintain equipment in top peak condition.

3. TPM Eight Pillars:

TPM involves everyone from the organization and is structured through the 8 pillars which will be explained in details. Each pillar will have their own unique role in improving the plants performance.

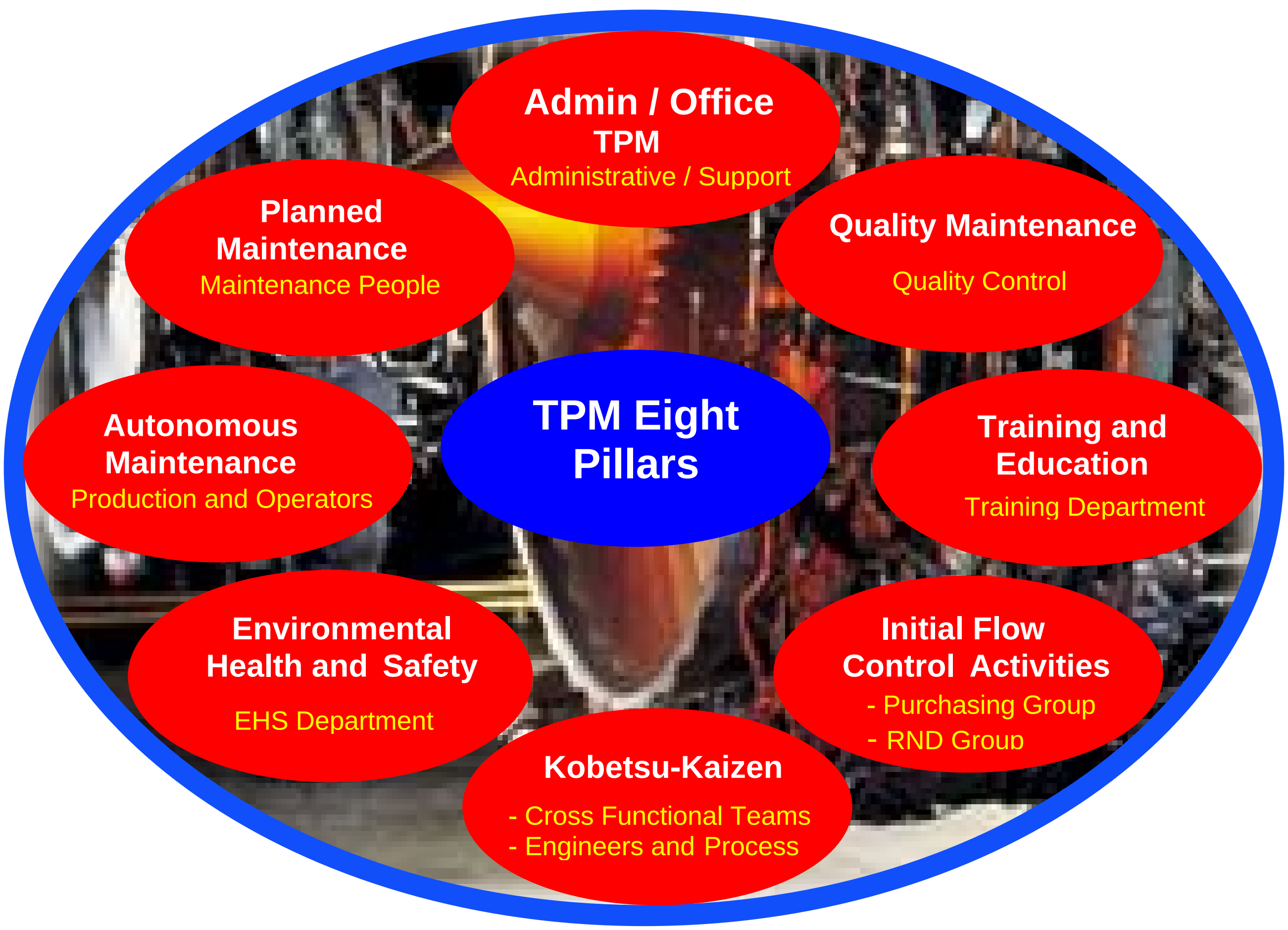


Figure 3: TPM Pillars

3.1 Training and Education:

A company's workforce is a priceless asset, and all companies must train their employees systematically. Industry workers are becoming scarcer, increasingly elite and more multi-skilled, so training must be an integral part of a career development system. Visualize the type of people you want your training program to produce. In other words, identify the specific knowledge, skills and management abilities you want them to have and then design a training program that will achieve this vision.

Training must also be tailored fit to serve the individual's needs. Assess each person to measure his or her grasp of required knowledge and skills and pinpoint weakness, then use the results to make the general training more effective. Workers and their supervisors should discuss the results of this assessment and use them to set the next year's targets and plan the next phase.

Also set firm schedules for achieving program targets. Decide the kind of people you want to have in how many year's time, then draw up a comprehensive plan for on the job and off the job training design to achieve this which also includes seminars and workshops.

Training also inevitably plays a major role in any improvement process. The continual investment in employee by upgrading their skills and capabilities is as critical as investing in plant equipment. People with the right education are an organizations most important asset. Their importance is recognized and promoted by the TPM process.

The traditional roles of the production operator, maintenance craftsperson are being reinvented. Operators are accepting greater responsibility for the health and performance of their equipment as they take on certain maintenance tasks that historically were performed by maintenance craftspeople. The craftspeople, in turn are relinquishing many routine maintenance tasks such as checking, adjusting and lubricating the equipment. Their efforts are increasingly allocated to higher value added activities such as Predictive Maintenance and Analyzing failures. Rather than simply being repairmen, they now are problem solvers performing the highly skilled analytical tasks of root cause analysis, reliability-centered maintenance and redesign. These changes in responsibilities for operators and Maintenance craftspeople have required new

Figure 4: Training and Education

Training and education plays a very important role in TPM. A training needs analysis should be performed for the different people working in the plant. Each pillar such as Planned Maintenance should be trained on maintenance related courses while Focused Improvement group should be well versed on different analytical tools and techniques. Likewise operators should be trained with proper operation and safety on their equipment. Education and training is a continuous process and should be provided to all employees.

emphasis on both basic and advance technical training. Besides the additional technical skills development, behavior, modification and process training is facilitating the change in historical work practices. This type of training usually focus on the change process and covers such subjects as group dynamics, communication workshops one point lessons and the use of disciplinary systems and procedures. Education and Training is being established to elevate the skills of operations and maintenance. It is not only limited to classroom training but also aid in the use of visual controls and one point lessons. Training group identify level of knowledge needed, prepare training curriculum and finally assess the skills of their people.

3.1.1 Four Levels of Skills:

Level 1: Lack both theoretical and practical ability (needs to be taught)

Level 2: Knows theory but not in practice

Level 3: Has mastered practice but not theory

Level 4: Mastered both practice and theory

3.2 Autonomous Maintenance:

TPM improves corporate business results and creates pleasant and productive workplaces by changing the way people think about their work with equipment through their company. Autonomous Maintenance which is performed by operators is one of the most important basic building blocks of any TPM program.

Two keys to developing a successful autonomous maintenance program are thoroughness and continuity. A further decisive factor is smooth integration with two other TPM pillars which are Planned Maintenance and Training and Education Pillar of TPM. The production department's mission is to produce good products as cheaply as possible. One of its most important roles is detecting and dealing with equipment abnormalities promptly, which is the goal of a good maintenance program. Autonomous maintenance includes any activity performed by the production department operators that has a maintenance function and is intended to keep the plant operating efficiently and stable in order to meet production plans. The goals of an autonomous maintenance program are:

- Prevent equipment deterioration through correct operation and daily checks
- Bring equipment to its ideal state through restoration and proper management
- Establish the basic conditions needed to keep equipment well maintained

Another important goal is to use the equipment as a means of teaching people new ways of thinking and working.

3.2.1 The Need for Autonomous Maintenance

In the past, plant operators in process industries were expected to keep their equipment working by checking it regularly and performing minor services. Although different companies had different practices, many expected operators to perform strip-down overhauls of equipment such as pumps. In general, plants practiced a high degree of autonomous maintenance.

During the high-growth era of the 1950s and 1960s, however, equipment became more sophisticated and complex as process plants grew larger and production technology advanced. With the introduction of preventive maintenance, equipment maintenance became increasingly specialized and more sophisticated... At the same time, many companies were making significant technical progress in automation and centralization. Faced with two oil price explosions in succession, Japanese companies reduced the number of plant operators in the aim of reducing costs. For many years now, production departments have played an exclusively supervisory role, concentrating on production and leaving maintenance to specialist which traditionally is known as:

I Operate, You Fix Syndrome

The future is uncertain, however, many companies hope to survive by cutting costs to boost their compete-ttiveness. As a result, autonomous maintenance has become an indispensible program in the drive to eliminate losses and waste from the production floor.

Participation of the production division in maintenance activities is one of the features of TPM. The importance of maintenance activities recognized anew for the corporation to survive in the fierce competitive environment. Resultantly, review of the operator's role and the maintenance operations becomes much more necessary.

Under these circumstances, QC circles and ZD (Zero Defects) campaigns have been gaining wide popularity in every enterprise and the concept that one's work should be voluntarily maintained by oneself has taken root and developed into the Jishu Hozen or Autonomous Maintenance concept of owning the equipment by oneself.

Autonomous Maintenance is the activities in which each worker performs daily inspections, lubrication, parts replacement, repair, troubleshooting, accuracy check and so forth on his own equipment, aiming at achieving the goal of keeping ones own equipment in good condition by oneself.

With the advancement of technologies, equipment has become more sophisticated and complex, and with expansion in the operation scale of enterprises, the maintenance functions have been divided into specific areas. The so called I operate you fix syndrome in which the operation division only engages in production while the maintenance division only takes care of maintenance had been disseminated throughout the production. As a result, many people came to think that the people who were engage in production should only handle the work and check their quality and such activities as the maintenance of equipment, lubrication and other care of machines and equipment should be left to the maintenance people.

Such critical attitudes such as the poor practice employed by the maintenance division and improper introduction of equipment by the division should be blamed for the trouble and we don't have any responsibility for the problem to be discarded. A little attention to additional tightening, lubrication and cleaning can often prevent trouble in advance or a little touch or care of the machine and equipment would often help to find any abnormality and prevent the trouble. In view of this operators are trained to be proficient in equipment mechanism. In order to satisfactorily perform Autonomous Maintenance, the operators should be knowledgeable with their equipment's. The operators won't be expected to merely be an operator and only sometimes be expected to initial TPM activities. In designating what cleaning tasks are of most value, the experiences of a qualified TPM trainer can be invaluable. Although individual tasks are assigned, the small group retains total control over the project. Production operator who is regularly responsible for the machine operation must be part of the cleaning team if the group is to achieve and act as a maintenance man. The more the equipment is automated, the more the operator should be equipped with the ability to perform basic equipment maintenance.

What is important and required for an operator is to acquire the ability to find abnormality, the ability to sense abnormality of the equipment or products by feeling suspicious behavior. To acquire the mentality, the operator should have the following basic abilities.

- Ability to tell normality from abnormality precisely
- Accustomed to strictly keeping the rules of condition control
- Ability to take quick and proper action against the abnormalities

Those who have the knowledge and ability to perform this task can be useful in predicting signs of defect or failure and take the necessary steps to prevent such embryos from developing into serious problems.

Autonomous Maintenance development is performed by a team under the leadership of supervisors based on the process, primarily established in order to increase the level of equipment and workers performance efficiency step by step and to have the Autonomous Maintenance pillar performed positively in the end.

In order to maintain higher productivity equipment and to cultivate workers who are proficient with the equipment and capable of Autonomous Maintenance, a step by step development should be implemented accordingly in 7 steps. A preliminary step is quite an important one in which we can recognize why TPM is necessary through understanding the adverse effects of forced deterioration in their equipment. In order to have the concept, the source of motivation can be found in the process of action understood, the action is prerequisite. The preliminary preparation is made through considering the reason why forced or accelerated deterioration can occur and understanding the importance of such activities.

Hence, before getting down to the actual developmental steps, consideration should be given to predicted accidents and safety education should be completed. Listing of all of the predictable unsafe actions and unsafe conditions and the countermeasures for each predictable accident should be completed through the initial clean up stages.

3.2.2 Seven Steps of Autonomous Maintenance

Step 1: Initial Cleaning:

All around cleaning up of dust and dirt, centering on equipment implementation of lubrication and machine parts adjustment, discovery and repair of abnormalities found on the equipment the purpose of initial cleaning is threefold. First, small work groups are able to join together in accomplishing a common goal, the cleaning of a particular machine or process. Second, it promotes a better understanding and familiarity with the machine and third the actual machine cleaning regularly uncovers hidden defects that when corrected will have a positive effect on equipment performance. The activities associated with initial cleaning are typically performed by members of the small group as part of the full benefits of the activity. It is necessary for the team to acquire safety training before commencing on initial cleaning.

Figure 5: Team performs initial cleaning on their equipment

Training prior to performing such initial cleaning activities is critical. Initial cleaning is not intended to be an overhaul or turn around of the equipment or process area. The focus is to increase understanding of the equipment through the cleaning process. If one were to perform initial cleaning on an automobile engine, key tasks would include steam cleaning the engine exterior, checking the head gasket bolts for looseness and possibly replacing the fan belt and doing a compression check. But one would not remove the head, hone the cylinder walls or replace the bearings.

Key activities for initial cleaning include:

- Perform all activities necessary to shut down, isolate and make the equipment or process area totally safe to operated
- Obtain copies of equipment drawings, documentation, history and other relevant information. If drawing do not exists, prepare sketches of the equipment or scan photographs for use in documenting lube points adjustment points and process check points. This documentation is used in successive levels of autonomous maintenance to develop stands for lubrication and autonomous inspection.
- Document initial condition of the equipment through photographs. Prepare forms for documenting equipment defects and tags for making items needing further inspection.
- Segment portions of the machine or process area and plan how to clean the machine with maximum efficiency and effectiveness.
- Obtain hand tools, rags, brushes, solvents, mops, brooms, scrapers and other tools required to perform the cleaning tasks.
- Clean each machine segment in a methodical manner. Remember that the goal is to put the machine back into as new condition as possible.
- Remove all dirt, grime, dust, grease, oil, sludge, chips, mists, trash and excess materials. Note any equipment abnormalities such as broken switches, bent guards, missing bolts and leaks. Cleaning is also inspection. Take the time needed to do a thorough and complete job. Speed is not nearly as important as understanding and working together as a team.
- Tag and document all equipment abnormalities. Address easily corrected abnormalities immediately and write work request for other abnormalities found.
- Re torque all bolts including hold down, fasteners, adjustment and structural bolts. Mark all bolts by painting a stripe across the stud head bolt and the bolt to indicate the relative positions of both when properly torque. Any future slippage or loosening of the bolt then can be noted easily as the marks will no longer line up together.

- Repaint areas if necessary according to predetermined specifications. The purpose of repainting is not just to prevent corrosion but to provide a surface that can be examined easily for cleanliness. Color code the piping, utilities, and guards for ease and observation.
- Note and mark all lubricating points. Document the points on a lubrication chart and mark the point physically on the machine. Color coding can be performed by painting a small colored circle in close proximity to the lubrication point. Some plants use plastic colored sticker to mark the position and lubricant type instead of a paint circle. The color of the circle designates the type of lubricants to be used. Lubricant containers can be color coded by painting the container the same color as the lubrication point circles.
- Photograph the clean machine or process area and compare with a before and after photograph to verify the machines progress on initial cleaning.
- Formally turn the equipment or process area back to production for startup and operations. Have the small group participate in the setup and startup activities for greater understanding of their equipment.

The time required to complete the above steps may exceed available time for a given shutdown period. It may be necessary to schedule the above steps over several shutdown periods to accommodate operating requirements.

Dozens of equipment abnormalities or improvement suggestions may result from the initial cleaning activities on a single machine. Many of the equipment issues will be fixed or improved immediately during the initial cleaning activities. Others will be backlogged as work request to be performed by skilled trades or external contractors.

Depending on existing equipment conditions, initial cleaning activities may require a major commitment of time and resources. Most companies underestimate the size of the commitment. Once they recognize the extent of resources required they either cut back on the amount of equipment to be included or perform only superficial cleaning. Some companies invest as much as 160 hours per plant employee on initial cleaning activities. This will inevitably depend on the size of the equipment.

Step 2: Address Sources of Contamination and Inaccessible Areas:

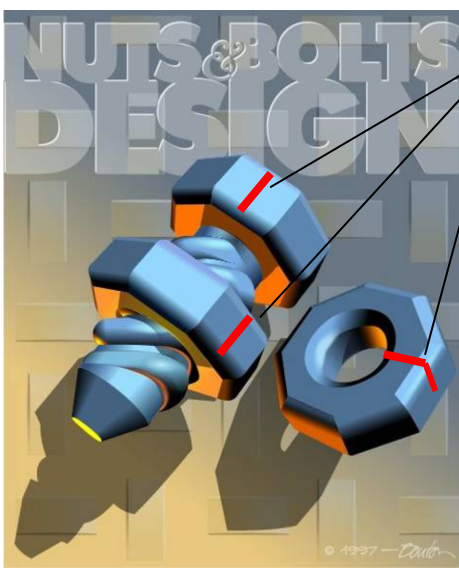
Initial cleaning activities identify contaminant that resides in the machine or area. Each contaminant type should be identified and documented. Typical contaminant type should be identified and documented. Typical contaminants include leaking process fluids, leaking lubricants, dust, corrosion, process, scrap, material handling scrap, worker generated trash, and other external pollutants. Contaminant identification cannot always be accomplished during the initial cleaning activates. Much time, due to the volume of the contaminant and the years of buildup, the initial clean-up activity can identify only that a contaminant exists. An example is seen in a discreet manufacturing plant that was built a few years ago. Management was concerned that the plant was not able to match the productivity numbers of its sister plants in Europe, even though the European plants were at least twenty years older. The plant had hundreds of grinding machines. Each machine was equipped with a catch basin, which was loaded with metal shavings, oil, cigarette butt, and candy wrappers. It was impossible to identify whether the oil was cutting oil, hydraulic oil or another type of lubricant. When ask why the catch basin was not clean in an attempt to increase machine reliability, the tour guide reply was, they would just get dirty again. People in this plant failed to understand that clean machines lead to improve equipment performance.

Step 3: Establish Cleaning, Inspecting and Lubricating Standards:

The development of cleaning and lubrication standards is a natural progression from the previous two levels of autonomous maintenance. Once a clean work environment is established and steps are taken to prevent deterioration, new, higher standards can be set and documented, the goal is to combine inspections for cleanliness with lubrication checks so that both activities can be performed together as efficiently as possible. Standards for lubrication and cleanliness also should be developed concurrently.

Small groups should be responsible for developing standards for equipment in their areas. The concept that should guide their work is that cleaning and lubrication are both forms of inspection. Many potential equipment problems can be spotted visually prior to their causing a deterioration in performance. For example some people establish a standard for the cleanliness and lubrication of their automobiles. In accordance with this self imposed standard, they periodically open the hood of their car to inspect fluid levels and check or change the lubricant. They also may inspect the engine block for cleanliness to ensure it is free of spilled oil and road grime. While the hood is up, a quick glance identifies whether the head gasket is leaking and whether there are any loose belts, or hoses. Those are simple activities that anyone with minor training can perform. The car owner is motivated to meet these standards of cleanliness so that he can avoid future repair bills. An individual who follows through with this type of inspection is also more likely to exercise greater caution in the operation of his vehicle. He would recognize that it is an acceptable risk to drive a car with a leaking head gasket to the repair shop, but he would not start a car with a broken oil pump in the process.

The format of cleaning and lubrication standards should be similar to that of good preventive maintenance procedures. The exemption is that they are developed by and for equipment operators as opposed to maintenance people. Visual images or pictures are excellent for communicating the designed standard. Some standards are developed in the format of a checklist for the production operator.



Match marks are placed on bolts and nuts so that operator can easily detect if bolts have been loosen due to excessive vibrations. These are being placed on critical bolts after each bolt had received their correct torque.

Blue line for bolts which Loosened for the 1st

Brown line for bolts which Loosened for the 2nd time

Red line for bolts which Loosened for the 3x and

Figure 6: Use of Match Marks

Step 4: Develop General Equipment Inspection Procedures:

Cleaning and lubrication comprise the bulk of routine inspections needed for most equipment. Additional inspection and adjustment can be grouped into an all inclusive category called general inspection. These activities include bolt torque or tightening, minor calibrations, adjustment, replacement of wear part and other process related visual, temperature, pressure or flow checks. General inspection also includes more detailed inspections on sub-systems such as hydraulic, pneumatic and electrical subsystems.

As was done with cleaning with the cleaning and lubrication standards, small groups should accept responsibility for the development of general inspection standards. The plant maintenance mechanics posses' ideal skills for this process but production and engineering also should take part.

One purpose of general inspection is to raise the level of operator understanding of there equipment and its maintenance requirements. By operator's participation in development of general inspection, valuable equipment knowledge is gained for future use in diagnosing equipment abnormalities. This method of developing procedures for inspection is consistent with the TPM objective of empowering small groups to address equipment management issues. Although small groups are empowered to determine what procedures are performed, they must act within the confines of the plant's policies or regulations. Their actions also are shaped by the plant's overall strategy, thus ensuring commonality of data and formats. Commitment and ownership over the process are heightened by the fact that the workers are the primary decision makers as to whether specific activities are best performed by operators or maintenance personnel.

Step 5: Conduct General Equipment Inspection Autonomously:

Autonomous inspection is the actual transfer of responsibility for equipment inspection. For this to become a reality, two specific activities must be accomplished. First, the previously developed lubrication, cleaning and general inspection standards must be institutionalized into a system. Second, production operators must be trained in that system in the technical aspect of the inspection.

It is important to develop checklist for operator position and organize them by performance interval. In other words, develop lists for all daily activities, weekly and monthly inspection checks. The checklists should be distributed in a logical manner to operators on the different shifts so that the workload is balanced and takes into account different shift operating conditions. The check sheets should make extensive use of pictorials to illustrate the tasks to be performed. The illustrations may be an actual part making it easy for the operators to understand the situation.

Step 6: Systematic Autonomous Maintenance and Management in the Workplace:

The plant that completes the first five steps of the autonomous maintenance programs, achieve optimal equipment conditions and establishes a system of standards to sustain these conditions. Equipment competent and process competent operators are able to detect and prevent abnormalities well in advance through proper checking and operation. Step 6 adds the finishing touches to the autonomous maintenance system.

One of the goals of this step is to allow operators to perform a sound, comprehensive autonomous maintenance of their entire process and to extend their activities into a realm of quality maintenance. Activities that promote this includes standardization of various control items, preparing process flow diagrams and quality maintenance manuals and deepening operators understanding of the relationship between equipment and quality. Operators expose sources of quality defects by performing general quality maintenance inspection, notes on these process flow diagrams and simple equipment structural diagram and gradually build a system that enables them to detect and promptly rectify abnormalities affecting quality.

Step 7: Independent Autonomous Maintenance and Empowered Workforce:

An independent autonomous maintenance is the point at which the operator's process becomes self-sustaining. External forces no longer are required to drive the pursuit of the concept of zero breakdown and defects. Empowered small groups are capable of interpreting company goals and policies and of self managing their continuous improvement activities. Minimal outside assistance and management direction is necessary. This state of being is the natural progression of the autonomous maintenance process.

Although Step 1 to 6 have accomplished results in concentrating all activities, in changing equipment and changing workplaces. In Step 7, ones own ability is recognize and the emotion to participate is high, solidarity, creation and emotions is enjoyed by indefinitely challenging under the kaizen initiatives are indefinite. This last step also aims in building operators who act like an electric train with self energy and motivation which completely change the attitude of the operator towards their equipment.

3.3 Planned Maintenance:

In every industry there seems to be a misunderstanding between operations and maintenance people. The never ending saga of feuds between the production and maintenance people is evidently and rampant where maintenance accuse the operations of flocking their equipments to death and when the machine is due for a Scheduled-Maintenance Overhaul, they endorse it to operations but it takes more than a shift to get it in running condition, and this time it's production turn to strike on their enemy. If this feud exists in your company, don't worry your not alone. Does the maintenance lack skills in performing their duties? Or the system in place needs to be replaced?

Doing maintenance is a serious business since it can constitute to 3 to 50 % of production costs, and without a good system in place, not only can it be costly but it might affect your company's survival as well. Some may advert to continuous improvement programs, modifications, purchasing the best maintenance software in town, benchmarking other companies, cost cutting programs, but mind you each of them have their own sets of limitation. Let me give you an example, in the company I previously work, there seems to be a battle of programs, more than a dozen continuous programs exists, TPM was in place and modifications and improvements was done, but the team missed out something, a very important point, the equipment is capable of producing was going to be phase out in a couple of months, so as the machine. And after a couple of months, the machine was pulled out, crated and stocked. Thousands of dollars, in improvement cost were gone.

Developing a strategic maintenance system must be done 2 folds, both a short term and a long term plan. The long term is where most maintenance managers and people lack, it is not sufficiently enough that "We Stop the Bleeding Syndrome" neglecting the fact of the possibility of other parts might be affected which can take a month or more to take effect. A good maintenance leader always sees this aspect in 2 ways, both the short term and the long term plan.

The sad fact is when we compare equipments 50 years ago nowadays, we can see a more complex, automated equipments, the change had been rapid, but the maintenance tasks performed most of the time had not change from a firefighting or reactive (fix when it broke) still to a firefighting or reactive mode. And when we speak of a strategic maintenance system that must be in place we must not only speak of lower cost and higher availability, but a maintenance perspective on the following must seriously be considered.

- Higher Plant Availability and Reliability
- Greater Safety
- Better product quality
- No damage to the environment
- Longer equipment life
- Greater cost effectiveness

Therefore, in a nutshell, when we speak of a system of maintenance that would be a dream for every. maintenance managers which is to select the most appropriate techniques in order to deal with each type of failure process in order to fulfill all the expectation of the owners of their equipment, in the most cost effective manner maximizing it's total Life Cycle Cost with the active support and participation of both operations and maintenance together

Therefore, the concept and basic understanding of Planned Maintenance is essential, it is not a cure all for our equipment problems, however, when you have applied the steps involved, not only can you have a piece of mind where you can sleep at night without the maintenance shift supervisor calling you early in the morning for a failure they can't handle, but a structured and effective Planned Maintenance system can guarantee you that the machine is expected to perform on it's optimum condition, and damages in cost savings on repair and maintenance would thus be reduced. Planned Maintenance is a long term solution for your daily day to day problems. We need to put a stop on firefighting practices, an accumulation of such practice will hurt your plant financially, shorten the life of your equipment, delayed deliveries to customers, long cycle time and high costs on spares. A company that wants to survive with their competition and an economic slowdown must focus on a rigid framework on their maintenance structure and strategy and must adopt a thorough Planned Maintenance System.

3.3.1 Planned Maintenance Defined

TPM composed of 8 major pillars Autonomous Maintenance, Planned Maintenance, Office TPM, Focused Improvement, Training and Education, Quality Maintenance, Initial Flow Control Activities and Environmental Health and Safety. There are Chapters on JIPM (Japan Institute of Plant Maintenance) books that cover the Planned Maintenance, and its definition varies from one author to another.

Planned Maintenance is the deliberate activity of building and continuously improving such a maintenance System. **By: Tokutaro Suzuki**

Planned Maintenance is defined as maintenance activities performed on a pre-determined schedule of activities. **By Charles Robinson & Andrew Ginder**

Although there may be more definitions on Planned Maintenance, I think that Suzuki's definition is the simplest way of defining it. Every company had their own system of maintenance in place; the job of Planned Maintenance is to continuously improve such a maintenance system. Planned Maintenance is a pillar of TPM which aims to achieve high reliability of equipments while minimizing maintenance costs. These are achieved through proper application of all the maintenance tasks such as Breakdown Maintenance, Predictive Maintenance, Preventive Maintenance, Corrective Maintenance which we shall define in the later part of this report, it also aims at targeting a complete zero reduction in unplanned breakdowns.

3.3.2 What Planned Maintenance Pillar Includes

A complete strategy on Planned Maintenance includes a Master Plan for the 8 major activities involved although the major focus would be on implementing the step by step activities on Planned Maintenance, In 4 Phases. The best way to carry out Planned Maintenance activities is to set a time frame of completion for each phase and having a Master Plan. Planned Maintenance activities include.

- Guidance and support for Autonomous Maintenance Activities
- Planned Maintenance 4 Phase Activities
- Lubrication Management Activities
- Setting up the Planned Maintenance Structure
- Spare Parts Management
- Reduction in Maintenance Cost Activities
- Enhancement and Upgrading of Maintenance Skills
- Success in Using Predictive Maintenance Instruments and techniques

3.3.3 What Planned Maintenance Wants To Achieve

I always tell my participants during training that having an effective maintenance system is no different than coaching a basketball team. Imagine if I am the coach and I put my first 5 with the smallest person to be 6' 8" then I will be strong on rebound, but definitely I wont be able to have an effective guard, because all of them have the center position, or what if I have a first five with the tallest being 5' 10", then our statistics shows we will not dominated on rebound. On the other side, your maintenance system must be balance, if you have your centers, forwards, and guards in the team, then you have an effective team, likewise in maintenance, if you know what parts will undergo breakdown maintenance, what parts will be on scheduled preventive maintenance, and what parts are under predictive maintenance then you have the best maintenance system. Traditionally, almost all tasks are undergoing Preventive Maintenance, this is like having 5 center positions in basketball, and if this is the case in your company then your maintenance is very costly as well as reactive in nature...

3.3.4 Introduction on Planned Maintenance

Implementing a long term Planned Maintenance system will take years to accomplish, but it's results is what every maintenance personnel can dream of, it's benefits will have effect on the following

• Reduction in Maintenance Costs

• Higher MTBF and Reduced Planned Breakdowns

• Higher Equipment's Reliability and Availability

• Upgraded and Higher Maintenance Skills

• Making Maintenance Pro-Active and Not Reactive

Will it be the same old ways in your maintenance groundwork's, or I have made you stop to think it's about time to change your maintenance system? Is it time to do some revisiting on your maintenance checklist and check its effectiveness if it truly serve its purpose? or are they a waste of time in doing it and the once that really need the overhauls and maintenance task are being neglected or not performed? Why not think about the long term plans on your maintenance activities.

Planned Maintenance activities are essential for any manufacturing or industry with equipments since the subject of maintenance must not be taken lightly. Most of the times this is neglected, while a company can hire the best maintenance manager truly capable of knowing every detail of the equipments he manage he can lack in approach and systems in how to perform maintenance. I emphasize strongly in the contents of this report that it is 100 times better to have a maintenance system in place than having the best maintenance software in town. Prioritize in having a system of Planned Maintenance built in your organization. If done properly and correctly, this investment can impact you on saving cost which can amount to hundred of thousand to million of dollars in waste on maintenance.

3.3.5 Planned Maintenance in 4 Phases

Although there are many variations as to how Planned Maintenance can be implemented, its goal is to achieve a level of Predictive Maintenance stage in their equipment by utilizing non destructive equipment diagnostic techniques. These instruments are useful in predicting equipment failures with potential failures. Likewise operators for Autonomous Maintenance are trained on how to use their senses to predict possible equipment failures. Predictive Maintenance aids in helping maintenance understand that a component is in the verge of failure and can likewise plan for this event before much more damage can be realized.

3.3.5.1 Phase 1: Stabilize MTBF through Restoration

There are three main activities in Phase 1 which include performing restoration, recurrence prevention of deteriorations uncovered and standardization. All these activities aim at establishing basic equipment condition while deteriorations are exposed and corrected. Before conducting Phase 1 activities, equipment mostly is subjected to accelerated deterioration and failures occur frequently. Deteriorations are left unchecked even if maintenance is aware of it. These are perceived as normal and breakdowns cannot be eliminated since boss does not approve our request for purchase of spare parts which need replacement. This attitude oftentimes spells disaster since one breakdown may lead to another causing more downtime and money. Activities on Phase 1 aim at changing the concept of the traditional approach on firefighting or reactive stage by doing the basics and restoring equipment to its original condition.

Prevent accelerated deterioration, this tasks involves extending the equipment lifespan by prolonging MTBF or Mean Time between Failures. The longer the interval for the time to repair the more the uptime of the equipment is utilized. Begin by tagging the equipment for deteriorations and abnormalities uncovered and correcting them all. Expect a dramatic reduction in breakdowns once Phase 1 had been completed. Analyze why deteriorations occurred and perform countermeasures to prevent the recurrence of accelerated deteriorations. Simple why-why analysis must be performed at this level.

3.3.5.2 Phase 2: Lengthen Equipment Lifetime

Once accelerated deterioration had been eliminated, equipments will suffer from natural deterioration. There are several spares and parts of equipment that will deteriorate naturally. Team exposed themselves to study several parts of equipment with inherent short natural lifespan and correct design weaknesses by improving the parts dimension, strength of materials, construction dimensions and so on. An MP or Maintenance Prevention Design Form is usually used for this activity and later on feedback to the IFCA or Initial Flow Control Activity Group so that when the company decides to purchase future equipments these improvements are discussed with the designers to be included in the new equipment purchase. A cycle must be established where MP Design improvements must be feedback to early equipment management.

Correcting design weaknesses can prevent major breakdowns from recurring unexpectedly. Teams are trained on special tools such as P-M Analysis & RCFA for a more detailed approach in dealing with Chronic Breakdowns. Likewise most breakdowns are caused by human errors, hence, both operators and maintenance must upgrade their analytical skills to eliminate human errors, application of Poka-Yoke solution may solve human errors but not necessarily improve the level of understanding of the mistake caused by the person involved. Equipment's failed parts with design weakness are modified, this must run in parallel in improving the skills on how the operator operate the equipment and how maintenance repairing skills must be standardize as well.

3.3.5.3 Phase 3: Periodically Restore Deterioration

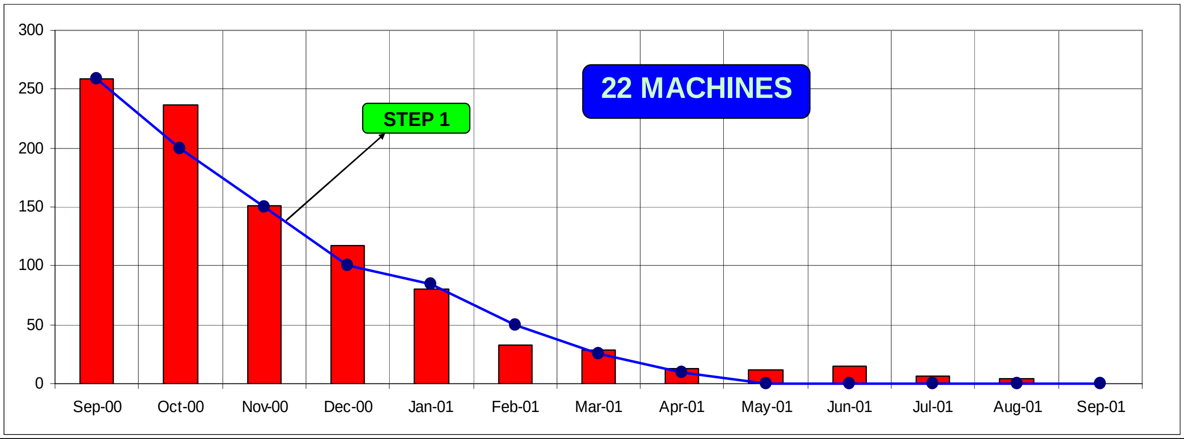
A thorough study of the maintenance tasks must be done to establish the correct maintenance to be performed. RCM2 is a perfect methodology for this concept. Not all parts need to belong to the Time-Based or Preventive Maintenance Calendar System. This can be done by having a thorough understanding on how such tasks can be performed correctly. Each part has their own failure characteristic pattern. The key in this activity is to know the 6 failure pattern so you can derive the correct maintenance tasks for each function through an Algorithm or Decision Diagram. In this activity we are not dealing with equipments alone but a comprehensive maintenance system that must be adopted. What parts must undergo time-based, what parts can be predicted, what parts needs inspection and what parts does not have any consequences at all and can be left to the Run-To Fail Tasks.

3.3.5.4 Phase 4: Predict Equipment Life

In Phase 4 we introduce the concept of Predictive Maintenance / Condition Based Monitoring Techniques, although this is similar in using the key senses of humans in a much higher perspective with the aid of instruments. Several parts of equipment can be predicted through the use of these techniques, this is done by checking the condition of the equipment. The key on using this technique is to know the P-F interval which means that if a part shows symptoms of potential failure, the parts are good candidate to use Predictive Maintenance in this regard. For example, a bearing may produce noise, increase in temperature, increase in vibration, these are the symptoms that a failure is likely to occur. Therefore, the maintenance can be well prepared for this occurrence. Advantage of Predictive Maintenance is that you can utilize the part to its maximum life without the need for a breakdown to occur. Parts can be replaced within hrs if it's going to fail; this is the essence and beauty of having a Pro-active Maintenance. Both Predictive and Preventive are Pro-active maintenance once you know how to adopt them properly and the key is to understand the 6 failure pattern curves.

1st PILOT BDO TRENDING FOR PM PILOT MACHINES

Sa Planned Maintenance, Isang Misyon, Isang Direksyon pa rin . . . .



		Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01
BDO	PLAN	259	200	150	100	85	50	25	10	0	0	0	0	0
	ACTUAL	259	237	151	117	80	33	28	13	12	15	6	4	0

Figure 7 showing Breakdown Occurrence from Planned Maintenance at Amkor Technology Philippines year 2000

3.4 Focused Improvement:

Focused Improvement or Kobetsu-Kaizen in Japanese includes all activities that maximize the overall effectiveness of equipment, processes and plants through uncompromising elimination of losses and improvement of performance. Many people ask about the difference between focused improvement activities that they may already be practicing. The basic point to remember about focused improvement is that if a company is already making all possible improvements in the course of routine work and small group activities, then activities of focused improvement are already in place.

Focused improvement aims to eliminate all kinds of losses. Identifying and quantifying those losses are therefore important issues. The traditional method of identifying losses, analyzed results statistically to identify problems, then searches back to find their causes. The method adopted in TPM emphasized hands on, practical approach and examines production process, equipment. materials, people and methods. And treats any deficiencies in this input as losses.

Achieving a profitable TPM in industries can be difficult if improvement teams limit their approach to that used in fabrication, and assembly industries. Proper mental and physical preparation is essential before starting any focused improvement project. Improvement teams should be prepared in the following ways:

- Understand fully the philosophy of focused improvement
- Understand fully the significance of losses and the rationale behind improving OEE
- Understand the production process well including its basic theoretical principles
- Gather data on failures, trouble and losses and plot this overtime
- Clarify the basic conditions necessary to assure proper functioning of equipment and define clearly what factors contribute to optimal state

- Understand the necessary techniques for analyzing and reducing failures and losses
- Observe the workplace closely to discover what is actually happening

Focused improvement often requires a high level of engineering technology. In addition to improving the level of proprietary technology relating to a company's products, it is also necessary to raise standards. It is easier and more effective to conduct improvement activities step by step documenting progress visually as you proceed. This approach has the following advantage:

- Everyone can see what is happening and take an active interest in the focused improvement pillar
- Plans for individual topics and teams are developed separately but integrated with plant wide goals to maximize results
- The focused improvement committee can more easily monitor program and control the schedule
- Holding presentations and audits on completion of each step make easier to consolidate the gains and sustain enthusiasm. Provide rewards and recognitions to successful teams that achieve lasting results with their improvements since people take pride in what they do.

3.4.1 Step by step procedure for Focused Improvement:

Step 0: Select an improvement topic

- Select and register the topic
- Form project team and plan the activities

Step 1: Understand the situation

- Measure failure, defects, and other losses and identify bottleneck areas
- Use baseline to set targets

Step 2: Expose and eliminate abnormalities

- Painstakingly expose all abnormalities uncovered
- Establish basic equipment condition by restoring deterioration and correcting minor flaws

Step 3: Analyze Causes

- Stratify and analyze causes by applying analytical tools, such as RCA, Fault Tree, and P-M Analysis etc.
- Employ specific technology, fabricate prototypes and conduct experiment

Step 4: Plan Improvement

- Draft improvement proposal and prepare drawings
- Compare cost effectiveness of alternative proposal and prepare budget
- Consider possible harmful effects and disadvantages of the countermeasure

Step 5: Implement Improvement

- Carry out the improvement plan and perform test operation and formal acceptance
- Provide instruction on improved equipment operating methods

Step 6: Check the Results

- Evaluate results with time as improvement project proceeds
- Check whether targets had been achieved

Step 7: Consolidate the gains

- Draw up control standards to sustain results
- Formulate work standards, manuals and instructions and feed information to maintenance prevention or early equipment management team

3.5 Administrative/Office TPM:

Companies must map out a clear strategy to respond to this essence of change and dramatically shorten their product time to market. At the same time, they must distinguish themselves from their competitors to both quality and costs. These are the most important challenges facing managers today.

Eighty percent of a product's quality and cost is already determined at the development, design and production stages. Development, design and all other staff departments must cooperate willingly to ensure that the production department does not produce useless or wasteful products. Meanwhile, companies must set up manufacturing plants in a way that enables the production department to fill orders on time at the quality and cost that the development and engineering departments prescribe. This is not the responsibility of production department alone; it requires a TPM program that embraces the entire company including the administrative and support departments of the plant.

TPM activities in administrative and support departments do not involved production equipment. Rather, this department increases their productivity by documenting administrative systems and reducing waste and loss. They can help raise production system effectiveness by improving every type of organized activity that supports their production. Their contribution to the smooth running of business should be measured.

3.5.1 The Role of Administrative and Support Departments:

Unlike activities in administrative and support departments, departments such as planning, developing, engineering and administration do not add value directly. As experts in their particular area, their primary responsibility is to process information, advise on and assist with the activities of the production department and other departments and help reduce costs.

Their second tasks are to enable the company to respond rapidly to changes taking place in the social and business environment and to outperform the competition. This means improving their own productivity, cutting cost and helping the company accomplish the strategic developments that senior management envisions. Their third tasks based on the preceding are to win customer confidence and create an outstanding corporate image. To pursue these goals through TPM, administrative and support departments must define their mission by answering the following questions:

- How do we support TPM activities of the production department and other departments?
- What issues must we address to maximize our own efficiency?

The function of administrative and support departments can be improve by improving efficiency so each department can perform its particular function satisfactorily and developing people able to sustain and continuously improve the new more efficient system. Improving efficiency means boosting output while reducing input. Boosting output means eliminating anything that reduces production system efficiency to enhance work functions and raise their effectiveness. Reducing input means eliminating administrative losses associated with the work and creating a cost effective administrative system able to provide high quality, timely and reliable information.

These are the ostensible goals of improving the organization and management of administrative and support departments. An even more fundamental goal is to use the activities to developed administrators who are extremely effective at processing information.

Each company must tackle this challenge differently; however, a firm's present and future problems needs depend on its type, scale, management, history, present circumstance and business environment. Each company must work out the best approach for its own situation.

3.6 Quality Maintenance:

As equipment takes over the work of production, quality depends increasingly on the conditions of the equipment. Quality maintenance evolved as a major TPM activity in certain fabrication and assembly industries that are becoming increasingly more automated. In environment where human intervention is decreasing, the goal of quality maintenance is to maintain and constantly improve quality through effective equipment maintenance.

For manufacturing industries, quality has always been build into the product through the process. The pace of new product development, however, is accelerating and the greater diversity of raw materials and products currently necessitates ever more frequent changeovers. To cope with this, production departments must review their quality assurance systems with the aim of tackling quality through equipment management. Quality is built into the product through process that provide the conditions needed for transformations such as reaction, separation, purification of materials as they become the final product. In order to produce perfect products, it is necessary to set appropriate process conditions such as temperature, pressure, flow rate, etc. for the particular properties, composition and volumes of the raw materials, reagents and other substances being handled. To achieve this, the equipment units that are make up of the plant and their component modules and parts must be installed so they function optimally to create no quality defects.

Industries always aim for this, but the results often leave much to be desired. Quality defect losses and reprocessing losses still occur and substandard products often has to be recycled, salvaged by mixing it with good products or downgraded. Customer complaints and dissatisfaction are a perennial problem. Meanwhile, in plants where chemical reactions take place, poor control of conditions not only affects quality but is also dangerous. To create safe plants that produce only flawless products, a company must analyze process and equipment rigorously to identify and maintain conditions that do not lead to defects. This is the role of quality maintenance. A quality defect is a property that falls outside the specific range.

Quality Maintenance consists of activities that establish equipment conditions that do not produce quality defects with a goal of maintaining equipment in perfect condition in producing perfect products. Quality defects are prevented by checking and measuring equipment conditions periodically and verifying that the measured values lie within the specific range. Potentially quality defects are predicated by examining trends in the measured values and prevented by taking corrective measures in advance.

Rather than controlling results by inspecting products and acting against defects that have already occurred, quality maintenance in TPM aims to prevent quality defects from occurring altogether. This is accomplished by identifying checkpoints for process and equipment conditions that affect quality measuring these periodically and taking appropriate actions.

The approach focus on the production inputs of equipment, materials, people and methods as sources of quality defects. Establishing conditions means setting the range for material, equipment method or operating conditions that must be maintained to produce flawless and defect free products. Once set, these conditions are maintained and controlled by competent operators extensively trained in production technology as part of their autonomous maintenance activities.

A quality maintenance program builds gains achieved through fundamental TPM activities such as autonomous maintenance, planned maintenance, focused improvement and maintenance skill training. There are several preconditions for a successful quality maintenance program, however, abolish accelerated deterioration, eliminate process problems and develop competent operators.

3.6.1 Who is Responsible for Quality Maintenance?

The Quality Control department must be responsible for promoting quality maintenance through their industry. Quality Maintenance projects vary considerably in difficulty, however, projects spanning a wide range of process or requiring advance technology should be tackled by project teams headed by section managers. Easier projects can be addressed by small groups in the workplace. After teams established the conditions for zero defects, operators should maintain and control most of these conditions as part of autonomous maintenance. More difficult problems should be addressed by project teams from the production department with the participation from departments such as product design, product engineering, equipment engineering, maintenance and quality assurance control.

3.7 Early Equipment Management:

As products diversify and their life cycle become shorter, finding ways to make new product development and equipment investment more efficient grows in importance. The goal in TPM is to reduce dramatically the time from initial development to full scale production and to achieve a vertical startup that is fast, free of bugs and right the first time. This is what early equipment management is all about

It is vital to develop products of readily assured quality that anticipate the users needs, products that are competitive, easy to sell, easy to produce and easy to do this efficiently. At the same time, however, the transition from development to full scale production must be rapid and problem free. To accomplish this you must identify the production inputs required to bring the products to the market, eliminate the losses associated with equipment that produces them and maximize return on investment. In other words, you must ensure that production equipment is easy to use, easy to maintain, highly reliable and well engineered. With such equipment free of bugs assuring product quality is simple.

Major equipment items are often customized to individual specifications, they are often designed, fabricated and installed in a rush condition. Without strict early equipment, such equipment enters the test operation phase with many hidden defects. The truth of this is borne out by the frequency with which maintenance and production personnel discover defects generated fabrication and installation during shutdown maintenance and start-up.

Early management is particularly important in industry because large amounts of money are invested in their linked processing units and management expects the plant to operate for a considerable number of years. Also after each period of shutdown maintenance, the restart operations must be manage by the same procedure followed when the plant was first commissioned. To accomplish this, all departments must cooperate closely not only from the research and development, design, engineering, production and maintenance but also from planning, marketing, finance and quality maintenance.

TPM gives equal importance to early product management, early equipment management and the other TPM activities. The basis of early equipment management is of course economic performance evaluation optimizing life cycle costs through and maintenance prevention or MP design improvements.

3.7.1 MP Design:

Maintenance Prevention design activity minimizes future maintenance cost and deterioration losses of new equipment by taking into account maintenance data on current equipment and new technology and by designing for high reliability, maintenance, economy, operability and safety. Ideally, MP design equipment must not break down or produce nonconforming products. It should be easy and safe to operate and maintain. The MP design process improves equipment reliability by investigating weaknesses in existing equipment and feeding the information back to the designers. Improvements done by autonomous maintenance, planned maintenance and focused improvement are being consolidated and discussed with suppliers of the equipment that these modifications should be imbedded when purchasing for future equipments.

3.7.2 The Importance of MP Design:

Even when the design, fabrication and installation of new plant and equipment appear to have gone smoothly, problems often emerge at the test operation and commissioning phases. Production and maintenance engineers struggle to get the plant working properly and they achieve normal operation only after repeated modifications. After the plant has begun operating normally, checking, lubricating and cleaning to prevent deterioration and failure may be awkward and difficult to carry out, as may be also for set-up and adjustment and repair. When equipment is not design for ease of operations and maintenance, operators and maintenance personnel tend to neglect routine housekeeping, set-up and adjustment takes too long and even the simplest repairs necessitate shutting equipment down for unconsciously long periods. Some people claim that numerous problems at the initial operation stage are inevitable in view of rapid advance of technology and the increased speed, size and automation of equipment. Never try to justify the problem like this. Equipment engineers must incorporate new processing and operating conditions into the equipment's design conditions. To ensure that equipment is highly reliable, maintainable, operable and safe, avoid relying on outside purchasing. Make full use of the in-house technology that your own production, design and maintenance engineers have accumulated from problems they overcame in the past. The thoroughness of the investigations performed at the design stage largely determines the amount of maintenance a plant requires after installation.

3.8 Environmental, Health and Safety:

Eliminating accidents and pollution is a mandatory requirement for winning the PM prize in Japan. The safety records of prize winning operations are in fact significantly better than before they introduce TPM. Review your own safety and environmental management system at the end of the TPM implementation phase and establish an environment that permanently maintains the improved safety record. Goal must be zero accidents and pollution.

3.8.1 Safety and Environmental Management

Ensuring equipment reliability, preventing human error and eliminating accidents and pollution are basic tenets of TPM. This is why safety and environmental management is a key for any TPM development program. Fully implementing TPM improves safety in many ways such as:

- Faulty equipment is a common danger source, so zero failure; zero defect campaigns also improve safety.
- Through the application of 5s principles, teams eliminate leaks & spills and makes workplace clean and tidy.
- Autonomous Maintenance and Focused Improvement eliminate unsafe areas.
- TPM operators are better able to detect abnormalities and deals with them promptly.
- Operators takes responsibility for their own health and safety

Practicing TPM builds safety into the work. It also contributes greatly to a healthy, hospitable working environment. Perfect safety and environmental cleanliness are basic manufacturing requirements. In practice, however, there is always a possibility of plant or equipment causing accidents and pollutions. The potential for disaster is always present even in a plant with a perfect safety record.

Plants that handle large quantities of flammable, explosive or toxic materials use high pressure gases, consume large amounts of energy or operate under extreme conditions are particularly at risk. The danger of fire and explosion is ever present and accidents may affect the surroundings as well as the plant itself. Pollution due to in plant accidents or process problems is also highly undesirable since it can harm local environments and communities. Eliminate these risks by taking the same approach that you take to improve safety. Since major accidents and disasters are so rare, zero accident momentum is easily dissipated. Stay alert for blind spots and remember that a tiny defect or problem can develop into a serious accident or pollution incident, so focus daily on zero activities toward zero accidents and zero pollution.

4. Equipment Big Losses

Equipment losses vary from one another, below is a TPM lists of losses equipment can suffer. This does not include interruptions or downtimes caused by outside factors such as power, facilities requirements, operator skills, and others. It is important to note what type of losses your equipment encounter most of the time and who should address them. It is recommended that each loss be treated separately as this type of losses needs different types of people to be addressed. Each of the losses specified below must not be addressed by the maintenance people alone, but by a cross selection of expertise.

4.1 Breakdown Loss

Sometimes called as Equipment Failure loss is a loss when machine stops due to lose in its specified Functions. There are two types of breakdowns, Function Reduction Breakdown which is when deterioration of equipment causes other losses in function even when the equipment can still operate. Imagine your car running, and stating that the primary function of a car is to travel from distance A to distance B. It can comply with the function, but one of the car's headlight is busted, side mirror is missing, wheels hub is missing, car have excessive oil leak due to damage in seal, car's aircon does not work, wiper is missing and so on, but still the car can function and travel from distance A to distance B, this is what Function Reduction Breakdown is and most equipment's suffer this type of losses and it seems that most of the time this type of losses are being neglected. These are breakdowns which account for the largest proportion of overall equipment losses. The second one is Function-Loss Breakdown which is failure in which equipment stops completely. These are losses in which production is stopped another term is unplanned downtime or simply termed as breakdown maintenance...

Breakdowns halt production, deliveries are delayed, quality problems arise, maintenance cost is increased, and a single breakdown can create havoc throughout the plant. Analysis in the breakdown failure can be attributed mostly to human problems, basic neglect on design problems, lack of operator skills, and lack of repair skills. That's why a basic understanding of the failure must be address thoroughly. Breakdowns are caused by many factors, and most of the time slight deteriorations are overlooked which contribute highly to equipment's breakdown. Improvement in equipment performance can be done by simple addressing minor problems such as loose and missing screws; abrasion, debris and contaminant are addressed. Zero unplanned breakdowns can be established by addressing the following:

- Prevent accelerated deterioration
- Maintaining Basic Equipment Condition
- Maintaining Operating Condition
- Improvement of Maintenance Quality
- Addressing root causes of breakdowns
- Guidance for Autonomous Maintenance
- Correcting Design weaknesses

Once a breakdown occurred be certain to possibly learn everything you can and study the causes, conditions, maintenance tasks involved, repair method, much can be learned to prevent it from happening. The basic responsibility of each maintenance is not to repair breakdowns but to analyze what had caused the breakdown problem and draw measures to prevent the recurrence of the problem. If this is not being performed, you will just be wasting your precious time on doing repairs and quick fixes on the same problem over and over again.

4.2 Set-Up Loss

It is the time required to remove dies, jigs for one product, clean-up, prepare dies and jigs for the next product, reassemble the equipment, adjust the equipment, perform trial runs and make further adjustments until product of acceptable quality is obtained. It begins when the production of one product is completed and ends when standard quality is attained on production on the next type of product being processed. Shigeo Shingo's (SMED) Single Minute Exchange of Dies deals in techniques in reducing Set-up time and adjustment time without reducing its accuracy. According to him, a good set-up time in manufacturing must fall between 10 minutes and below. A finding of Shigeo Shingo, why set-up time is prolonged is due to the following:

• Preparation of materials, jigs, tools and fittings	20 %
• Removal and attachment of jigs, tools and dies	20 %
• Centering and Dimensioning	10 %
• Trial Processing and Adjustments	50 %

The first step in improving set-up is to distinguished activities that can be performed while the equipment is running from those that can be performed only when it is shut down. Differentiate external from internal set-Up. External set-up is those activities which can be performed while the machine is running while an internal set-up is those activities which can be performed only when the machine had been shut down for conversion. The goal on set-up is to minimize the time to perform it, and one of the techniques is to write down all the steps performed in doing your set-up, then converting internal set-up to external set-up This can be accomplished by using a standard one touch jig, compare the shapes of tools and jigs for different products and consider preparing a standard jig that can be shared by all. Eliminate adjustments during internal set-up time by using intermediate jigs. Here are 2 steps that can be taken to eliminate the need for adjustment. First in many cases adjustments can be scaled down simply by improving the precision of equipment, jigs and tools. The accumulation of imprecise settings creates the need for many avoidable adjustments. Second, standardize procedures. Lack of consistency in the standards for measurement, quantification and other operation and maintenance procedures is another cause of unnecessary adjustments. Set-up losses cannot be eliminated but they can be reduced dramatically, poor set-up can cause other losses such as breakdown, quality problems and it is best that procedures on each product set-up must be standardized. One maintenance can set-up one equipment differently and might take 15 processes while one may take as much as 20 to 25 steps. What is important is that whoever is performing the set-up procedure has a set of standards to follow. Much can be learn by knowing the difference between what are internal and external set-up practices and most of them only need common sense

4.2.1 Tips on Shortening Internal Set-Up Time

• Simplify clamping mechanism by using quick fitting jigs

• Adapt parallel operations; two people working together can perform a set-up faster and more effective

• Optimize the no. of workers and division of labor especially for large and complicated set-ups Doing this simple basic steps will greatly reduce your set-up time

4.2.2 Eliminating Small Losses in Set-Up

• What type of preparations needs to be made in advance?

• What tools must be on hand?

• Are the jigs and tools to be installed in good condition?

• What type of workbench is needed?

• Where should jigs and dies is placed after removal?

• How will they be transported?

• What types of parts are necessary?

• How many maintenance people are needed to perform the set-up?

Figure 8: Shigeo Shingo

4.2.3 Traditional Setup Approaches

Processing setup operations are the main emphasis in most plants. First, Shingo addresses the traditional strategies for improving setup operations. In traditional manufacturing operations, efficient setup changes require knowledge and skill. As a result, efficient setups require highly skilled workers or “setup engineers”. While a setup engineer is performing the setup, the machine operator is idle or performing some other insignificant miscellaneous tasks. Shingo points out that this is approach to set up are a common misconception, and are very inefficient. Many companies have setup policies to raise the skill level of workers, while few have tried to implement strategies that lower the skill level required by the setup itself. Traditionally, manufacturing companies have also increased lot size to hide the effects of longer setup times. A large lot size production seems the easiest and most effective way to minimize the undesirable effects of setup operations, because the setup time is minimal compared to the operating time for each unit. This large lot size also increases inventory. Inventory itself does not produce added value, so the space it ties up is wasted, and the costs to store inventory increase. Inventory stock is at the risk of becoming outdated or even damaged. This approach assumes that reductions in setup time are impossible. The SMED system makes these reduced setup times a reality, and a better alternative to increasing lot size.

4.2.4 The SMED System

Shingo found through observation that setup operations are composed of two different types, internal setups and external setups. Internal setups are setups that can be performed only when a machine is stopped. External setups are setups that can be conducted while the machine is in operation. This distinction between internal and external setups is one of the driving factors behind SMED; reduce setup times by converting internal setups to external setups. SMED was developed over nineteen years as a result of closely investigating the theoretical and practical aspects of setup improvement. It is a scientific approach to setup time and reduction that can be applied in any factory to any machine. It was implemented into the Toyota Production System, and has helped them to become the leading production system. In traditional setup operations, internal and external setups are mixed up. Some setups that could be done externally are performed as internal setups, causing machines to remain idle for extended periods of time. The first and most important stage in implementing SMED is to identify which setups are internal and external. The next stage is to convert the internal setups to external setups. The third and final stage is streamlining all aspects of the setup operations. In traditional setup operations, many different kinds of waste occur, because internal and external operations are not distinguished. For example, in some manufacturing facilities the machine is turned off when finished goods are transported to finished goods inventory, wasting valuable time. The first stage of SMED is to separate internal and external setups. This task sounds easier then it actually is, therefore Shingo suggests using various techniques to accomplish this task. Checklists, charts, check tables, function checks, and identification and improvement of transportation to and from the machines are all suggested to help facilitate this stage. The next stage is to convert internal setup to external setup operations. This stage is different for each process, and Shingo provides various examples. Shingo introduces the concept of function standardization; standardizing only those parts whose functions is necessary from the standpoint of setup operations. Efficient function standardization requires analyzing the functions of each piece of apparatus, element by element, and replacing the fewest parts possible. When converting internal setups to external, standardizing the process as much as possible will reduce setup time. Standardizing is accomplished through different jigs and clamps, working toward making everything the same, so setup changes are minimal. Standardization reduces setup time substantially, simplifies the organization, eliminates the need to search for appropriate tools, and eliminates the need for adjustments. The final stage in SMED is streamlining all aspects of the setup operation. Improvements in transportation and storage of all parts, products, and tools can assist to streamlining operations. This stage doesn't necessarily reduce setup time just by itself, but it does aid SMED in creating a continuous flow.

4.2.5 Techniques to Implement SMED

Some work in a manufacturing facility involves work at both the front and at the back of the machine. A single person working at one of these machines wastes time and movement when they have to continually walk around the machine. Shingo suggests parallel operations, involving more than one worker, in this situation. The most important issue in parallel operations is safety. Some sort of signal system has to be worked out so that workers in the process know when to do their respective jobs. The concept of parallel operations is also a technique that can be used to streamline operations. A functional clamp is an attachment device that is used to hold objects in place with minimal effort. Shingo points out that most of the time, a nut and bolt are used to fasten or tighten a clamp. If the bolt has fifteen threads on it, it can't really be tightened until the last turn, and it is loosened in the first turn. The other fourteen turns are wasted. It is with this observation that Shingo spent time developing one-turn attachments and one-motion methods.

There are also several techniques used to eliminate wasted adjustments. Adjustments and test runs normally account for as much as 50% of the setup time. Therefore, if there is a decrease in the adjustments, there is a reduction in setup time. Inaccurate centering, dimensioning, and other procedures that take place in the internal setup necessitate test runs and adjustments. In order to eliminate these adjustments, Shingo says that we must improve the stages of internal setup. Minimizing these adjustments can be accomplished by fixing numerical settings, setting centers on machines, using gauges, and using reference planes. Shingo also introduces the Least Common Multiple system as a technique for eliminating adjustments. Finally, after every attempt has been made to improve setups, mechanization could be used to reduce setup times. Mechanization should be considered last to reducing setups because it is an inefficient setup operation that will achieve time reductions, but it will do little to remedy the basic faults of a poorly designed setup process. Mechanization can also cost a lot of money to implement. It is more efficient to mechanize setups that have already been streamlined. Shingo strongly believes that success with SMED involves knowing why the system works rather than just knowing how to implement it. Therefore, he provides a plethora of actual examples of the SMED system in operation, so that the reader can gain further insight into the concepts and its principles.

4.2.6 Effects of SMED

The goal of SMED is to reduce setup times, but there are other effects that SMED has on a production system. One effect that SMED has on a production system is that inventory is minimized. A reduction in inventory can lead to more efficient use of plant space. The unusable stock due to model changeovers or mistaken estimates is eliminated. Productivity increases because of stock handling operations are eliminated. Goods are no longer lost through deterioration or damage. The ability to mix production of various types of goods leads to further inventory reductions. Some other beneficial effects of SMED are that machine work rates and productive capacity is increased. There is an elimination of setup errors and the elimination of trial runs lowers the occurrence of defects. Quality and safety are both improved. Standardization reduces the number of tools required and those that are still needed are organized more functionally. Tool changes are quick and simple, eliminating the need for skilled workers; therefore SMED lowers the skill level requirements for a process. SMED increases the manufacturing flexibility because of quick changeovers; therefore a company can increase their production flexibility because it will be able to respond rapidly to changes in demand. SMED can also have effects on the attitudes within the company. SMED welcomes employee involvement toward continuous improvement. The effects of SMED consist of more than just reduced setup times and improved work rates. Companies can gain more from SMED then they realize. Shingo provides twelve case studies in the second part of the book for the reader to see how the SMED system has actually been applied. Case studies range from applying SMED to Toyota Production systems to developments in producing slide bearings.

4.3 Idling and Minor Stoppages

As equipment becomes more complex and automated, more losses are attributed with Idling and Minor Stoppages (some companies term this as assists). First let us define this type of loss. A minor stoppage occurs when a failure or an error in automatic handling, processing or assembly of parts and work pieces, or an equipment stoppage due to the occurrence of quality related abnormality. This type of losses arises mostly in automated processes and includes the following:

- Work piece flow stops
- Operator resets work pieces correctly
- Operator reactivates process and machine runs

The problem with this type of losses is the number of occurrence or frequency, and most of the time this type of error is left unrecorded since the time to fix it can be done by just resetting the buttons and it will spend more time to record and write down the error. Idling and Minor stoppages sometimes are mistaken for breakdowns, which must not be the case; these must be separated from breakdowns. These types of losses can be addressed by Autonomous Maintenance through initial cleaning; JIPM experts believe that having equipment free from dirt and dust can reduce minor stoppages from 20 to 60%. While more complicated minor stoppages which cannot be reduced through cleaning must be addressed by a cross functional Focused Improvement team composing of engineers and maintenance people. Some examples of Idling & Minor Stoppages includes a work piece jamming, resetting of sensors, error reading on monitor of computerized equipment where the machine is stopped temporarily, operator resets and the machine starts running again. These problems occur more frequently in automated equipments. In addressing minor stoppages, ensure the following: Observe what is happening. These can be done by carefully observing the equipment until a minor stoppage had occurred and plan corrective measures. Correcting slight or minor defects, a small dent in the chute may be a cause of minor stoppages and oftentimes we overlook this factor, maintaining clean equipment can minimize stoppages

4.4 Design Speed Loss

Design Speed Loss is the loss production caused by the difference between the design or theoretical speed and the actual operating speed. Lack of care at the design stage of the equipment may result in speed reduction. Equipment is operated beyond its operating speed limit, quality defects and breakdowns are encountered. Although Japanese and Europeans systems of maintenance had conflicts on this type of losses, Japanese TPM experts still consider this to be a loss and according to them to reduce speed loss we must address the following:

- Level 1: Achieve Standard Operating Speed for each product
- Level 2: Increase Standard Operating Speed for each product
- Level 3: Achieve Design Speed
- Level 4: Surpass Design Speed

Equipment may be run at less than the design or ideal speed for a variety of reasons which may contribute to mechanical problems, quality and defect problems, history of past problems, and sometimes not knowing what is the optimal speed. On the other hand deliberately increasing the operating speed actually contributes to problem solving by revealing latent defects in equipment conditions.

4.5 Start-Up Loss

Start-Up loss is a type of loss that occurs during start-up or running in. Problems arise during starting the equipment. Start-Up Loss means that the material loss caused at the initial stage of production launching, namely the loss caused during the period from start-up of production to stabilized production stage. Its frequency depends on several factors such as unstable machining conditions, poor maintenance and operator skills

Start-Up loss can also occur after a poor set-up or conversion, after overhauling equipment subject to their Preventive Maintenance Schedule. It takes sometime for a machine to stabilize.

Start-up loss is difficult to identify. Their scope includes the stability of processing conditions, workers skills and training, loss incurred by test operations and other factors. A thorough understanding of why this type of loss occurs can be addressed through RCM2 or Reliability-Centered Maintenance. RCM term this failure as infant mortality failure.

4.6 Defect and Rework Loss

This is the loss caused when defects are found and the product has to be reworked. In general, these defects are likely to be considered as a waste which should be disposed of but since even the reworked products need wasted manpower to repair them. Included on this type of loss are products being shipped back due to customer complaints? Products are returned and reworked in the production area.

Quality Defects and rework losses are caused by malfunctioning production equipment. In general, sporadic defects are easily corrected. Chronic defects require a thorough investigation and innovative remedial action. The conditions surrounding and causing the defect must be determined and then effectively controlled. Tools such as P-M Analysis is suitable in dealing with chronic problems, it aims at reducing defects to zero, however, P-M Analysis must only be used after extensive use of conventional tools had been used and around 1 to 5 % of the problems still exists, this is where P-M Analysis must be used ideally. Sporadic defects are easy to solve and it is more difficult to solve chronic defects.

Although other TPM books includes 8 Major Equipment Losses, the other two losses mentioned are shutdown loss which means stopping the equipment for periodical or Time-Based Maintenance and Cutting blade change which is loss caused by line stoppage for replacing grinding wheel, cutter, bits which might be broken or worn out after excessive usage.

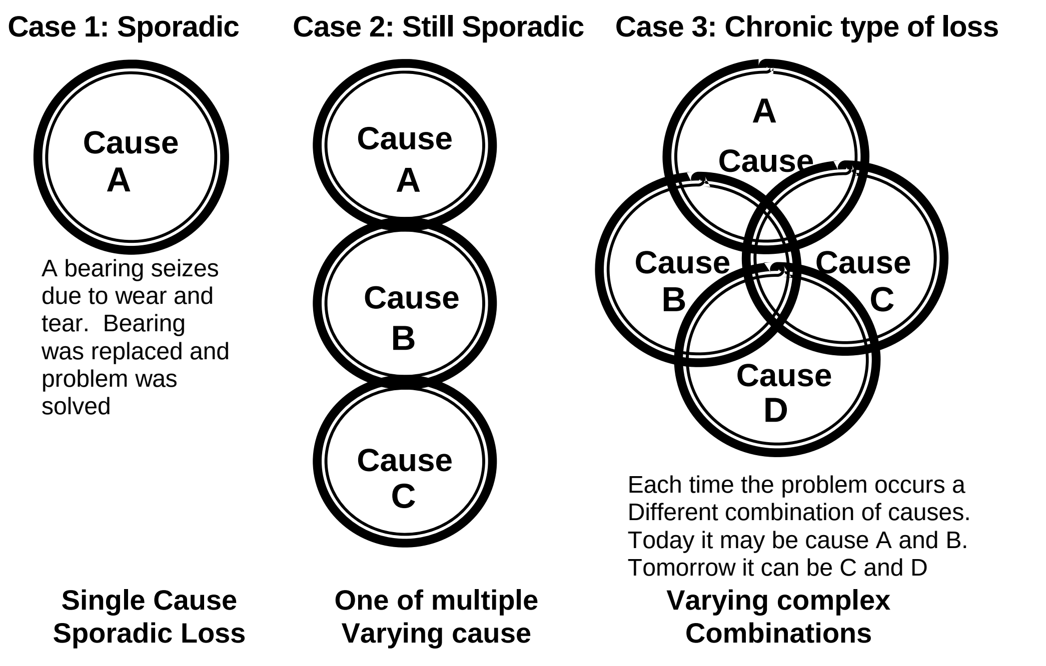


Figure 9: Sporadic and Chronic Loss

Responsibility for Each Loss

Type of Loss	Responsible	Indices / Measurement to Use
1. Breakdown Loss	Maintenance People	BDO and MTBF
2. Set-Up Loss	Cross Functional Team	Improvement in Set-Up Time, MTTS
3. Minor Stoppages	Major - Cross Functional Team	MTBA and Frequency of Assist Minor - Operators
4. Design Speed Loss	Cross Functional Team	No. of Output Produced
5. Start-Up Loss	Maintenance People	Downtime Loss due to Start-Up
6. Defects and Reworks	Cross Functional Team	Yield in percentage

5. Overall Equipment Effectiveness:

The main indices or measurement which can be use to track the improvement of equipment is know as the OEE or Overall Equipment Effectiveness, however, for separate focused on improving each losses, I have detailed on the above a table for the most appropriate measurement of indices in improving each type of losses. A cross functional team is a Focused Improvement Team composing of engineers, Quality People, Maintenance Experts, Production Supervisors and Operator teaming up to solve these losses. Team must compose of people with enough knowledge on the function and process of the equipment being involved, as a person who does not have enough understanding even on the basic equipment condition may not contribute to the problem they are solving. The goal is to determine which type of losses most of your equipment suffers, set-up the team to improve on them and replicate these improvements on equipment's with similar problems operating under the same conditions. Note: While it must also be studied whether the improvement must be done where marketability of the products is still in demand, equipment will still be used for a number of years, decision as to whether improvements should be replicated on similar machines under low loading, and other factors as modification, changes and improvement on equipments will cost and entail company's money.

OEE = Availability x Performance Rate x Quality Rate x 100 %

- Availability = improving availability will improve the number of breakdowns, reduce time to set-up
- Performance Rate = will improve Minor Stoppages and Design Speed loss
- Quality Rate = will improve defects and rework and start-up loss

OEE is the primary measure of performance in TPM. Calculating a true and meaningful measure is extremely important to any improvement process. Equally important is the visibility and communication of the measure to the people who can impact it the most. The higher OEE, the better the equipment is in terms of availability, performance rate and quality rate. For single product equipment computing OEE is simple, however for equipments processing two or more products, ideal cycle time for each product together with the time each product was process must be known. This is the safest and most accurate way to get the true OEE for that particular equipment rather than averaging. Target to achieve 85 % OEE on your equipment, isolate which losses contribute most and set-up Focused Improvement team to work.

Some companies attempt to calculate an overall division or corporate OEE numbers. Generation of these numbers requires a method similar to that of the weighted average methodology. Individual plant OEE numbers can be weighted by the relative value added by each plant. These numbers can be used by corporate management as both economic and equipment performance measures as well as a means to measure the effective use of the company's capital assets. In OEE each loss is attacked separately to find and correct the root cause resulting in permanent fixes to equipment losses. All plant personnel understood the importance of the measures and took visible pride in how they had improved them by addressing equipment issues in their equipments.

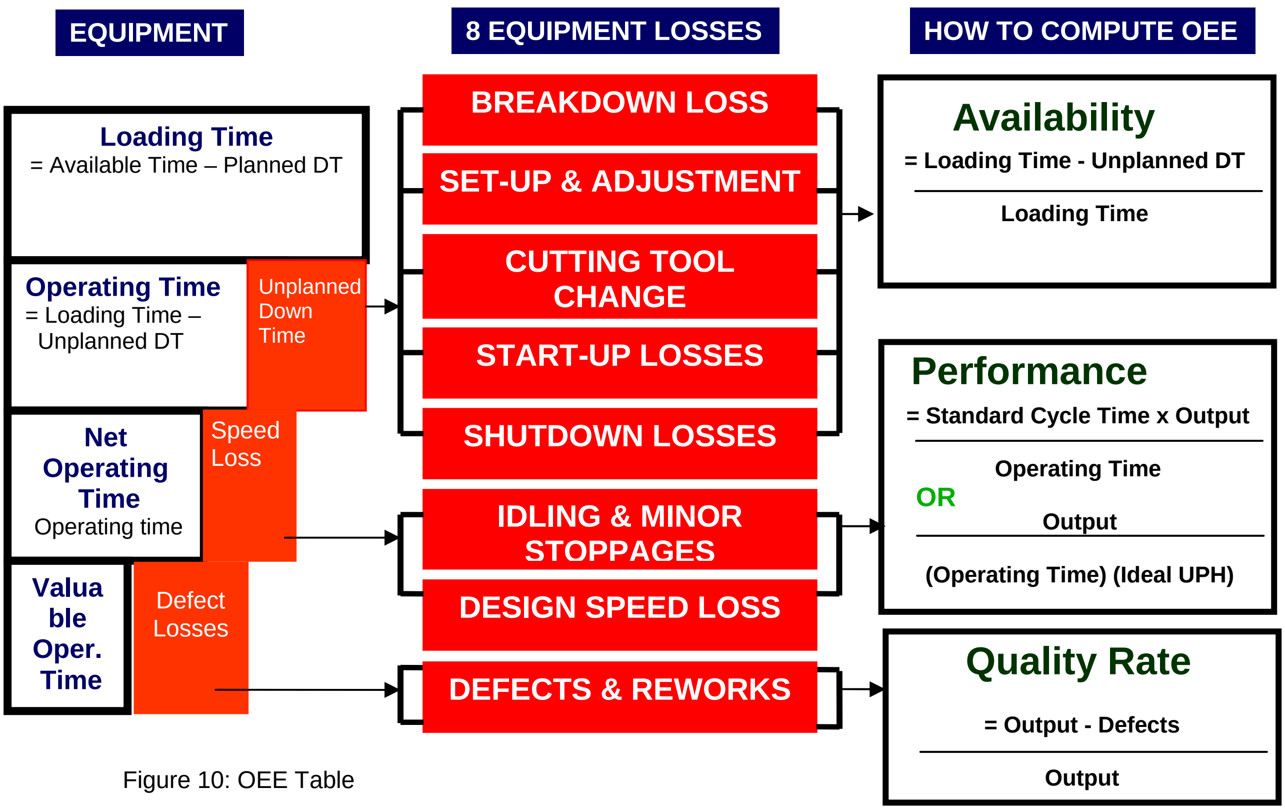


Figure 10: OEE Table

OEE is the most effective measure for driving plant improvement. It continually focuses the plant on the concept of zero waste. When used effectively, its power is awesome. Just the calculation and display of the measure can help drive performance improvement without any other action taken by management. People want to provide value in their job and will focus on what is perceived to be improvement. We are what we measure, if we measure what is important then our efforts will be rewarded.

6. TPM 12 Developmental Steps:

Plants and industries initiating a TPM Development program will need to follow a cookbook format on how to implement it. There are three stages which are the preparation, implementation and stabilization stage. This 12 developmental stage of TPM is consistent with the process originally outlined by Seiichi Nakajima, although its order had been change slightly to fit western style organization. This is typically how TPM in plants should be implemented.

Step 1: Top Management Formally Announce To Implement TPM

President / Plant Manager must make a written announcement to support TPM. Members of the Top Management organization must demonstrate their support for the official announcement of TPM Management preparedness also needs to answer typical questions in the implementation. If possible, union officers must participate also in the announcement or to highly endorse the program. It is critical for Management to clearly specify that TPM is being implemented not to reduce headcount or add burden to operators but a way of solving complex internal problems so it can stay competitively and tough and ride on heavy storms. Although the formal announcement of management intent to embark TPM seems a simple task, but it must be positioned and structured correctly for maximum impact on the organization. Employees recognize the significance of the event only if management delivers a clear consistent message.

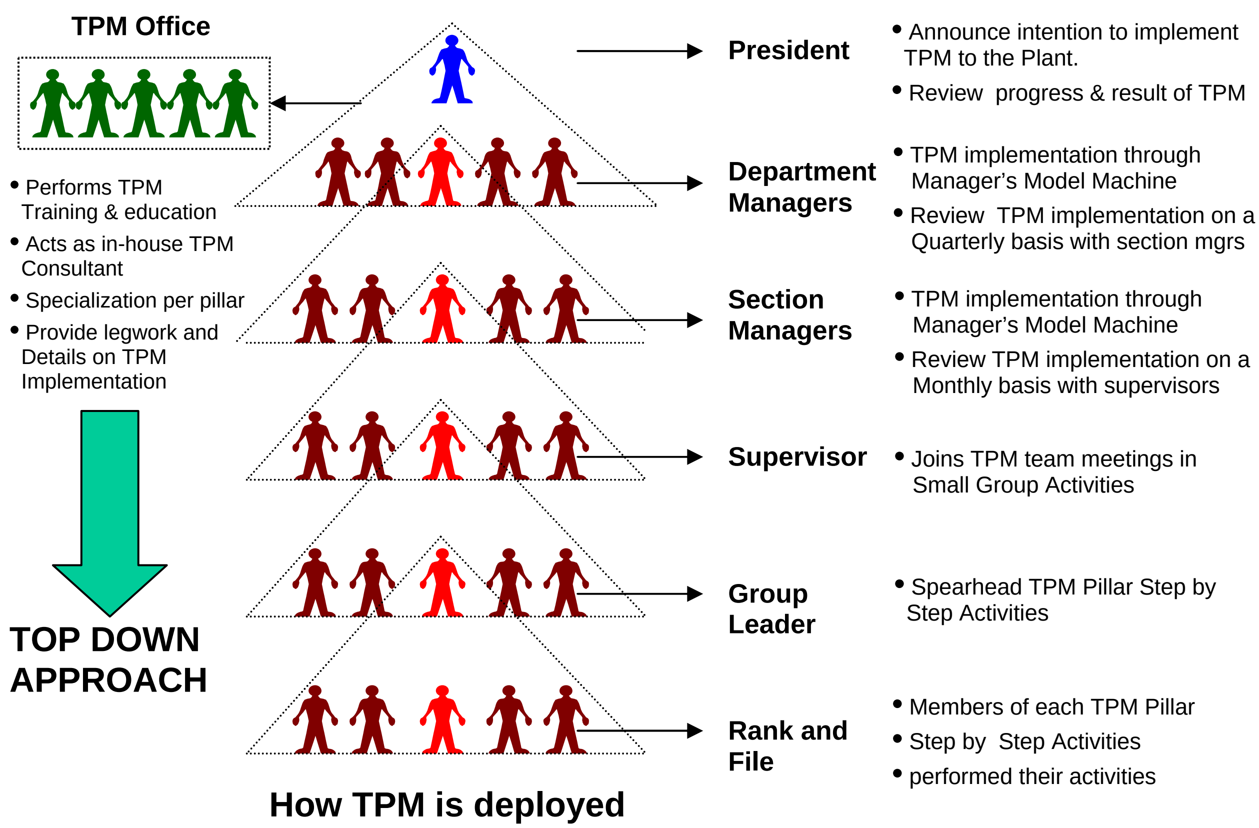


Figure 11: TPM Deployment Plan

Step 2: Top Management Formally Announce To Implement TPM

Objective of initial TPM education is to establish a general awareness throughout the plant and to build support for its concept and implementation. Let the employees understand TPM and the challenges they will be facing in its implementation process. A combination of methods should be employed to educate the organization about TPM. Many training or consulting companies offer general seminars and training on TPM. These sessions normally are offered to the general public at the organizations plant for in-house training. The purpose of the introductory training is for the people to understand what TPM is all about. These first seminars need only be introductory in nature since the objective at this point is to generate an awareness of TPM and its value. Opportunities should be taken, however, to define how potential benefits to the company might accrue and how people could be directly impacted. Books may be offered to supplement the workshops but should not be the only source of education. TPM videotapes are also available and can be especially effective if a trained moderator is available to lead a discussion on TPM.

Although only appropriate for small groups, interplant visits are exciting way to introduce personnel; to TPM seeing the activities successfully installed on the plant floor can help sway even the most cynical. Not all employees will be able to share directly in the experience due to time and cost considerations so care should be taken in selecting respected and credible individuals who can accurately report their impressions of the visit. The objective of initial TPM education is to establish a general awareness throughout the plant of the process and to build support for its concepts. To that end, candidates for education should be drawn carefully from all functions and levels of the organization including workers and union leaders.

Step 3: Create A TPM Promotional Organization:

TPM is promoted through a structure of overlapping small groups, in this system leaders of small groups at each organization level are members of small groups at the next higher level. Top management itself also constitutes a small group. This system is extremely effective for deploying top management policy and goals throughout the organization. Establish a TPM promotion office responsible for developing and promoting effective TPM promotion strategies. To be effective, the office should be run by a permanent, full time staff, assisted by various TPM activities on track, spearheading focused campaigns, disseminating information and arranging publicity. The TPM promotion office plays an especially important role in managing the implementation of all pillars most especially autonomous maintenance, focused improvement and planned maintenance. Here are partial lists of activities to be performed by the TPM Staff:

- Summarizing the activities of all teams and provides update report to the TPM Core Group
- Guide the team in their TPM Journey and implementation
- Coordinate all training requirements needed by the team
- Provide echo training together with the TPM Office
- Follow up all logistical support needed by his team
- Follow up the teams on their progress specially those with delays
- Highlight teams with exceptional performance and those with valued concerns
- Attend meetings conducted by the TPM Office and TPM Core Group
- Strategize fan-out or replication together with their respective teams
- Schedule the teams audit with the certified pool of auditors
- Provide weekly updates of TPM implementation in his respective pillar
- Provide all the necessary communication with the TPM Site Office

Step 4: Established Basic TPM Policy and Goals:

A company’s basic TPM policy must be an integral part of its overall business policy and should indicate the goals and directions of the activities to be carried out. TPM goals should relate to the company’s long and mid range business goals and should only be decided after thorough consultation among everyone involved, including top management. The TPM program lasts for the length of time required to attain these goals and objectives. Express goals numerically as far as possible. To set goals, start by establishing clear baseline. These should provide a snapshot of the existing condition and expressed quantitatively and partly qualitatively. Setting a goal means aiming for a desirable level of attainment above a particular baseline. Deciding how far above the baseline to set the goal is always the most difficult question. Goals should be challenging. The TPM promotional office staff should begin by establishing basic policies and goals and should be aligned with the overall company goals of the plant. Since it takes at least three years to move toward eliminating defects and breakdowns through TPM, one basic management policy should be committed to TPM and incorporate concrete TPM development procedures into the medium to long range management plant. Although company mottos and slogans are often simply displayed on the walls, concrete basic policies and annual goals of management must be adhered to. Although policies may consist of abstract written or verbal statements, the goals should be quantifiable and precise, specifying the target, quantity and time frame. For example, a basic management policy might be: To reduce losses by eliminating breakdowns, defects and accidents while enhancing the profitability of the company and creating a favorable working environment for all employees. In this statement, the goals of management are clear and succinct and the basic policy can be expressed in concrete figures as quantitative goals.

Step 5: Formulate A TPM Master Plan for Deployment:

The next responsibility of the TPM promotional headquarters is to establish a Master Plan for TPM development. The daily schedule for promotion of TPM beginning with the preparation stage before implementation must be included. Below is an example of a TPM Master plan where TPM development centered on the 8 major pillars of TPM and its timeframe of implementation. To formulate a master plan for implementation, first decide what activities must be pursued to achieve the TPM goals. This is an important step because it makes people think about the most efficient ways of bridging the gaps between baseline and goals. The TPM master plan must include the 8 core pillars of TPM which are as follows:

Figure 11: TPM Master Plan

TPM MASTER PLAN				Preparatory				Implementation Stage								Stabilization			
Item		Details of Activities		2002				2003				2004				2005			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1		Top Management Formally Announce TPM	Plan	■															
			Actual																
2		TPM Introductory Education and promotional campaign	Plan	■	■	■													
			Actual																
3		Creation of TPM Promotional Organization and Office	Plan	■	■														
			Actual																
4		Established Basic TPM Policy and alignment of goals	Plan		■														
			Actual																
5		TPM Master Plan of Completion	Plan			■													
			Actual																
6		TPM Kick-Off	Plan				■												
			Actual																
7		Maximize Production Effectiveness																	
	7.1	Implement Focused Improvement (Kobetsu-Kaizen Pillar)	Plan					10 cases	20 cases	30 cases	40 cases	50 cases	60 cases	61 cases	62 cases	63 cases	64 cases	65 cases	66 cases
			Actual																
	7.2	Implement Autonomous Maintenance	Plan					Step 1			Step 2 - 3			Step 3- 4			Step 5 - 7		
			Actual																
	7.3	Implement Planned Maintenance	Plan			Phase 0		Phase 1			Phase 2			Phase 3			Phase 4		
			Actual																
	7.4	Training Skills and Education	Plan			Planning		Step 1			Step 2 - 3			Step 3- 4			Step 6		
			Actual																
8		System for Initial Flow Control Activities (Early Equipment Management)	Plan								Step 1 - 2			Step 3 - 4			Step 5		
			Actual																
9		System for Quality Maintenance Aim for Zero-Defects	Plan								Step 1 - 2			Step 3 - 4			Step 5 ➡		
			Actual																
10		Administrative/Office TPM	Plan					Step 1			Step 2 - 3			Step 3- 4			Step 5 - 7		
			Actual																
11		Establish Effective EHS System Aim for Zero Accidents, Zero Pollution	Plan								Step 1 - 2			Step 3 - 4			Step 5 ➡		
			Actual																
12		Challenge the TPM Excellence Awards 2nd Category	Plan																■
			Actual																

Step 6: Hold TPM Kick-Off:

The TPM Kick-off is the first step in the implementation process, the beginning of the battle against the major equipment losses as the different pillars of TPM are preparing themselves to launch their initial TPM activities. During the preparatory stage (Steps 1 to 5), management and professional staff play the dominant role. From that point on, however, the individual workers must move away from their traditional daily work routines and begin to practice TPM. Each worker now plays a crucial role. As someone once said that there is no room for sitting in TPM meaning that every person is a participant and there are no onlookers. For this reason, every worker must support top management TPM policy through activities to eliminate the 6 major equipment losses. The kick-off should help to cultivate an atmosphere that increases worker morale and dedication. In Japan, this often takes the form of a meeting for all employees. Frequently, representatives of client companies as well as affiliates and sub-contractors are also invited. At the meeting, top manager's report on the plans developed and work accomplished during the preparation phase such as the TPM promotional structure, the TPM basic policy and goals and the master plan for TPM Development. Then a representative of the workers affirms their commitment to achieve the goals and challenge the PM Prize.

Step 7: Fundamental TPM Development Activities:

Companies must select and implement activities that will achieve the goals of TPM effectively and efficiently. Although different companies may choose slightly different activities, the pillars described below are the most common. They have been shown to yield excellent results when properly pursued and they are the foundation and support of any successful TPM Development Program.

Step 7.1: Initiate Focused Improvement:

Focused Improvement is an improvement activity performed by a cross functional project teams composed of people such as production engineers, maintenance personnel and operators. These activities are designed to minimize targeted losses that have been carefully measured and evaluated. In addition to the equipment losses experience in fabrication, manufacturing and assembly industries there are also other losses to consider such as people related losses such as work and wrong operation, raw material losses such as yield, unit consumption and recycling losses and management losses and energy losses. The goal of Focused Improvement pillar is to eliminate these losses and improve the equipment's Overall Equipment Effectiveness measure and achieve a rating of 85% or more...

The trend toward unattended operation is well advance in process industries and will probably be taken even further into the future. For these reason ideas for stabilizing processes and eliminating equipment breakdowns, idling and minor stops are also important topics for Focused Improvement. When the focus is strictly on equipment, project teams follow a systematic approach as discussed on the pillar of Focused Improvement. They document and analyze the major equipment related losses, then study the equipment carefully to identify the process conditions it is required to provide and ensure that it can fulfill them. Whether the focus is on the process, work flow, equipment or operating procedures, however, focused improvement activity is founded on effective use of cause analysis methods such as PM Analysis, Root Cause Failure Analysis, Fault Tree and other analytical tools and methods.

Step 7.2: Deploy Autonomous Maintenance:

Autonomous Maintenance detailed in the TPM pillars is one of the most distinctive activities of TPM. After preventive Maintenance was introduced into Japan from America, operation and maintenance were formally separated. As of operators lost ownership of their equipment, they gradually lost their sense of responsibility for maintaining it. The Autonomous Maintenance practice in TPM reverses this tendency. Operators become involved in routine maintenance and improvement activities that halt accelerated deterioration, control contamination and help prevent equipment problems. Because process plants employ a small number of operators in relation to the number and size of equipment units, strategies for achieving autonomous maintenance goals must be adapted somewhat from the traditional approach followed in fabrication and assembly industries. When tailoring autonomous maintenance to individual process environments, planning teams must consider how autonomous maintenance steps can be conducted effectively on different types of equipment.

Autonomous Maintenance activities are typically implemented in 7 steps and are only effective if the progression from one step to the next is strictly controlled. To manage this, appoint official auditing groups and lay down the standards. A plant's top management should give the final approval for groups to graduate and move from one step and on to the next step.

Step 7.3: Implement Planned Maintenance:

Planned Maintenance embraces three forms of maintenance, breakdown, preventive and predictive. Like other TPM activities, building a planned maintenance system should be done systematically one step at a time. The purpose of performing predictive and preventive maintenance is to eliminate breakdowns, but even when systematic maintenance practices are carried out, unexpected failures still occurs. Such failures reveal inadequacies in the timing and content of maintenance plans and highlight ineffective recurrence prevention measures. In TPM, planned maintenance activities emphasize monitoring MTBF (Mean Time Between Failures) and using that analysis to specify the intervals for tasks in annual, monthly and weekly maintenance calendars.

A classic example of planned maintenance activity is shutdown maintenance. To make them more effective companies are preparing for shutdown earlier and earlier. Their goal is to lay out reliable plans before the job begins. Because the tasks performed during shutdown maintenance follow a set pattern, it is helpful to base the work plan on a Work Breakdown Structure (WBS) diagram. This diagram facilitates accurate estimation of the tasks to be performed during shutdown maintenance along with their sizes. It can be used to gauge the staff and materials needed for the job and to monitor the budget and the achievement of the objectives of their overall efforts.

Step 7.4: Training and Education:

A company's workforce is a priceless asset and all companies must train their employees systematically. Industry workers are becoming scarcer, increasingly elite and more multi-skilled, so training must be an integral part of a career development program. Visualize the type of people you want your training programs to produce. In other words, identify the specific knowledge, skills and management abilities you want them to have and then design training that will achieve this vision. Training must also be tailored to serve the individual needs. Assess each person to measure his or her gap of the required knowledge and skills and pinpoint weaknesses, then use the results to make the general training more effective. Workers and their supervisors should discuss the results of this assessment annually and use them to set the next year's target and plant the next phase. Also set firm schedules for achieving program targets. Decide the kind of people you want to have in how many years time, then draw up comprehensive plans for on the job and off the job training including seminars designed to achieve this.

Step 8: Early Equipment Management:

This includes both product management and early equipment management. The purpose of this activity is to achieve quickly and economically products that are easy to produce and equipment that is easy to use. Early equipment management concerns equipment users, engineering companies and equipment manufacturer and address areas of equipment investment planning, process design, equipment design, fabrication and construction, test operation and startup activities.

All activities from the initial design of a piece of equipment to its installation and test operation can be viewed as a single giant project. The project starts with process design, basic plant design and detailed design and unfolds to include procurement, fabrication, and construction and test operation. In planning such a project, the project team determines the plant and equipment's required technical levels together with its ability level then established budgets and schedules to achieve them. In designing a plant, various designs are performed, functional design, reliability and maintainable design, safety design and economy design. Establishing maintenance prevention specifications and performing MP design in particular help assure that the plant and equipment are reliable and easily maintained. Several design reviews should be performed in the course of designing, fabricating and constructing a plant. After completing these activities, teams install the equipment, perform test operation and initiate the startup management phase. Start up management is an activity designed to achieve as quickly as possible the condition for its own termination, which is conditions that enable the plant to start producing stable quality product with zero failures. In TPM this efficient approach to stable, full-scale production is known as the vertical start-up of activities.

Step 9: Quality Maintenance:

Quality Maintenance (QM) is a method for building in quality and preventing defects through the process and through the equipment. In quality maintenance, variability in a product quality characteristic is controlled by controlling the condition of equipment components that affect it. Quality characteristics are mainly influenced by the four production inputs: equipment, materials, people's actions (skills), and methods used. The first step in quality maintenance is to clarify the relationships between these factors and a product's quality characteristics by analyzing quality defects. In process industries, the effect of equipment on quality characteristics is particularly important. In process industries, the process determines the type of equipment needed. Therefore, teams should focus first on process, then on the equipment. In other words, first clarify the relationships between product quality and process conditions and ascertains the precise process conditions required for producing perfect product. Equipment is a means of implementing a process. Therefore, applying a QM approach in equipment design, teams begin by identifying the components that will affect the product's quality characteristics. These are called "quality components". Next, they pinpoint the quality component conditions required to maintain the quality characteristics. Quality maintenance used in this way assures quality at the very beginning of the production process.

Step 10: TPM in Administrative and Support Departments:

Administrative and support departments play an important role in backing up production activities. The quality and timeliness of the information supplied by administrative and support departments have a major impact on these activities. TPM activities performed by administrative and support departments must not only support TPM in the workplace; they should also strengthen the functions of the departments themselves by improving their own organization and culture. Compared with production, however, it is not as easy for administrative and support departments to measure the effects of their activities. A TPM program in such a department must aim to create an "information factory" and apply process analysis to streamline the information flow. Think of administrative and support departments as process plants whose principal tasks are to collect, process, and distribute information. This understanding makes it easier to promote and measure autonomous maintenance, focused improvement, and other TPM activities in an office environment

Autonomous maintenance in administrative departments aims for efficient, trouble-free work execution from two angles: administrative function and administrative environment. Implemented step by step, the first set of activities reduce costs and boost efficiency by improving administrative processes. The second set of activities removes obstacles to effective work hidden in the physical and psychological environment. Focused improvement of administrative tasks aims to improve their efficiency and speed and reduce the number of staff required. To achieve this, automate office tasks and install electronic data-processing systems such as local-area networks. At the same time, increase administrative efficiency to support the planning and decision-making of executives and managers.

Step 11: Safety and Environmental Management:

Assuring safety and preventing adverse environmental impacts are important issues in process industries. Operatability studies combined with accident prevention training and near-miss analysis are effective ways of addressing these concerns. Safety is promoted systematically as part of TPM activities. As with all TPM activities, safety activities are implemented step by step.

Certain issues are of particular importance in the process environment. For example, it is particularly important to incorporate fail-safe mechanisms---that is, to design equipment that will remain safe even when people do not take the proper precautions. Assuring safety during shutdown maintenance is also important. In process industries, shutdown maintenance requires considerable assistance from outside subcontractors, as do operations such as cleaning. This makes it doubly important to ensure safety during such operations. Check the skills and qualifications of subcontract workers well in advance whenever possible. Take every practicable step to assure safety, including giving rigorous safety training and carefully supervising the work itself.

Step 12: Sustaining TPM Implementation and Raising Levels

There are several keys to maintaining TPM levels once they are achieved. Building strong teams at every level and staffing a promotion organization helps integrate TPM in daily work, for example. Following the systematic, step-by-step approach recommended for TPM activities helps lock in results. Emphasizing a continuous-improvement approach through the PDCA cycle, continually revising goals upward, and setting new challenges, like the PM Special Prize, are also helpful. None of these approaches will be effective without the support of careful, continuous, and concrete measurement. Start with clear baselines and document improvement results regularly and in detail. Use management indicators that show everyone (at every level) what concrete progress is being made and motivate their continued involvement.

7. TPM Case Studies:

Below are just a few company's who have started a TPM program and had reaped its rewards. These are their actual experience in their journey towards TPM excellence.

7.1 DuPont

DuPont, one of the premier chemical companies, has mostly continuous process plants manufacturing hydrocarbon-based chemicals, plastics, fibers and petroleum products. It is established worldwide with plants on almost every continent. DuPont is widely recognized for its outstanding safety record as well as its vigorous approach to benchmarking.

As a result of studying outside companies, DuPont learned of the TPM process before most other North American companies. The company organized an internal staff function, the Corporate Maintenance Leadership Team (CMLT), and gave it the responsibility for helping plants improve their equipment management function. The CMLT participated in a 1987 "Best of the Best" benchmark study of maintenance practices of European and Japanese companies. The result of the benchmark concluded that the U.S. based plants had:

- Had higher maintenance cost
- Made less use of contactors and had less support staff
- Had much higher levels of maintenance spare parts

DuPont as a corporation decided that maintenance needed to be viewed strategically in order for it to support overall corporate goals. Years before DuPont made a similar commitment to safety. The results dramatically helped DuPont gain notoriety as one of the world's safest companies. The DuPont Cape Fear, North Carolina plant holds the record for the longest stretch of employee hours worked without a lost time accident.

Part of DuPont's new strategic view of maintenance included the development of a vision of success and the establishment of a process to achieve that vision. The vision and process were developed by the CMLT with input from the plants. The improvement process drew heavily from the TPM process and the team's maintenance benchmarking results. DuPont uses a measure they call Uptime which tracks all sources of loss in production, much like OEE. The company also has established an internal award system that recognizes excellence in equipment management. The Award is called Maintenance Excellence Recognition Award (MERA).

Although DuPont has made tremendous progress and recognized corporate savings in excess of $ 200 million per year, management recognized that the company is just beginning to understand the potential benefits of TPM. The primary efforts to date have been focused on efficient maintenance and repair and in the future will emphasize eliminating failures and other forms of waste in their plant.

7.2 Magnavox

Magnavox knows firsthand the rigors of Japanese competition. Twenty years ago it was a major player in the consumer electronics industry making radios and television. Unsuccessful in defending its market share in that field, it turned to a business less subject to foreign competition, the defense industry. Unfortunately, its entry coincided with the government's slashing of the defense budget and Magnavox had to fight for a share of a shrinking market. Its survival depends on delivering quality parts to the government at lower prices than its competition.

TPM is not voluntary at Magnavox as management considers it a key to future success. Small group activities have pushed decision making authority down to the lowest levels of the organization where teams have adopted nicknames such as "Fuzzy Wooziest" or the "Stack Maniacs". Each phase of the TPM process has promoted a theme. For example, the initial cleaning activity was called Operation Clean Sweep. TPM has been embraced as on of the keys to survival

7.3 Texas Instruments

Texas Instruments (TI) makes electrical components, microchips and assemblies as well as specialty metals and motor controls. Its managers first learned of the TPM process in 1986. Forced to compete head to head with the Japanese in many areas, TI continually studies Japanese manufacturing techniques and philosophies.

TPM is seen by TI as a potential answer to some unique maintenance situations. In the microchip production process, many operations take place in a clean room controlled atmosphere environment. Access to the clean rooms is limited sources of contamination to the sensitive processes. Autonomous Maintenance is seen as a method of lowering the total number of entries into the clean room by allowing the production operators to perform many routine maintenance procedures. TI has empowered a corporate staff with the responsibility for promoting TPM in each of their plants. The responsibility of the corporate group is to prepare generic processes, disseminate information, educate and train personnel and coordinate the total corporate TPM effect. Significant changes took place as TI implemented TPM

- Modifications were made to the plant infrastructure
- Identified shortcoming in operator training led to the development of detailed training program
- The unavailability of information for analyzing equipment performance necessitated the purchase & implementation of a CMMS system
- The need for better quality of spare parts led to a decision to make certain parts in house
- The need to better control parts led to the establishment of a decentralized spare parts system

Despite heavy emphasis on these activities TI reports that it is still several years away from full implementation at the plants within the Materials and Controls group. Acceptance of the TPM process within TI operations management is mixed. TI found it necessary to report quantitative results from pilot areas in an attempt to get management on board. Operations management also has been allowed to change the process to meet particular needs of the areas or plant. This ability to customize the process has increased feelings of ownership. Results from the TPM process at the TI pilot have been impressive and report includes that:

- Equipment productivity has improved by 50 to 80%
- Spare part cost are reduced by 20 to 30%
- Maintenance breakdown labor decrease by 67%
- Lead times have been cut by 50 to 75%
- On time deliveries have increased from 50 to 95%

TI Reports the following lessons learned.

- Both technical (hard) and team building training (soft) were critical to the TPM process
- The change to a decentralized area based organizational structure reduce bureaucracy far more than was expected
- In analyzing and documenting maintenance tasks that were to be turned over to production operators, changes in procedures were made that greatly improved safety, quality & productivity.
- Managers became interested in TPM after they were exposed to quantifiable results
- Maintenance engineering started the TPM process and played a leadership role until implementation of the new decentralized infrastructure. Then production management stepped in to lead the process

8. PITFALLS OF TPM

Spending at least 7 years as a TPM Senior Engineer in one of the biggest semiconductor industries in our country provided me some insight and indebt understanding as to why TPM (Total Productive Maintenance) is not easy as you think to implement. Many books had been published on TPM with industries reaping its rewards and having a dramatic increase in their productivity, decrease in defects and breakdowns and not to mention the reduction in their operating and maintenance cost, but on the other side, many industries initiating a TPM journey in their plant had miserably failed and abandoned the process completely. I truly believe in the TPM process without a doubt, but TPM can only be successful if you know how to implement it correctly. Hence, before embarking on initiating a TPM Strategy, take note of the following because if these factors are not taken seriously, then all TPM efforts are doomed to fail in your industry. Therefore, for those plants initiating a TPM strategy in your plant these pitfalls must be understood. Many industries who implement TPM failed for different reasons, remember that TPM is not about adapting to the Japanese culture but rather finding out what works and do not work in your plant. These pitfalls should be carefully examined by plants implementing TPM and should not be taken lightly.

1st: TPM is a Top-Down Approach

TPM is a Top-down approach and never a Down-up approach. TPM should be initiated by the high-est. member of the company which is a CEO, General Manager or President. As noted from TPM's Twelve Developmental Steps, a formal announcement from Top should help get your TPM started.

2nd: TPM requires an Office and not a Facilitator

TPM requires a full time staff and not a part time facilitator. Assigning one person to handle TPM would surely lead you to its doomsday and downfall. As to how many people will be staffed in the TPM Office will depend upon the size of the plant. Just to give you an idea, the plant I've worked for have around 8,000 employees, and 8 of us belong to the TPM Office and each one of us directly reports to the TPM Manager, I was assigned to carry on the pillar of Planned Maintenance and Early Equipment Management. TPM Office will provide the details and legwork on how each of the pillar is being implemented, initial audits and certifications per step and phase, training on their respective pillars, team recognition and most importantly consolidating the work of every single pillar. Remember TPM requires everybody's involvement and all employees of the plant will have a specific pillar to attend to.

3rd: TPM is a long term approach not short term

Operations and maintenance want everything fast; therefore they result to quick fix solution in which eventually causes problems to resurface again in the near future. Management must understand that TPM is a long term and not a short term approach. Benefits will be realized first on a small scale which will eventually and gradually be felt on other areas of the plant. There is no short cut to this process. TPM is being implemented on a Step by Step approach.

4rth: TPM will require a Budget

The most difficult part in the TPM implementation would be the Preparatory Stage or Start-up. As most management are sensitive to the issue on cost. TPM is costly in the initial stages of implementation and believe me when I tell you. Some of the expenses in the initial TPM stages will include training and educating all employees on TPM and their respective pillars. Initial cleaning for Autonomous Maintenance in which the teams try to correct abnormalities in their equipment. Restoration activities for Planned Maintenance since the aim of TPM will be to bring back the equipment as close as possible to its original basic condition.

5th: TPM and company goals must be aligned

This is one of the most important aspects of any TPM implementation that is mostly overlooked. Both TPM and Company goals must be aligned, it cannot be different. Otherwise TPM will be seen as a separate activity and not as a plant directive. This will include the indices and KPI's which is tracked down to view the company's progress. OEE or Overall Equipment Effectiveness should be part of the company's primary measures.

6th: TPM is heavy on documentation

What is being done should be documented in the TPM process. Documents should be placed on

Activity Boards and not on binders and folders so that everyone not yet involved in the TPM journey can see the benefits and results of TPM implementation. The activity boards should be updated regularly by the team involved in the TPM activity.

7th: Managers Model Machine for Managers

Managers must be involved and must have their share of responsibility in the TPM Process and most especially they should be part of a team. This will be an initial requirement for any industry aiming for TPM Certification and therefore essential to the success of any TPM implementation. Part of their role is to see to it that their pillar is moving and advancing to the next step. Remember that each TPM pillar is performed on a step by step approach and there are not shortcuts to it.

8th: AM must be done in parallel with PM

Although Autonomous Maintenance (AM) would be the largest pillar in terms of population on the number of people involved, Planned Maintenance (PM) should be and must be the strongest pillar in any TPM implementation. The equipment is always a shared responsibility for both operations and maintenance together. One of Planned Maintenance utmost responsibility will be to educate the operators on their equipment, as operators learn to accept some minor responsibilities in their equipments such as doing the basics which are maintaining the equipment clean, proper lubrication and tightening of bolts, these things can only be appreciated by operators with the aid of Planned Maintenance as their mentors. If Planned Maintenance Structure is weak so will be its Autonomous Maintenance. Planned Maintenance should serve as the Autonomous Maintenance coaches and mentors in their equipments. On the other side, maintenance can only advance to other maintenance activities and get out from the reactive mode of firefighting if Autonomous Maintenance will take part in their shared responsibility on their equipment.

9th: Management Commitment and not Support

Management can support and never commit to any TPM activities. In TPM what we need are Managers who can provide commitment and be part of the process. This is a very important lesson in TPM. These two words are entirely different “Support and Commitment”. Remember that TPM must be done not as a separate activity but rather management must realize that their day to day activities must be part of the TPM process. TPM is not a once a week meeting or activity but rather a continuous process.

10th: TPM is all about people and not machines

Most industries that implement TPM think that it is all about improving equipment yet little regard is being provided in educating its workforce. Many say that people are the company’s greatest asset; I hate to disagree with this statement because I think that the right people are a company’s greatest asset. And how can we have the right people? Only if they are equipped with the right knowledge to perform their jobs correctly. People will improve their equipments and it’s not the other way around. Hence, people must continuously be educated and their knowledge upgraded.

11th: OEE is the impact of all TPM Pillars combined

Having a high OEE is not a product of only one pillar but rather is the consolidated effort of all pillars involved. Improving OEE means improving the six major equipment losses and all pillars will have their corresponding role in improving them. Below are the six major equipment losses and the pillar that will impact these most such as Breakdown Losses by Planned Maintenance, Set-up, Adjustment and Conversion by Focused Improvement and Planned Maintenance Pillar / Start-Up Losses by Planned Maintenance and Early Equipment Management (Initial Flow Control Activities) / Idling and Minor Stoppages (chokotei) by Autonomous Maintenance, Focused Improvement and Planned Maintenance / Design Speed Loss by Focused Improvement Pillar / Defects and Rework Loss by Focused Improvement and Quality Maintenance Pillar

12th: TPM is not culture bound

Although TPM originated from the east "Japanese", it will work on any industry since it is not bounded by culture and beliefs. Japanese have a certain way of doing things, and what is important is not to imitate them but rather to be flexible and transparent in adopting TPM to your own culture.

9. Lessons on TPM:

TPM once carried out according to the 12 developmental steps would yield significant results and lessons can be shared and learned from it. Results from TPM will come after 2 years or more of implementation. Remember that TPM is never an overnight affair and will take time to yield results. Also that TPM is all about people, a lesson that we all must realize and that only the right people will improve their equipment and it's not the other way around. All people from the plant from the Top down to the shop floor people will have their role to undertake in TPM. Results motivate people and provide pride in their workplace. Rewards and recognition is essential to sustain enthusiasm among the teams implementing TPM most specially Autonomous Maintenance, Planned Maintenance and Focused Improvement. These pillars will work together as teams in order to realize an improvement in their OEE indices. Here are some basic lessons on TPM that we should reflect for a while:

TPM Lesson 1:

Most failures start from small things that had been left unattended and neglected, TPM emphasizes the importance of establishing Basic Equipment Condition on their machines. Basic Equipment Condition includes cleaning, lubrication and completing bolts needed for the machine.

TPM Lesson 2:

Implementing TPM is a Top-Down Approach and cannot be a Down-Up Approach. Both company and TPM goals must be align in order for TPM to be successful. The company's President or CEO must make a formal announcement that TPM will be adopted.

TPM Lesson 3:

Performing TPM requires a change in direction, a change in the way people think about their assets, a change in the way people act, unless these changes are accepted by all levels of organization and are willing to perform the necessary steps required for such a change to take place then only can we realize the difference between success and failure in any TPM undertaking.

TPM Lesson 4:

Companies that achieve results in their TPM journey usually challenge the JIPM Awards to attain certification. There are around 100 criteria that must be satisfied and mostly the reason for attaining JIPM certification is to provide an edge in their business competition.

TPM Lesson 5:

Although all pillars are important in TPM, the strongest pillar must be Planned Maintenance as these are the people who will educate and coach Autonomous Maintenance. Although AM is the larger force, PM must be equipped w/ the right training and tools to coach operators

TPM Lesson 6:

The pillars that will bring the most impact will be Focused Improvement, Planned Maintenance and Autonomous Maintenance, however, the rest of the pillars will also be important and will support these 3 major TPM Pillars specially Training & Education

TPM Lesson 7:

When the goals of the company and TPM are not aligned TPM will always be considered a separate program. The best way to internalize TPM and make it a way of life for the company is if all improvement initiatives of a company must be in the umbrella of TPM and not TPM under the umbrella of any said program. Focus on one continuous improvement strategy and get the most out of it than having so much improvement strategies in your plant such as lean, six sigma, RCM and in the end only confuse their people as to which strategy should be prioritized.

TPM Lesson 8:

TPM is a journey, in the book "TPM World Congress" around 3,000 companies have started their TPM journey and only 10% have achieved the results, although there are a variety of reasons for the failure. Management commitment is the number one reason why TPM fails, a lesson that must be learned at the beginning of any TPM initiative.

TPM Lesson 9:

Do not imitate the Japanese, as Deming quotes companies expect miracles and are looking forward for a silver bullet that will make things happen, it simply does not exits, the American Management thinks they just can copy from Japanese but the problem is they do not know what to copy. Adopt TPM in a way that best fits the culture of your company.

TPM Lesson 10:

TPM is not a maintenance program alone but a plant wide process involving everyone from the top to the bottom. With TPM, maintenance takes the mind set that preventing failures is more important than repairing them.

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