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Process Optimization by Reduction in Cycle Time using MOST Analysis Technique

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Abstract: *Industries are facing an everyday challenge to produce more by spending less. Hence, Industries ponder over ideas that aim at saving money. Process Optimization leads to better results by reducing costs, time and resources. The main aim of process optimization is to reduce or eliminate time and resource wastage, unnecessary costs, bottlenecks and mistakes while achieving the process objectives. The importance of optimizing the process is in fact that after moulding of thermosets, it is not possible to melt and mould them again. Waste of time results in wastage of money which is a huge loss for company. The paper has proposed optimizations for productivity enhancement by saving time through Observations, Data Collection and Statistical Analysis. In this paper, MOST and comparative time study using different methods is discussed and impressive results would be brought and conceive the ideas to solve them. The results include the time in seconds which can be saved.*

Keywords: *Data Collection, MOST, Observations, Process Optimization, Statistical Analysis.*

I. Introduction

"Bring production up to optimum level" is the main aim of Process Optimization, which is in lead position of objectives of many companies. Production process optimization demands complex ideas, but it also opens up new scope for research. Process optimization is the term that defines improvement in performance by labor-cost reduction. "Productivity Improvement" is main aim of all the big industries running today. Hence, "Process Optimization" will contribute to a great extent in order to increase company's productivity by analyzing and setting an optimum time for each process and proposing suggestions which will save time, resulting in reduction of resources used. The main tool used for carrying out the research is Maynard Operations Sequence Technique (MOST).

1.1 Literature Review

This section highlights completely different journal papers relating to this research. The papers are:-

1. Ashwinkumar Arivoli and Vignesh Ravichandran, in their paper titled "Reduction in Manufacturing Cycle Time using Line Balancing" in International Journal of Innovative Research in Science, Engineering and Technology, present usage of Pareto Chart and Cause and Effect Diagram in reduction of manufacturing cycle time of air-oil separators of compressors using line balancing algorithm. Using the above tools and COMSOL algorithm, the line was balanced in order to meet the takt time.
2. Ankit Mishra, Vivek Agnihotri and Prof. D. V. Mahindru, in their paper titled "Application of Maynard Operations Sequence Technique for enhancement of Productivity" in Global Journal of Researches in Engineering, depict the use of MOST Technique to get the standard time in which a worker should perform a given task and optimize the resources. The research was carried out two companies and result shows 32.2% decrease in time as per MOST and Time Study.
3. Anuja Pandey, Dr. V. S. Deshpande and Santosh Gunjar, in their paper titled "Application of Maynard Operation Sequence Technique" in International Journal of Innovations in Engineering and Technology, present the use of MOST Technique in an auto-part vendor firm to enhance capacity of valve body department. Result was that manpower utilization was improved by 10% by reduction of 25% of excess manpower.

II. Path Of Research

In order to bring out constructive results, 6 basic steps are followed, which together form the Project Path Diagram. First step is to Study the Composition of Composites. Further, Compression Moulding Process is studied and Actual Process Mapping is done in order to generate a process flow chart which is used to collect actual data. Hence, Data Collection is the next step in which actual Cycle Time is noted down step-by-step. Next step is to sort the most important data which is useful for further analysis. This is done by Pareto Analysis. Further, the Ideal Cycle Time is calculated by using the MOST Technique. Lastly, by comparing actual and ideal data, Optimizations are suggested which will reduce the Cycle Time effectively. Project Path Flow Diagram is shown in Figure No. 1.

Fig. 1: Project Path Diagram.

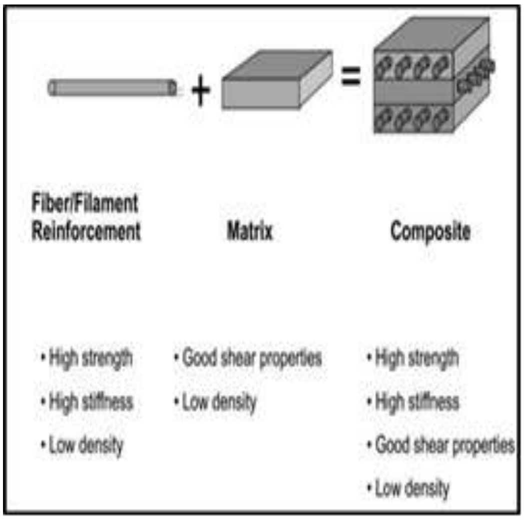

Fig. 2: Composition of Composites.

III. Study Of Composites

Fiber-Reinforced Polymer (FRP) Composites comprise of polymer matrix which is reinforced with a fiber (artificial or natural) or any other reinforcing material. This composition can be seen in Figure No. 2. The Matrix acts as a media for transmitting the external load to the reinforcements. The Fibers carry load along their length in a required direction. Matrix and Fibers, collectively form a high strength Composite. [1] [2] [3]

IV. Actual Process Mapping: Moulding Shop Process Flow & Layout

Moulding Shop Process Flow starts with cutting and weighing charge as per the the details given in the SOP (Standard Operating Procedure). After following the given instructions, the mould is cleaned using a pneumatic air-gun for several seconds. The charge after being placed in the mould undergoes curing for specified time as in the SOP. During curing, appropriate amount of pressure and temperature is applied which completes the moulding of the part. The hydraulic press-ram then opens upwards and the part is ejected by means of the hydraulically actuated ejector pins which are placed on the ejector plate. Part is then removed and inspected against the air-bubbles and cracks. If any carrier pins are inserted in the parts, then they are removed and cleaned. Further, if essential, post-moulding operations like deflashing and sandering are performed. Part is then placed on fixture for cooling. After cooling is completed, the part is stacked and transported to the Post-Moulding Shop.

V. Data Collection

As the name itself suggests, Data Collection is a process of collecting actual quantitative data of proposed variables of interest, in a pre-established sequence or order that enables one to study, analyze, compare and evaluate outcomes based on collected data. Before data collection, a Template is created which serves as a starting point for collecting data. The Template includes all the necessary parameters for which data is needed to be collected. This template is created in Microsoft Excel. Template is designed on basis of observations done in the Moulding Shop and all the activities that are performed. The template is actually divided in three main parts which are as follows:-

i. Basic Information

a. Date.
b. Part Name.
c. SAP Code.
d. Material and Grade.
e. Machine Used.
f. Type of Inserts.
g. Number of Inserts.
h. work Force.

ii. Compression Moulding Parameters

a. Actual and Standard Tonnage.
b. Actual and Standard Core Temperature.
c. Actual and Standard Cavity Temperature.
d. Actual and Standard Charge Weight.

iii. Actual Time and Ideal Time for each activity of Process Flow.

Data Collection comprised of all data of 23 parts which is further used for Statistical Analysis. All the data is stored in form of Excel Sheets.

VI. Pareto Analysis

Pareto Diagram is a tool which uses magnitude of contribution as a base to arrange items in a specific order which helps to identify top items that create a maximum influence on the overall results. This statistical tool is used in Organizations for prioritizing company projects, sorting products based on quantity of complaints received, identifying the nature of complaints occurring most often, identifying most frequent causes for rejections or for other similar purposes. [4]

Basic criteria used for Pareto Analysis is Revenue. Cost of raw material per kilogram is multiplied by the required charge weight for all the parts. Using this data, graph is plotted by using Pareto as the tool (Cost of raw materials, that is SMC & DMC cannot be revealed as per Company Guidelines). Top 10 parts are selected on basis of results of Pareto Analysis, that is, the 80/20 Rule, and Number of readings collected for each part. The resultant Pareto Chart is shown in Figure No. 3. After referring the Pareto chart, 10 parts are sorted for further MOST analysis.

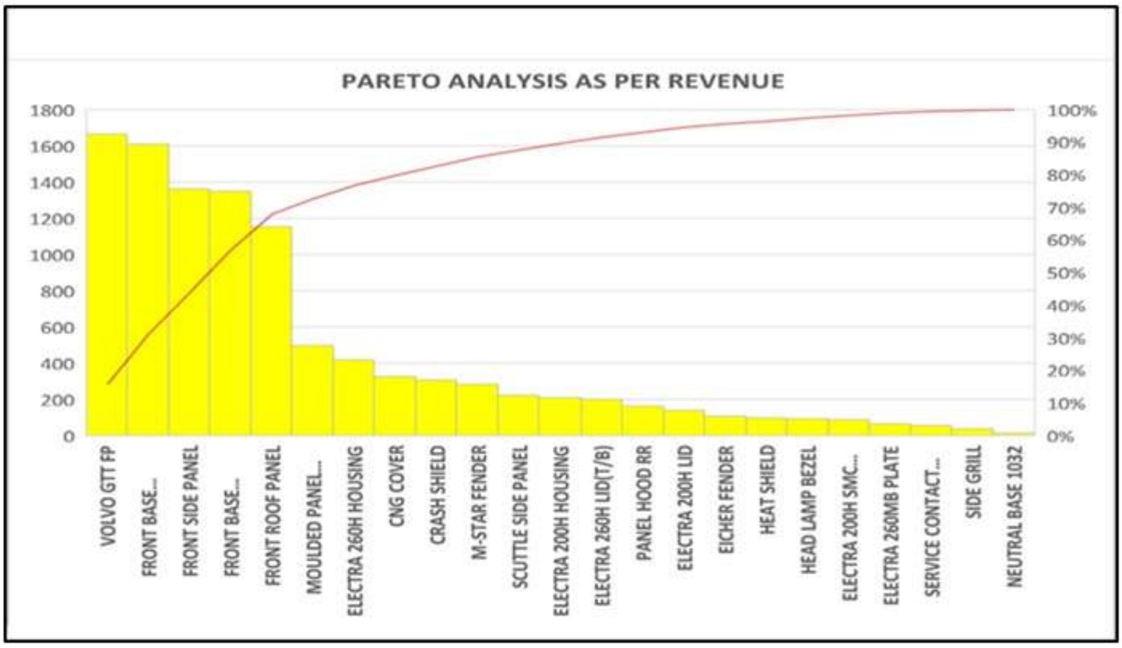

Fig. 3: Pareto Chart.

VII. Most Analysis

MOST, that is, Maynard Operations Sequence Technique, is a method of measuring work in quantitative data. MOST mainly concentrates on the movement of objects as well as human movements. All the motion patterns that are observed are arranged and choreographed in such a manner that outcome of these motions will result in a highly efficient and productive work. This is the basic logic of MOST technique and is popularly known as Method Study.

During actual data collection, it is seen that motions of objects as well as human motions follow a certain pattern, which is repeated a large number of times, such as reach, grasp, move and position the object. These patterns are observed, noted down and arranged in a proper order of events (or sub activities). Modelling of this sequence is done which acts as a standard base for analysing the movement of the object. The sequence models can be seen in Figure No. 4. [5]

MOST technique is applied to the sorted 10 parts and the ideal time is calculated. Also, deviation between actual average values and ideal values is calculated. Table No. 1 depicts the Actual and Ideal cycle times for the all 10 selected parts.

Basic MOST® WORK MEASUREMENT TECHNIQUE		
ACTIVITY	SEQUENCE MODEL	SUB – ACTIVITIES
General Move	A B G A B P A	A – Action Distance
		B – Body Motion
		G – Gain Control
		P – Placement
Controlled Move	A B G M X I A	M – Move Controlled
		X – Process Time
		I – Alignment
Tool Use	A B G A B P _ A B P A	F – Fasten
		L – Loosen
		C – Cut
		S – Surface Treat
		M – Measure
		R – Record
		T - Think

Fig. 4: MOST Sequence Models.

PART NAME	ACTUAL CYCLE TIME [seconds] (Data Collection)	IDEAL CYCLE TIME [seconds] (MOST Analysis)
Front Base Panel (18.375 kg & 15.375 kg)	523.82	520.71
Front Side Panel	523.5	526.78
Front Roof Panel	569.23	528.56
Moulded Panel Assembly	623.13	524.26
Electra 260H Housing	269.71	254.67
CNG Cover	221.6	218.92
Crash Shield	214.8	218.2
Electra 200H Housing	185.97	181.76
Panel Hood RR	230.87	213.96
Electra 200H Lid	183.39	178.8

Table 1: Actual and Ideal Cycle Time.

VIII. Suggested Optimizations

After performing the MOST analysis, block-holes in the process of all the sorted 10 parts are found out. Steps like Mould Cleaning, Charge Cutting, Charge Placement, Inserts and Carrier Pins Placement and Part Removal are found to be time consuming and there is a great variation between actual time taken for these processes and the calculated Ideal time. Key Observations are noted down and then Suggestions regarding time saving are proposed by proving that there can be a chance for optimization in part production time.

IX. Key Observations

The key observations noted during the complete manufacturing of any part are helpful. These include press problems, management issues, ignorance of operators as well as durations of break times. This data will help to reduce the non-value-added time and overcome management and press issues.

9.1 Press & Shop-floor Observations

The observations are that 500 Ton Press ram opens before Curing Time, Mould change-over time is very high and Required SOP's and not displayed at the work-station.

9.2 Shop-floor Management Observations

Supervisors are the Shop-floor managers. It is observed that they don't do continuous supervision and they don't note down the actual machine parameters.

9.3 Ignorance Of Operators

Operators change the shift number to be written on the faulty part. They write wrong names on part as they are not informed about it. They usually shift the machine to manual mode so as to achieve the target and leave the shop-floor early.

X. General Solutions

"PROBLEMS DEMAND SOLUTIONS". The feasible solutions for above mentioned issues are classified and listed below:-

10.1 Solutions For Press & Shop-floor Problems

Machine maintenance must be done regularly and a Proper technique must be used for mould change-over which will reduce the time. Necessary SOP's must be displayed before production starts.

10.2 Other Solutions

Supervisors/Company Officials must be present on the shop floor during Shift Change-over, Lunch-Breaks & Tea-Breaks and they must do continuous supervision.

XI. Conclusion

This research investigated the cycle time for manufacturing various parts in the industry. After collecting various parameters necessary for each of the part produced on the production line, the data was used to calculate the Cycle time. To reduce or eliminate the idle and/or down time, improve the working methods, standardize the time as well as enhance the overall productivity, the MOST Analysis was incorporated. In general, a possible way of achieving Process Optimization may result in replacement of workers and modifying the methods in processes, some workforce can be reduced or utilized in various sections of the industry.

Finally, if the Ideal Time calculated by MOST is achieved, the Actual Cycle Time for a part manufactured on 2000T Press can be reduced by an average of 22 seconds. Similarly, for a part on 500T Press, it can be reduced by 9 seconds. Also, for 400T Press and 250T Press, Actual Cycle Time can be reduced by 11 seconds and 4 seconds respectively. A reduction of a big figure of 99 seconds can be achieved for 150RI Press.
In terms of money, it is concluded that, for CNG Cover, if Ideal cycle Time is followed, an amount of □ 7,238 can be saved in 2 shifts of a day. Similarly, □ 12,209 can be saved per day for Electra 260H Housing.
Fishbone or Cause and Effect Diagram, that is Figure No. 5, for Low Productivity is developed based on the noted key observations. This depicts all the reasons for Low Productivity.

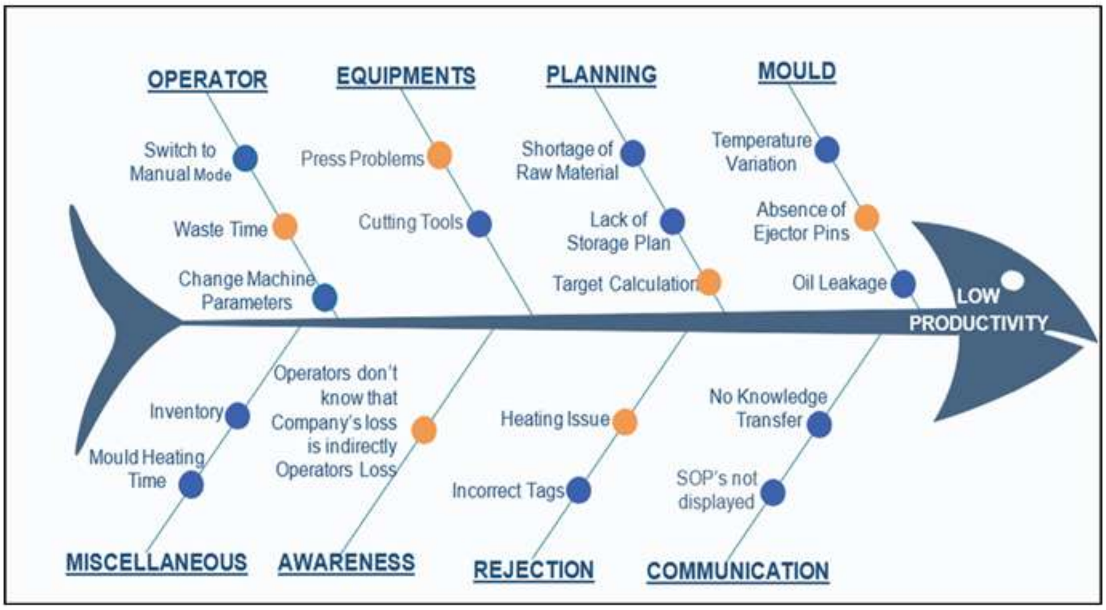

Fig. 4: Fishbone Diagram.

Future Scope

The incorporation of the MOST to estimate the standard times for various elemental tasks involved in different operations can substantially improve the productivity of the industry. Hence, there is scope of increase in production in near future. MOST analysis can be applied to the Post-Moulding shop of the industry which can bring forth many blockholes and help to reduce cycle time.

Acknowledgement

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