ANALYSIS AND IMPROVEMENT OF OVERALL EQUIPMENT EFFECTIVENESS IN AUTOMATIC FETTLING MACHINE

V.Manojkumar[1],Dr.R.Kesavan[2], S.Kalyanakumar[3],

[1&2] Dept. of Prod. Tech., MIT Campus, Anna University, Chennai, 600044, India.

[3] Aarupadaiveedu Institute of Technology, Vinayaka Missions University, Kancheepuram – 631504.India.

Abstract—

The OEE tool gives the ability to measure the machines for productivity improvements. OEE not only measures inefficiencies but groups them into three categories which are availability, performance and quality to help analyze the machine and have a better understanding of the manufacturing process. This study intended to apply overall equipment effectiveness (OEE) as a performance measurement tool to measure the effectiveness and performance of the automatic fettling machines in a foundry plant. Apart from this, the study employed to conduct the analysis part of the study where data have been computed to provide information for decision making. The primary findings of this study were the possible factors that dominantly affect the equipment effectiveness in the machine. These findings were used to serve as a guideline to improve the OEE for the selected machines. Ultimately, it was recommended that the Foundry plant employs OEE as their primary performance measurement tool.In this project, the OEE level was analyzed and found out that Availability and Performance level of the machine is very low, which lower the OEE Levels.

I. INTRODUCTION

Overall Equipment Effectiveness (OEE) is a way to monitor and improve the efficiency of your manufacturing process. Developed in the mid 1990's, OEE has become an accepted management tool to measure and evaluate plant floor productivity. OEE is broken down into three measuring metrics of availability, performance, and quality.

These metrics help gauge your plant's efficiency and effectiveness and categorize these key productivity losses that occur within the manufacturing process. OEE empowers manufacturing companies to improve their processes and in turn ensure quality, consistency, and productivity measured at the bottom line.

OEE = Availability x Performance x Quality

II. ABOUT MACHINE: MAUS SAM 500

SAM stands for "Scabatulla Automatica Machine" which means fettling automatic machines. It consists of two cells.

i. NC GRINDING CELL

ii. ROBOTIC GRINDING CELL

NC Grinding Cell

In NC grinding cell, machine does standard four face grinding (Head face, Sump face, Front End & Rear End). Component is placed on the fixture mounted on the rotary turn table. Each component has separate fixture arrangement.

Robotic Grinding Cell

The robotic grinding cell. In this cell, machine does grinding work on cope and drag box side. Component is placed on the fixture mounted on the rotary turn table. It ground projection of riser pins, ingates. It also ground flashes in bearing cap area and engine bore area. This cell has two robots take up grinding simultaneously on the casting. The robot can pick up the required tools from the Automatic tool changer (ATC). Its fixture is universal, but need to adjust the clamping column according to the end 2 end bore distance of each component.

III. REWIEW OF LITERATURE

Anand Relkar et al (2012) discussed continuous availability of reliable sophisticated equipment with precision is need of the competitive market. Overall equipment effectiveness (OEE) is important performance measure metric for equipment effectiveness. An attempt

has been done to measure and analyze existing overall equipment effectiveness of critical machinery producing important automobile components like serration cap, Dowel rod and sequence rod.

Chandrajit Ahire et al (2012) discussed that to compete in global market, no organization will tolerate losses. Overall Equipment Effectiveness (OEE) is such a performance measure metric which will indicate performance rate with very simple calculations. It considers all important measures of productivity. Implicitly it indicates amount of losses each parameter contributes to reduce productivity. By applying quality improvement tool such as Failure Mode and Effect Analysis (FMEA) root cause of any OEE measure can be found out.

Nazim Baluch et al (2012) discussed that today maintenance is considered as a strategic and integral part of the business process and it is an established fact that "It creates additional value." As the understanding of the strategic importance of maintenance has risen, so too has, the efforts to control, measure, and better manage this function. Performance Management and measurement is important because it identifies current performance gaps between current and desired performance and provide indication of progress towards closing the gaps.

IV. METHODOLOGY

Addressing and Minimizing the Major Loss Events of OEE

Breaking OEE data up into the three metrics helps monitor and analyze the data.If it can improve OEE numbers it will improve machine's productivity. Listed below are the six Major Loss Events outlined on the previous page that affect OEE and steps to help reduce these events to increase your overall machine's productivity. The overall goal of the Simple OEE tool is to reduce or eliminate these Major Loss Events.

TIME STUDY

Time study is a direct and continuous observation of a task, using a timekeeping device (e.g., decimal minute stopwatch, computer-assisted electronic stopwatch, and videotape camera) to record the time taken to accomplish a task and it is often used when

a. There are repetitive work cycles of short to long duration,
b. Wide variety of dissimilar work is performed, or
c. Process control elements constitute a part of the cycle.

Direct Time Study Procedure

Following is the procedure developed by Mikell Groover for a direct time study

i. Apply an allowance to the normal time to compute the standard time. The allowance factors that are Define and document the standard method.
ii. Divide the task into work elements.
iii. These first two steps are conducted prior to the actual timing. They familiarize the analyst with the task and allow the analyst to attempt to improve the work procedure before defining the standard time.
iv. Time the work elements to obtain the observed time for the task.
v. Evaluate the worker's pace relative to standard performance (performance rating), to determine the normal time.
vi. Note that steps 3 and 4 are accomplished simultaneously. During these steps, several different work cycles are timed, and each cycle performance is rated independently. Finally, the values collected at these steps are averaged to get the normalized time need in the work are then added to compute the standard time for the task.

V. PROBLEM SOLVING PROCEDURES

i. Analysis of the current situation. This includes data collection and various forms of documentation completed based on the work area to be improved. Use forms for data collection to quantify stock levels, measure and draw all transport routes taken,
ii. Measuring and describing all activities and motions. Creation of a flow chart showing the process in detail is also recommended.

iii. Display the analysis of the current situation. Create and display an overview of the data and documentation obtained Defining possible issues, solutions. Use the flow chart and other documentation to analyze the process at each workstation, marking value-added and non value-added activities, differentiating between cyclic and non-cyclic activities, grouping value-added and non value-added activities in each case. Reassemble the revised process and test it out. Draw the new layout and describe the sequence of activities, including a revised and updated flow chart. Check to see if the plan is realistic, workable.

iv. Display the agreed solutions. Create an overall view for all to see and further analyze, making any final changes for improvement.

VI. STANDARDIZING

Standardizing a method requires that we choose out of many methods, assessing the best one, refining and using it. It means nothing if not standardizing upward—meaning we must continually improve on the standard. Thus, a new standard is the sum of all good ways we have discovered to present. There should be no resistance to standardize upward, improving continuously. Today's standards must be the standard upon which tomorrows' improvement is assessed and based.

VII. ANALYSIS OF OEE

PROCESS DESCRIPTION

This project concentrates on the process of Automatic fettling process.

Fettling Process

The complete process of casting called fettling. It involves the removal by grinding of cores, gates, sprues, runners, risers and chipping of any unnecessary projection on the surface of the castings.

Fettling Process by the Automatic Machine

This Machine does the grinding work on the possible area for remove projection of gates, sprues, runners, risers and flashes. All the grinding works are carried out by using Industrial Diamond Tools.

a) List of Tools in NC Grinding Cell.
   i. 760 mm Diameter grinding Wheel

b) List of Tools in Robotic Grinding Cell
   i. 200 mm Diameter Grinding Disc
   ii. 50 mm Diameter Grinding Disc

VIII. DATA COLLECTION

Table 1 Fixture Changeover Time for NC Grinding cell

Fixture change over time			
Sl. No.	**Description**	**Items**	**Sec.**
1	Dowel pin removal from fixture	10mm dowel-1 no,12 mm dowel-1no	1800
2	lock bolts removal	M 10 Allen head bolt-6 no's	900
3	replacing of fixture	For new/other product fixture	60
4	re fixing of bolts	M 10 Allen head bolt-6 no's	750
5	Dowel pin fixing on fixture	10mm dowel-1 no,12 mm dowel-1no	30
		Total sec	**3540**

Table 1 show that time taken for changing the fixture is 3540 secs, in which the removal dowel pins takes more time.

Cycle Time

Cycle Time of NC grinding machine : 60 secs

Cycle Time of Robotic grinding machine : 70 secs

Table 2. Input Variables

SL.NO.	DESCRIBTION	VALUE	UNITS
1	WORKING TIME/DAY = 24 Hrs	480	MINUTES
2	NO OF SHIFT/DAY	2.5	SHIFT
3	TOTAL WORKING TIME/DAY	1200	MINUTES
4	TOTAL WORKING TIME/MONTH	31200	MINUTES
5	MEAL BREAKS (1 /SHIFT)	30	MINUTES
6	SHORT BREAKS (2/SHIFT=EACH 15 MIN)	30	MINUTES
7	MEAL BREAKS /DAY	75	MINUTES
8	SHORT BREAKS / DAY	75	MINUTES

IX. CALCULATION

1. Planned Production Time = Shift Length – Breaks

2. Operating Time = Planned Production Time – Down Time

3. Good Pieces = Total Output – Total Rejection

4. Availability = $\frac{\text{OPERATING TIME}}{\text{PLANNED PRODUCION TIME}}$

5. Performance = $\frac{\text{TOTAL OUTPUT} / \text{OPERATING TIME}}{\text{IDEAL RUN RATE}}$

6. Quality = $\frac{\text{GOOD PIECES}}{\text{TOTAL PIECES}}$

Below Parato chart shows that Reasons for the Low OEE of the Machine. Fixture problem on both cells is relatively high than the other Breakdown.

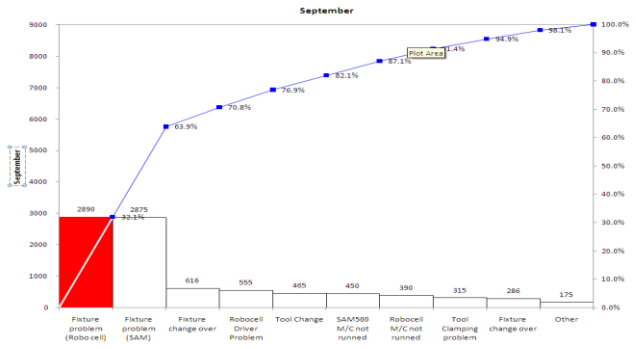

Fig.1 Parato Chart

X. IMPROVEMENT OF OEE

IMPROVEMENT BY MODIFICATION

In NC Grinding Cell, previously fixture locator and locking device is made of Mild Steel will range in hardness from 119 - 159 Brinell. Currently these locator are modified to EN8 carbon steel Hardness ranges from 201-255 Brinell. These EN8 Carbon steel has high wear resistance. Because of this wear rate of locator got reduced and replacement frequency also reduced. This made Improvement in Availability.

In ROBO Grinding cell column, in this locking point can be separated from column. Material of this locking point is modified from Mild steel to EN8 carbon steel, which wear rate of locator got reduced and replacement frequency also reduced.

In ROBO Grinding Cell locking screw pitch is modified as 5mm from 3mm which increase the clearance distance of Casting to locking point . That allows loading and unloading freely. Also screw and nut are material are modified as En8. This reduce the wear rate at mating point of Screw and nut and reduce replacement frequency.

IMPROVEMENT BY INTRODUCTION OF TOOL

The Dowel Puller, which is turned to ease the removal of Dowel from the fixture. Dowel pulling action is done by manual impact force created by hitting the top flange by hand piece.

Table 3 Fixture Changeover Time for NC Grinding cell

Fixture change over time			
Sl. No	**Description**	**Items**	**Sec.**
1	Dowel pin removal from fixture	10mm dowel-1 no,12 mm dowel-1no	300
2	lock bolts removal	M 10 Allen head bolt-6 no's	900
3	replacing of fixture	For new/other product fixture	60
4	re fixing of bolts	M 10 Allen head bolt-6 no's	750
5	Dowel pin fixing on fixture	10mm dowel-1 no,12 mm dowel-1no	30
		Total sec	**2040**

Table 3 show that time taken for changing the fixture is 2040 secs, which is 1500 secs reduced from the previous change over time.

Additional Material Handling system and manpower

Additional Material Handling System which is an Air Hoist and operator is provided to assist Loading and Unloading on both Cells. This increase the Production.

XI. RESULTS AND CONCLUSION

As OEE is an important performance measure for effectiveness of any equipment, analysis is required to know the OEE. A excel has used as simple tool to analyze and record the collected data.

In this project, previously OEE was below 50%. After the Improvements done on the machine, its OEE is raised above 50% also performance is greatly increased above 70%.

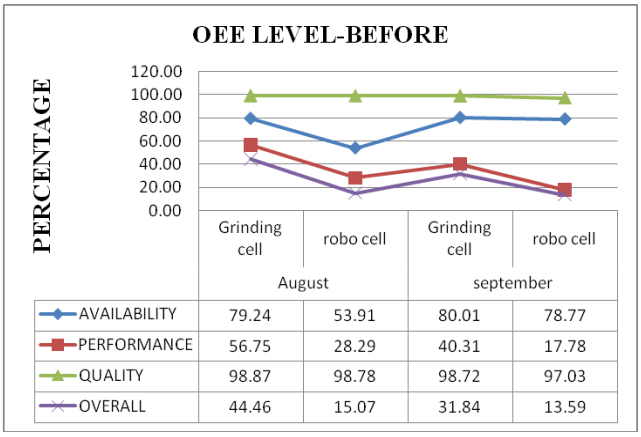

Fig 2. OEE Below 50%

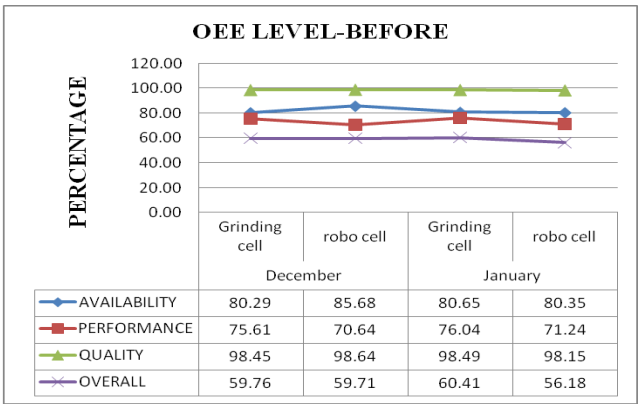

Fig.3 OEE Above 50%

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