Implementation of Synchronized Manufacturing System in Producion

Akash Chourey¹, Mukesh Dubey²
¹M.E. (Production Engineering), Department of Mechanical Engineering, Bhilai institute of Technology Durg, INDIA
²Associate Professor, Department of Mechanical Engineering, Bhilai institute of Technology Durg, INDIA

ABSTRACT
Planning and plan and product designing. What so ever is the present from of work, definitively a improved one from past, and to have a possibility of change to get a improved one, this process is going on and remain till the existence of man and hence work.“Synchronized Manufacturing System” is one of the most versatile systems in the present scenario. 3M, Kanban, S', TQM, TPM, Single Piece Flow. SMS is the combination of above stated systems. For understanding SMS, we must go through what is called “Conventional Manufacturing System”. The traditional system of production used to follow process based production.

Due to Equipment Efficiency:-
- Failure loss
- Setup / Adjustment loss
- Cutting blade loss
- Start up loss
- Minor stoppage loss
- Defect / Rework loss

Due to Human Work Efficiency
- Management loss
- Motion loss
- Line organization loss
- Failing of automatics
- Measuring and adjustment loss

Due to production Resources:-
- Yield loss
- Energy loss
- Die jig and tool loss

Amongst all these losses basically six big losses are considered:-
- Breakdowns
- Setups and adjustments
- Reduced speed
- Minor stoppages
- Defects and reworks
- Start up loss

We came across the major types of losses that the industry faces. Research and development work carried out in this field has led to the evolution of maintenance practice for minimizing these losses. Here the word “MAINTENANCE(1)” is concerned with the activities required to keep the facility in a built conditions and prolong its utility, with minimum cost.

I. INTRODUCTION

DEFINITION OF QUALITY: QUALITY IS EASILY THE MOST IMPORTANT FACTORS OF ANY PRODUCT, TO MAINTAIN QUALITY; AN ERROR FREE, SMOOTH WORKING PRODUCT IS A MUST. SO WE SEE IT IS OF FOREMOST IMPORTANCE TO REMOVE FACTORS CONTRIBUTING TOWARDS LOSSES AND DEGRADING QUALITY. GENERALLY THREE ARE MANY TYPES OF LOSSES. FEW OF THEM ARE LISTED BELOW:-

Due to Equipment Efficiency:-
- Failure loss
- Setup / Adjustment loss
- Cutting blade loss
- Start up loss
- Minor stoppage loss
- Defect / Rework loss

Due to Human Work Efficiency
- Management loss
- Motion loss
- Line organization loss
- Failing of automatics
- Measuring and adjustment loss

Due to production Resources:-
- Yield loss
- Energy loss
- Die jig and tool loss

Amongst all these losses basically six big losses are considered:-
- Breakdowns
- Setups and adjustments
- Reduced speed
- Minor stoppages
- Defects and reworks
- Start up loss

We came across the major types of losses that the industry faces. Research and development work carried out in this field has led to the evolution of maintenance practice for minimizing these losses. Here the word “MAINTENANCE(1)” is concerned with the activities required to keep the facility in a built conditions and prolong its utility, with minimum cost.
OBJECTIVES OF MAINTENANCE:
- Achieve stable operation by elimination equipment failure
- Prevent equipment failure by productive maintenance
- Increase mean time between failure
- Reduce mean time to repair
- Reduce maintenance cost
- Establish efficient equipment management system
- Development of advanced maintenance management techniques

ACTIVITIES OF MAINTENANCE
- Restore deterioration
- Improve equipment to lengthen maintenance interval
- Equipment condition monitoring
  a) Vibration monitoring
  b) Lubricants monitoring
- Establish on-line maintenance methods
- Introduction of corrective maintenance activity
- Introduction of computerized maintenance system

An Efficient Planned Maintenance program, combines Time based Maintenance; Condition based Maintenance & Breakdown Maintenance as rationally as possible. So we see there are typically four maintenance methods.

1. Preventive maintenance
2. Breakdown maintenance
3. Corrective maintenance
4. Productive maintenance

PREVENTIVE MAINTENANCE
Preventive maintenance maintains the equipment’s healthy conditions. It prevents deterioration by carrying out routine maintenance, periodic inspection, equipment diagnosis and repair to restore equipment condition.

It is classified in following types:
1. Periodic maintenance: time based maintenance (TPM)
2. Predictive maintenance
3. Condition-based maintenance (CBM)
4. Over haul: inspection and repair (IR)

Periodic Maintenance: Time based Maintenance (TPM)
The repair period (theoretical and empirical values) is set based on parameters (production volume, pieces or number of operating days) most proportional to deterioration of equipment (productivity, number of repair etc) repair is executed unconditionally if the end of the period is reached

Predictive Maintenance
Monitor and analyze the deterioration data regularly and constantly repair. If deterioration parameter reaches a pre determined critical value, inspection is carried out to examine the state of deterioration and to carry out repair based on inspection results.

Condition based Management (CBM)

Equipment deterioration is recognized on an online basis on various measurement data and their analysis and repair is carried out when the deterioration value reaches the preset deterioration standards.

Overhaul: Inspection and Repair
Equipment is regularly disassembled or inspected and excellence is judged at that time (no control of deterioration trend is executed) with defective parts replaced subsequently.

BREAKDOWN MAINTENANCE
The method of carrying out maintenance after the occurrence of breakdown to be applied to the following cases:
- Cases in which breakdown maintenance is advantageous i.e. effects and losses of breakdown are small.
- Dispersion of deteriorating trends is so great the inspection and examination is impossible.

CORRECTIVE MAINTENANCE
The method of maintenance in which steps for extension of service life and cost reduction are taken to applied to the following:
- Cases of short services life, high failure frequency and substantial maintenance expenses.
- Case of line repair time, serious affects on other and high maintenance cost.
- Cases of great dispersion of deterioration trend and difficulties in inspection and examination.

PRODUCTIVE MAINTENANCE
When breakdown and defects in machine are eliminated equipment operation rates improve, cost reduced and production rose automatically and as a consequence, labors and material productivity improves. Such maintenance is called productive maintenance.

PROBLEMS IN MAINTENANCE
- Level of skill of workers is low
- Major equipment available for maintenance only during refractory maintenance stoppages.
- Poor availability of electrical power in terms pf voltage and frequency. Thus affecting the life of the equipment.
- Difficulty in changing the attitude and work culture because of specific job description.

INDIA being a developing nation is coming up with new ideas, technologies, big brains and working hands, which are changing the image of the currently running industries. We are swinging up with the inherited ideas of the west counting are days as a single step-up each towards development.

Eicher Motors is one such example, which fits fully with the picture of developing India. The new technologies and development moves one step after the other. Eicher motors after is establishment in 1982 at Pithanpur proves to be an increment to the Indian Economy. This increment seems to be growing with years with the support and hard work of a very flexible management ready to accept and
implement thoughtfully, everything, which adds to the company. One such example of a flexible manager’s bench is the recent implementation of a Managerial philosophy “TOTAL PRODUCTIVE MAINTENANCE(2)”. It’s been nearly two years with the company tooling with TPM and it is still at a phase of ‘implementing TPM’. Eicher has worked up with two of the eight pillars of TPM i.e.

- Individual Improvement
- Autonomous maintenance

Eicher Motors at Pithampur is an assembly unit rather than a manufacturing unit but still, the final finishing of some assembled parts, welding, painting etc. are done at Eicher. These are some basic frame lines of the company which actually the unit has installed the technology TPM and where the relate results could be very easily studied.

The Eicher machine Shop is a unit, which is having a gradual, noticeable & profitable change since the year of establishment. This is the unit responsible to refine the powerhouse of an Eicher LCV, MCV or HCV or the latest designed busses i.e. the engine block & the engine head casting, which are brought here from the DCM foundary Chennai. The complete machining of these cylinder heads and blocks are done in this unit to prepare the engine for the next assembling and power-transmitting unit. Initially machine shop had lathes, then gradually with the growing production these lathes were replaced by the CNC’s, ATC’s, APC’s, etc. These machines made the worker’s job easier, more precise, reduced lead-time, production time, defect rate & finally increased the production of the machine shop.

Since last year i.e. with the implementation of TPM(3) the machine shop is undergoing further alterations. The complete shop layout is modified. Instead of a random machine arrangement, the shop has two main bay and two platforms. One bay handles the cylinder heads and the other handles the cylinder blocks. The two platforms carry out the buffing and other precise machining operations on the other parts and sub-assemblies.

The two bays consists of the CMC’s but now, the CNC’s are also replaced by a further advanced Japanese technology machine known as MAZAK MACHINES. This is a heavy investment in the machine shop but with the idea of increasing the production to more than twice the existing capacity and capability. Each MAZAK machine costs near about 2.5 crores & the unit currently owns 8 such machines. One MAZAK replace 2 CNC, MAZAK has approximately doubles the unit’s production from 1200 pieces per month to 2000 pieces per month. MAZAK has even reduced the lead-time and increased the production and profit. A comparison between the MAZAK machine and CNC machine is tabulated as under:-

<table>
<thead>
<tr>
<th>CNC MACHINE</th>
<th>MAZAK MACHINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two CNC machine work as one</td>
<td>One MAZAK replace two CNC’s MAZAK</td>
</tr>
<tr>
<td>CNC takes to see per operation</td>
<td>MAZAK takes 2 see per operation</td>
</tr>
<tr>
<td>It stores as much as 2-3 programs</td>
<td>Can stores as many program as required</td>
</tr>
<tr>
<td>One CNC employees more than one worker</td>
<td>One MAZAK employees only one worker</td>
</tr>
<tr>
<td>Works on old CNC programming</td>
<td>Works on new technology i.e. AUTOCAD</td>
</tr>
<tr>
<td>Operations are complicated</td>
<td>Operation are more systematized and easy</td>
</tr>
<tr>
<td>Production with CNC was 1200 pieces per month</td>
<td>Production with MAZAK is 2000 pieces per month</td>
</tr>
<tr>
<td>Cutting time same as Mazak</td>
<td>Cutting time same as CNC</td>
</tr>
<tr>
<td>More non-cutting time</td>
<td>Reduced non-cutting time by 40%</td>
</tr>
<tr>
<td>Low productivity</td>
<td>Increased productivity by 33%</td>
</tr>
</tbody>
</table>

Even after such heavy investment, big machines and a new technology a company cannot flourish if:
- Its working ways are not proper & streamlined
- The machines aren't cleaned
- The machines are not oiled and maintained properly
- The workers don't love their work & machines and don't treat them well

But the best part is that Eicher carries all these responsibilities with elegance. Its workers know :-
- How to love his work and do it at his best
- How to maintain his working area and his working machine, &
- How to do his job on time
So, here is where the first pillar of TPM comes in picture – “INDIVIDUAL IMPROVEMENT(4)”. Each worker or employee is dedicated to Eicher. They are trained for new technologies and new, working methodologies to be more efficient in less time. The whole process very gradually comes in action without hurting any mind or heart. Every Mazak just requires one worker but still Eicher has never sacked even a single worker. It has provided a total job security & a caring atmosphere for both the workers and his family. There are local health houses, entertainment days relaxing period. Hence, it is well proved that the first pillar “Individual Improvement” is very well implemented and adopted at Eicher Motors Pithampur.

A commendable point was house keeping of the complete shop. With such a heavy and continuous working there wasn’t,

- any spot of grease on the floor
- no split oil anywhere
- machine were clean, inspite being working
- no loose metal chip here or there
- clean machine surfaces of blocks and head

This means that not only ‘Individual Improvement’ but even the second most important pillar of TPM was under a successful plan of implementation and that is- “A UTONOMOUS MAINTENANCE”. Every machining needs a proper maintenance process and with the maintenance, safety of every worker is equally important. Eicher Motors gives every possible training for such maintenance and safety precautions. Now it becomes the company’s responsibility to take care or the workers safety as well. Workers are being trained but some unseen mishaps do brings a sudden wave of concern.

II. NEW MANTRAS OF WORLD CLASS MANUFACTURING (5)

_The 5’S_'

1. **Proper Arrangement (Seiri)**
   - Sort through and then sort out,
   - Sort through what you have, identify what you need, and discard what is unnecessary,
   - Saving of time and saving of place

2. **Orderliness (Seiton)**
   - Set things in order,
   - Assign a separate location for all essential items
   - Make the space self explanatory so everyone knows what goes where,
   - Simplify, means to neatly arrange and identify parts and tools for ease of use.
   - Less difficulty in getting the things
   - Lesser useless purchases

3. **Cleanliness (Seiso)**
   - Clean equipment, tools, and workplace,
   - Keep the workplace spotless at all times.
   - A clean environment at work place.

   ✓ Clean machine and lesser maintenance

4. **Standardize (Seiketsu)**
   - Maintain equipment and tools,
   - Keep the workplace clean.

5. **Discipline (Shitsuke)**
   - Stick to the first four rules scrupulously,
   - Make them a habit.

III. TOTAL PRODUCRIVE MAINTENANCE (TPM)

Total Productive Maintenance (TPM) is an initiative for optimizing the effectiveness of manufacturing equipment. TPM is team-based productive maintenance and involves every level and function in the organization, from top executives to the shop floor. The goal of TPM is “profitable PM.”

**Kaizen**

It refers to efficient utilization of worker, equipment and materials through, gradual, orderly and continuous improvement in the process or procedures etc. the bases of these activities are to enhance and demonstrate the technological and analytical power of worker. TPM analysis is being used as a tool in order to obtain effective solution to chronic problems. The 15 major losses are classified as follows:

I Fig Total Productive Maintenance for Kaizen

- Failure or breakdown losses,
- Measurement loss.
- Minor stoppage losses,
- Cutting toll loss,
- Reduced speed loss,
- Management loss,
- Quality defects and reworks loss,
- Startup loss,
- Adjustment step loss,
- Line organization loss,
- Operating motion loss,
- Energy loss,
- Logistic loss,
- Die and jog loss,
- Yield loss,

IV. TOTAL QUALITY MANAGEMENT

In TQM, we are considering “one present improvement in thousand things rather than thousand percent improvements in one thing”. In short, we are considering the improvement of quality in each functional aspects of company i.e we expect quality of finance,
quality of humane behavior, quality of administration, etc. TQM(7) is a complete “bottom up” management philosophy.

**TOTAL**

Everyone in each function of the company is responsible for the quality of the output.

**QUALITY**

Conformance to agreed customer requirements. Quality is not relative high or low. It conforms to the requirements if it is a quality product.

**MANAGEMENT**

Like any other business strategy it is management led and seeking a strong bottom up involvement.

Kanban(8)

Kanban carries the information for production control. They are frequently tags or pieces of paper.

I. The subsequent process goes to the former process to get parts,

II. The former process produces the quantity removed by the subsequent process.

III. Quality is built into the product. Defects are never sent to the subsequent process.

IV. Kanban always accompany products on the line thus ensuring through visual control.

V. Production quantities are level to avoid fluctuations and eliminate wastes.

VI. Reducing the number of Kanban increases their sensitivity and reveals places where process improvements are needed. This is inventory control.

V. CELLULAR MANUFACTURING

Cellular Manufacturing is an application of Group Technology in which dissimilar machines or processes has been aggregated into cells, each of which is dedicated to the production of the part or product family or a limited group of families. The typical objectives in cellular manufacturing are:

- To shorten manufacturing lead times, by reducing setup, work part handling, rating times and batch sizes.
- To reduce work in process inventory smaller batch sizes and shorter lead times reduce work in process.
- To improve quality. This is accomplished by allowing each cell to specialize in producing a smaller no. of different parts. This reduces process variations.
- To simplify production scheduling. The similarity among parts in the family reduces the complexities of production scheduling. Instead of scheduling parts through a sequence of machines in a process type shop layout, the parts are simply scheduled through the cell.
- To reduce setup times. This is accomplished by using group tooling (cutting tools, jigs and fixtures) that has been designed to process that part family, rather than part tooing, which is designed for an individual part. This reduces the no. of individual tools required as well as the time to change the tooling between the parts.

**CYCLE TIME OR PULSE RATE**

- “Cycle Time(14)” is the time is takes to carry one part all the way through the cell. As we know that the raw material has to go through different operation un-till, we get the final product. Therefore, the time consumed during this operation is the “Cycle Time or Pulse Rate”.
- How to Calculate “Cycle Time”.
- Daily Quantity = Monthly Quantity Needed / Working Days perm Month

1. STATEMENT OF PROBLEM

Management is all about learning. Things are not mellifluous all the times. Especially when we talk about productivity in this highly competitive environment we need to be constantly updated about the new methods and new techniques of production. Since need is the mother of all the inventions and need of humans is never satisfied.

Now during production each and every machine contributes to the process of production. Each and every worker also plays an important role in productivity. But still the efficiency of any plant i.e. number of effective product coming out restrained by some factor may be man or machine.

This may also results from improper location or positioning of machining this restrains the number of product coming out of any machine or plant and this situation is known as bottleneck and the operation is known as bottleneck operation. In this project too the bottleneck operation was the prime concern and it was to be found out in machine shop of KBL. The target with proper standards after implementation of SMS was 200 units but only 154 units could be brought to compromise upon which 123 units are produced daily.

2. ANALYSIS OF THE PROBLEM

The problem of bottlenecking needs prime attention. This situation can be traced by one of the many prevalent methods of industrial engineering. The method we adopted here to trace the product cycle over each machine tool using “Time Study Technique (stop watch technique)”. Measuring the time with a stopwatch, taken by the operator to perform each element of the operation. Either continuous method or snap back method of timing could be used.

Time study has been defined by British Standard Institution as “The application of technique designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance(9)”. This is absolutely essential for both the planning and control of operations. Without the measurement data, we cannot determine the capacity of facilities or it is not possible to quote delivery dates or costs. We are not in position to determine labour utilization and efficiency. Here a
Steps in making time study:
1. Select the work to be studied
2. Obtain and record all the information available about the job, operator, working conditions is likely to affect the work condition.
3. Break down the operation in the element an element is a distinct part of a specified activity composed of one or more fundamental motion, selected for convenience of observation and timing.
4. Measure the time by means of stop watch taken by the operator to perform each elements of the operation at the same time assess the operator effective speed of work relative to the operators concept of normal speed this is called performance rating.
5. Adjust the observed time by rating factor to obtain normal time for each element.
   Normal time = (observed time * rating) / 100
6. Add the suitable allowances to compensate for fatigue, personal need, contingencies to give standard time for each element.
7. Compute allowed time for entire job by adding element standard time considering frequency of occurrence of each element.
8. Make a detailed job description describing the method for which the standard time is established.
9. Test and review standard are necessary.

Equations

3. WORK PROGRESS SCHEDULE

Behind every successful organization exorbitant management ethics is involved. To implement such ethics and techniques class managers and co-operative co-workers and subordinates too are integral.

Management is not always all about learning only but at time is also about implementing Thus, effective management has always enticed us as budding engineers and one such philosophy is SMS, which needs special attention. Now SMS as our project was no easy job and required some adroit follower of it. So, our acumen paved its path in the following manner-

WEEK –1 Exhaustive search was carried out on SMS and its elements such as Kanban, JIT, Kaizen, TQM etc. and we were frenzied to know all of them.

WEEK –2 Study was carried out by taking each subject and their principles into account and pillars of such management techniques were jotted down.

Week –3 Each and every process has its own way to handle situations in any organization. So every module can only be understood but not covered in details thus we were drawing limits and boundaries against the search and study.

WEEK –4 We understood how SMS can really change the productivity The change in layout could bring such a substantial hike was really an enigma getting solved.

WEEK – 5 We also understood that for better analysis an expert follower of SMS was to be found out soon from the market. Now one such beneficiary was Kirloskar Limited, Dewas. But semester exams delayed the good work.

After our exams we needed to move immediately to KBL, Dewas and collecting statistics as well as studying layout and bottleneck was of prime concern.

FINAL WEEK-

It was the climax nearing and we need to study the industry as per the philosophy of SMS. After much toil and labour we were able to find the bottleneck operation and recommended few words against the present layout. Time Study really helped us a lot in concluding our project and thus it was a moment to be exulted.

VI. ANALYSIS OF SINGLE PHASE CENTRIFUGE PUMP CELL AT KBLE

A number of quantitative techniques(13) have been developed to deal with problem areas in cellular manufacturing. The analysis is carried out under two steps.

- Grouping parts and machines into families
- Arranging machines in a cell.

Now as far our problem is concerned we are going to suggest an innovative method of grouping produce and their machines in the single phase centrifuge pump cell of KBL, Dewas, in order to obtain even much better product flow. Foremost we need to understand the basics of problem forming and thereby the following theory would assist us to solve the enigma.

VII. PRODUCT FLOW ANALYSIS

This is an approach to part family identification and machine cell.

Formation that was pioneered by J.Burbridge. Production Flow Analysis (PFA)(10) is a method for identifying part families and associated machines grouping that uses the information contained on production route sheets rather than on part drawing. Work parts with identical or similar routings classified into part families. These families can than be used to form logical machine cells in a Group Technology Layout. The procedure in PFA must begin by defining the scope of study, which means deciding on the population of the parts to be analyzed. Should all of the parts in the shop be included in the study or should a representative sample be selected for
an analysis? Once this decision is made then the procedure in PFA consists of the following steps-

DATA COLLECTION

The minimum data needed in the analysis are the part no and operation sequence which is contained in the shop documents called “Route Sheets” or “operation Sheets”. Each Operation is usually associated with a particular machine so determining the operation sequence also determines the machine sequence.

SORTATION OF PROCESS ROUTING

In this step the parts arranged into groups according to the similarity of their process routing. To facilitate this step all operations or machines included in the shop are reduced to code numbers. A sortation procedure is then used to arrange parts into PACKS(12), which are group of parts with identical routing. Some packs may contain only one part number indicating uniqueness of the processing of that part.

PFA CHART

The processes used for each pack are then displayed in a PFA Chart. This Chart is a tabulation of the process or machine code numbers for all the part packs by Moody (Refer 2). In recent GT literature the PFA Chart have been referred to as Part Machine Incidence Matrix, the entries have a value $X_{ij} = 1$ or $0$. A value of $X_{ij} = 1$ indicates that the corresponding part I requires processing on machine j and $X_{ij} = 0$ indicates that no processing component I is accomplished on machine.

CLUSTER ANALYSIS

From the pattern of the data in PFA Chart related grouping are identified and rearranged into a new pattern that brings together packs with similar machine sequence.

QUANTITATIVE ANALYSIS IN CELLULAR MANUFACTURING

The problem addressed here is to determine how machine in an existing plant should be grouped into machine cells. The problem is the same whether the cells virtual or formal. It is basically a problem of identifying part families. By identifying part families the machines required in the cells to produce the part families can be properly selected.

THE RANK ORDER CLUSTERING TECHNIQUE

First proposed by King(11) is specifically applicable in production flow analysis. It is an efficient and easy to use algorithm for grouping machines into cells. Rank ordering clustering works by reducing the part machine incidence matrix to set of diagonalized blocks that represent part families and associated machine groups. Starting with the initial part machine incidence matrix, the algorithm consist of following steps-

1. In each row of the matrix read the series of 1’s and 0’s from left to right as a binary number. Rank the rows into order of decreasing values. In case of tie rank the row in the same order a they appear in the current matrix.
2. Numbering from top to bottom is the current order of rows the same as the rank order determined in the previous step? If YES GO TO STEP 7 if no go to the following steps-
3. Re order the rows in the part machine incidence matrix by listing them in a decreasing rank order starting from the top.
4. In each column the matrix read the series of 1’s and 0’s from top to bottom as a binary number. Rank the columns into order of decreasing values. In case of the rank the row in the same order as they appear in the current matrix.
5. Numbering from left to right in the current order of columns the same as the rank order determined in the previous step. If YES GO TO STEP 7 if no go to the following step-
6. Re order the column in the part machine incidence matrix by listing them in a decreasing rank order starting with the left column GOTO step 1.
7. STOP

VII.   SOLUTION TO THE PROBLEM

Let us thereby start the solution by getting into the very first step of analysis- Grouping parts and machines into families. The machines involved and product components are abbreviated as –

<table>
<thead>
<tr>
<th>Machines Involved</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LATHE M/C</td>
<td>L</td>
</tr>
<tr>
<td>COLD PRESS M/C</td>
<td>CP</td>
</tr>
<tr>
<td>CNC</td>
<td>C</td>
</tr>
<tr>
<td>DRILL M/C</td>
<td>D</td>
</tr>
<tr>
<td>GRINDING M/C</td>
<td>G</td>
</tr>
<tr>
<td>THREAD ROLLING</td>
<td>TH</td>
</tr>
<tr>
<td>SLOTTING</td>
<td>SL</td>
</tr>
</tbody>
</table>
VIII. RESULTS & CONCLUSIONS

In this era of globalization it is not easy for any company to sustain and make profit since competition among different companies as well as among their products is increasing consistently. So there is a need to adopt a modern philosophy. During our project we found that implementation of SMS brings about wonderful changes in productivity, waste management, work management and last but not the least in inventory management too. Labour and different resources are also efficiently managed and ultimately reduce the cost of production. Hence to make a company consistently competent and demanding in market. SMS can do miracle for any company.

Changes in production procedure are continuous and in our industrial observation and study at KBL, Dewas we found scope of changes, which could put some profit in companies pocket are jotted below-

√ Implementing SMS was worker friendly and reduced frequent breakdowns.
√ Inventory built up between two machines or processes was reduced.
√ The hazardous situation of smoke and spillage of oil as well as heat from conventional Shrink Fitting of bearings was replaced by the new Cold Press Fitting Operation.
√ Ownership feeling of workers over their machines was admirable concept by SMS.
√ Team work to obtain group incentives instead of individual ones was another excellent move.
√ Work place was so designed that there was chair in place of bench which implies that only required amount of rest or allowances are acceptable otherwise the person would have even which would again make him lazy.
√ Cleanliness was really improved and noticeable.

Implementation of the above discussed management ethics displays the following excellent improvements:

Figure: Time vs. various points

The reduced number of the breakdowns during the past 3-years with the help of TPM is represented as under:
Breakdowns nos.

**IX. DISCUSSION & SCOPE FOR FUTURE WORK**

The following graphical results depicts the summary of what we analyzed at Kirloskar Brother Limited, Dewas-

In the entire machine shop the rotor and shaft sub-cell consumes the maximum cycle time excluding the assembly line. Since assembly line is an automated time bound operation therefore it has the minimum margin of alteration. Thus, it is concluded that rotor and shaft sub-cell need the prime attention.

![Graph](image)

Component of cycle time on single-phase cell-I

Taking feedback from the above conclusion, Shaft and Rotor sub cell clearly shows that the grinding m/c involved the maximum cycle time of the product. This also indicates the amount of inventory built at grinding which is not at all desirable. The remedy may be an implementation of some new technology m/c.
REFERENCES


Figure: Component of cycle time at several stations on a shaft & rotor