

# Productivity Improvement of Metal Casting Industry

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**Abstract**—Metal Casting is the process of foundry which has capacity to produce discrete output from raw material. Productivity of metal casting process is nothing but rate of overall production of one organization. Metal Casting process involves pattern making, core making, sand preparation, mold making, melting, pouring and shakeout activities. Several organizations in India followed manual operations to perform these activities. This paper represents the data of manual metal casting operations collected from one organization which produces automotive components. There are various problems identified in industry, low productivity, manual heavy operations, ergonomic problems, ineffective plant layout, process flow problem are represented in this paper. So it is clear from collected data that it affects on profit of organization. The work is done for minimization of these problems. The paper represents solutions, effective plant layout, automatic mold making operation and sequential process flow with minimization of back flow of material helps to solve these problems. The work done is to improve productivity and profit of industry. So this paper represents solution for improvement in productivity and profit of organization.

**Index Terms**— Productivity, Plant layout, Ergonomics, Process flow, Manual operations, effective plant layout, Automation for mold making, Sequential flow of operation.

## I. INTRODUCTION

Metal casting is one of the direct methods of manufacturing the desired geometry of component. The principle of manufacturing of casting involves creating a cavity inside a sand mould and then pouring molten metal directly into mould cavity. Casting is versatile process being used for number of engineering applications in today's world. Automotive components are common and popular application of metal casting. In India manual casting production method is most common in number of foundries.

There are different casting processes like investment casting, sand casting, die casting, but sand casting is popular and simple method of production for automotive components. Sometimes the foundry industry in India suffers from poor quality and productivity due to number of problems in casting process. In this work manual sand casting production method is analyzed and some problems in daily routine are identified which affecting on productivity of foundry industry. For this work one foundry industry is selected from Maharashtra which produces automotive components by manual sand casting method.

This paper represents all the problems occurred in this industry like, productivity problem, manual heavy operations problem, ineffective plant layout problem and mixed process flow problem etc. Collected data from this industry directly shows loss to the organization. Hence company wants to improve productivity and profit by solving all these problems. By applying knowledge of engineering and trying to solve the problem as far as possible and improving productivity.

The main aim of this project work is to improve productivity of industry, which is very helpful to other medium and small scale industries to improve profit.

## II. LITERATURE REVIEW

According to S. M. Sane, Promod. P. Shewale, et.al, they are working on "Improvement in plant layout using systematic layout planning for increased productivity". According to them the research is to study about plant layout of compressor manufacturing based company on the systematic layout planning pattern theory (SLP) for increased productivity. In them research, amount of equipments and tools in compressor production are studied. The detailed study of the plant layout such as operation process chart, flow of material and activity

relationship chart has been investigated. The new plant layout has been designed and compared with the present plant layout. The SLP method showed that new plant layout significantly decrease the distance of material flow from stores until dispatch. The research describes original plant layout & proposed new plant lay out. By this it was found that there was wasted time or delay in manufacturing. According to these, the researchers would like to analyze the way to solve such problems and find the way to improve the plant layout. The basic industrial layout planning is applied to systematic layout planning (SLP) method in which showed step-by-step of plant design from input data and activities to evaluation of plant layout. This method provides the new plant layout that improves the process flow through the plant, and help to increase space in industries, and effective utilization of resources for improving productivity.

1. Reduction of back flow of material.
2. Improvement in productivity.
3. Space utilization.
4. Avoiding delay in transportation.
5. Time reduction in processes.

According to Mayank Singh, Raval Apurv J et.al, overall productivity improved by reducing problems like plant layout, manual operations etc. Author working on project of overall productivity improvement in casting and fastening industry. The purpose of this research is to improve productivity for small scale and medium scale casting industry. This study concentrates on small and medium scale industry, where production of metallic components using casting process by company, fasteners production & hardening of same by company. According to author there is lots of scope for fulfilling the objective of project research. This is change in plant layout, process layout, using ergonomics, providing semi automation in processing and material handling methods. By using this scope the project reaches to the higher heights of success without compromising the quality of products.

Emmanuel Brousseau and Eldaw Eldukhri works on automation techniques in casting process. Author suggested advances for innovative manufacturing. Author works on some manufacturing processes for improvement in productivity like, Micro and Nano processes. Author also

describes some points on production automation and control. Author works on innovative design techniques for development. So author focuses to minimize the operational ease and automate all processes for improvement in productivity.

Girish Pude, G. R. Naik et.al. had performed an analytical and experimental work on minimization of waste and improvement in batch flow which results in productivity improvement. Author chooses foundry industry for their work. Author implemented various tools and techniques like value stream mapping etc. which shows improvement in productivity and cleaner production output. Author express case studies related to their work and experience. From results it proves that automation is an efficient and effective tool for improving productivity and cleaner production.

### III. PROBLEM IDENTIFICATION

Productivity can be defined as, "The ratio of aggregate output to aggregate input". Productivity implies development of an attitude of mind and constant urge to find better, cheaper, easier, quicker and safer means of doing a job, manufacture a product and providing services.

Some objectives behind problem identification;

1. To study performance of a system
2. To attain a relative comparison of different systems for a given level
3. To compare the actual productivity of a system with its planned productivity.

So following problems in organization is identified.

#### A. Manual Process

At present situation in this company all processes are performed manually. There is not a single processes is being operated automatically. Hence for operating these activities skilled workers are required. The manual operations are more time consuming and have more limitations in operations. In organization for production of metal casting mold making is major process. It is performed manually hence it is heavy and time consuming operation which affects on productivity.

#### B. Problem of Ergonomics

In this organization ergonomic problems are more, because manual operations. In general there is no problem of rising temperature exists but at the time of molten metal pouring temperature are increased 50 and more than it. Also other operations are noisy. Surrounding environment contains sand particles mixed in air. So working efficiency of worker is reduced.

#### C. Ineffective Layout

The existing plant layout of organization is ineffective. This layout is for manual operations of casting. These operations are performed on demand basis. Hence this layout affects on productivity of organization. This ineffective plant layout means ineffective utilization of plant area.

#### D. Material Movement Problem

The organization suffers from problem of material movement. This problem is due to ineffective plant layout and manual operations. The organization have problem of flow of material improper and time consuming. Sometimes back flow

is exists in material movement. So results are loss in productivity.

## IV. DATA COLLECTION

Data of existing system in organization is collected. All data represents all the problems identified. So the data like, existing plant layout, mixed process flow and other some manual operation details is presented in this section.

### A. Existing Plant layout:

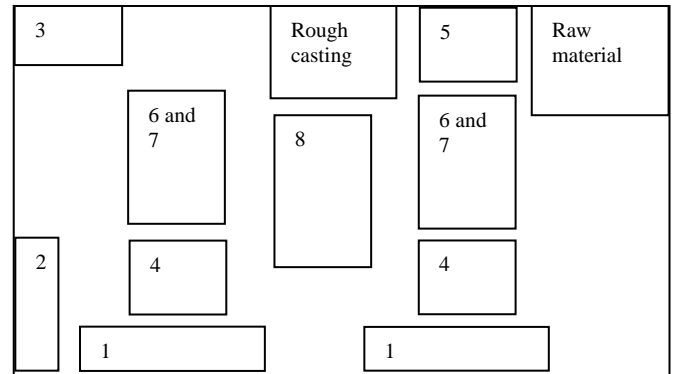


Figure 1. Existing Plant Layout

The fig. 1 shows existing plant layout which has departments, Sand Preparation (1), Pattern Making (2), Core Making (3), Mold Making (4), Melting (5), Molding Lines for Pouring (6-7) and Shakeout (8). All these departments are arranged in non sequential manner hence wastage of time for movement is more. So it affects on productivity of organization. This figure shows that ineffective utilization of plant area, so it is required to analyze it and change according to automation.

### B. Existing Operation Details

In foundry industry processes like sand preparation, mold making, core making, pouring and shakeout are performed for production of metal casting. The organization studied has all these operations but performed manually. So organization suffers from more problems.

In this organization sand preparation is performed by sand mullers. So this sand preparation section sends prepared sand to mold making section where bench molding machines going to produce mold boxes in cope and drag form. In organization mold boxes produced with bench molding machine which is operated manually. So for production of molds more than 10 mins are required. These produced molds are sending to pouring section where mold lines are made for manual pouring with hand ladle. So poured mold boxes are placed for cooling and shakeout is performed. So castings are removed from this mold boxes and placed for ready to dispatch. Above figure of existing plant layout shows all the departments engaged for production of metal casting. Following section shows process flow for production of metal casting.

### C. Existing Process Flow Diagram

The following figure shows process flow exists in organization. This diagram of existing processes shows that there is mixing of all processes hence it affects on productivity in organization. Also mixed process flow shows more back flow of material.

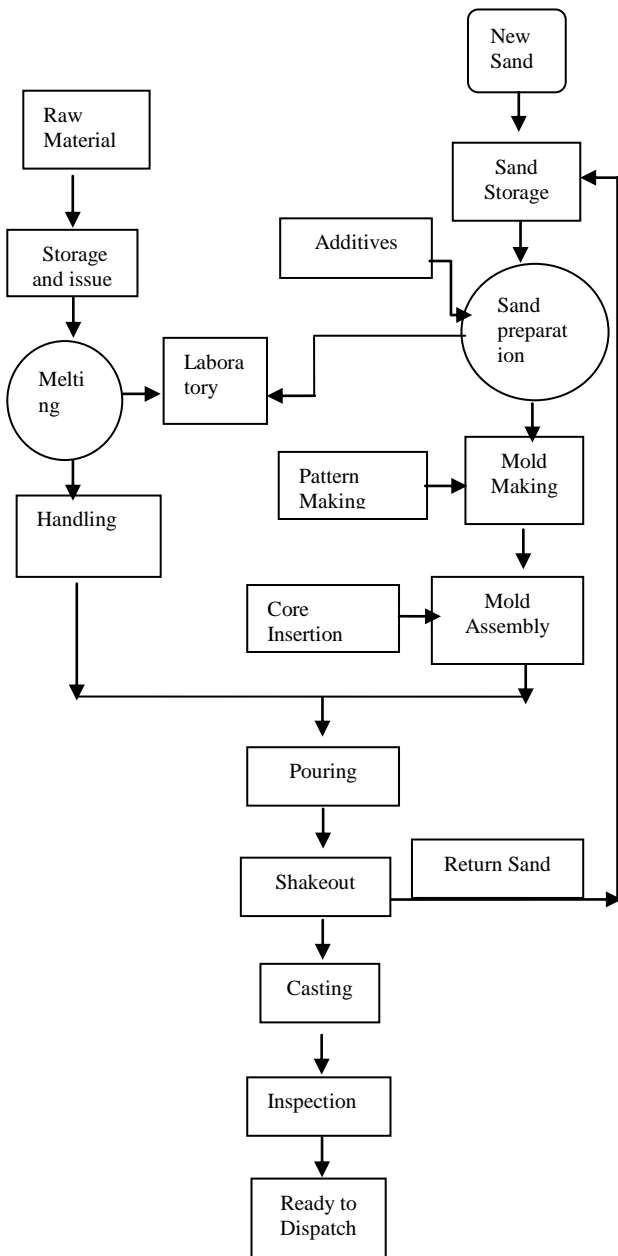


Figure 2. Existing Process Flow Chart

VI. DATA ANALYSIS AND PROPOSED METHODOLOGYS

The data collected from industry and problems identified shows that there is requirement in changing molding production method for improvement. Also it is required to adopt some ergonomic problem solutions with proper flow process and plant layout. So first focuses on changing molding production method to machine molding.

A. Concept for Automatic Molding

The problems shows loss in productivity hence it is required to automate molding production method. So here we show Jolt Squeeze automatic molding machine concept which usefull for mould making process. The figures 3 shows jolt squeeze machine layout with details. This machine is engineered with utmost care to improve productivity in affordable cost. The machine has simultaneous jolt squeeze for high mold strength with gradual lifting and simultaneous vibration for improved separation of mould from pattern.

The machine produces mold boxes within five to six minute period. Machine has pneumatic control.

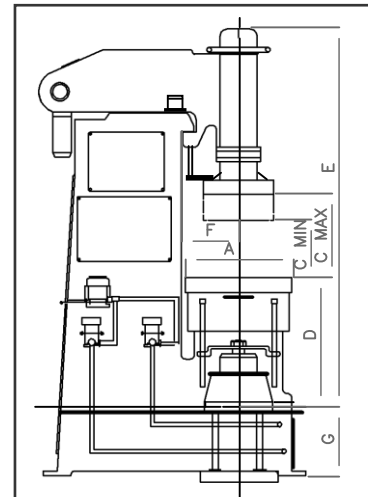


Figure 3. Jolt Squeeze Molding Machine

So above all figures shows the Jolt Squeeze machine which is automatic mold production machine. The machine has capacity to produce the mold from 500 to 1000 mm range.

B. Analysis for Ergonomic Problem :

As discussed above problems of higher temperature exists during pouring. Also other operations are noisy and inefficient to operate the activities. The problem of noisy and heavy operation is identified in mold production activity so by automatic machine it is minimized. For reduction of temperature problem it is required to provide proper roofing condition there is possibility of temperature reduction. Here we have shown possible roofing for temperature reduction.

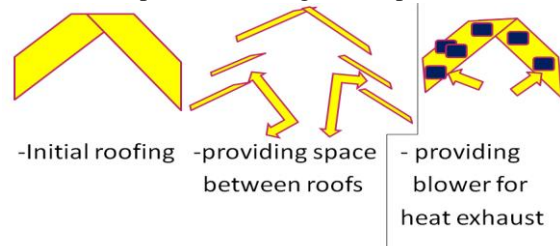


Figure 4. Roofing Techniques

In above fig. 4 three roofing possibilities it is better to use blower in between roofs. Also in some parts of roof it is possible to use propelling fans. Hence blowers and fans both reduce temperature and maintain environmental conditions healthy and efficient to work in organization.

*C. Analysis for Proper Flow of Material*

As the identified the problem like mixed process flow and ineffective plant layout, these affecting on productivity, so it is required to change plant layout and process flow. Change in plant layout changes the positions of machines and equipments. So there is new layout which is analyzed shown below.

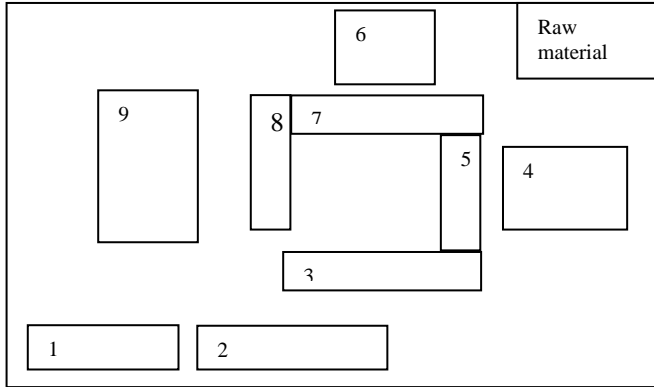


Figure 5. New Plant Layout

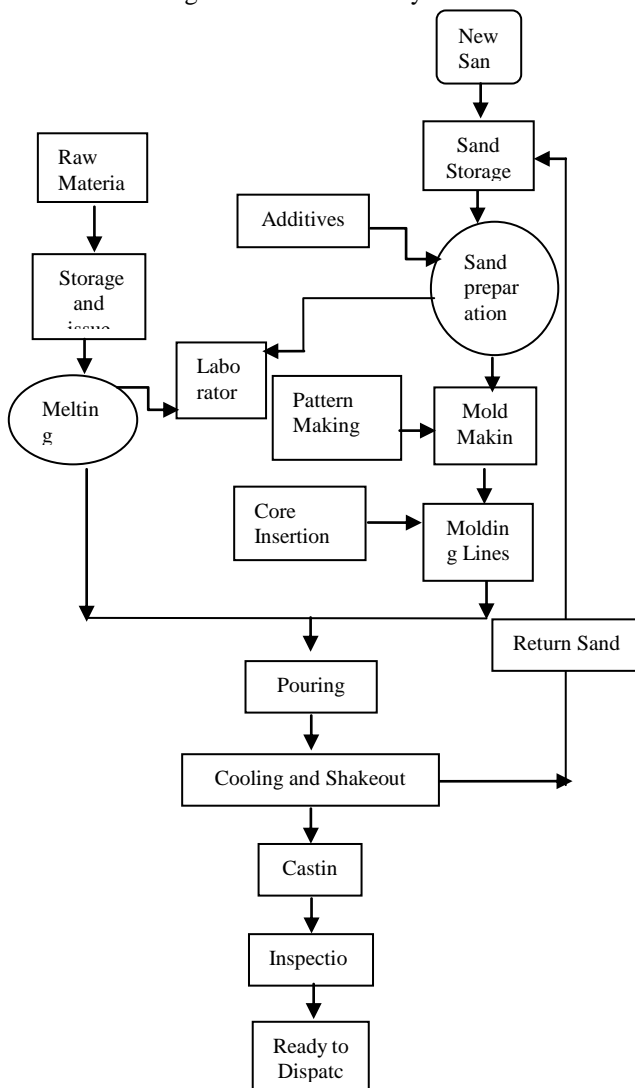


Figure 6. Process Flow Chart

According to this layout fig. 5, the activities are performed effectively with proper utilization of space. The layout shows Pattern Making Section (1), Sand Preparation Section (2), Mould Making Section (3), Core Making Section (4), Molding Lines with Core Insertion (5), Melting Furnace Section (6), Pouring Section (7), Cooling and Shakeout Section (8) and Rough casting storage section (9). So in this layout there is no back and separate flow of material hence reduction in bottleneck in process. So this directly affects on productivity improvement. According to this layout process flow is done which is shown below.

So the process flow fig. 6 shows that handling process is removed from existing process flow and addition of cooling section with shakeout is in new process flow chart. Removing handling operation is due to automatic mold box production method which continuously produces mold boxes hence there is no requirement of molten metal handling before pouring in mold box. Also cooling section reduces defective production.

Also the Ergonomic problem is more important which affecting on workers efficiency of doing work, by changing roofing, temperature is reduced by 5°C. This reduction of temperature helps workers to do work with good effort. The problem of Plant layout and process flow is solved to major extent. The solution of this problem gives advantages, Easy and effective material movement, Space available for storage, Effective movement of processes so back flow is neglected, Arranging all processes sequentially reduces handling problem also the time required is reduced to more extent. So these are fewer changes which produce more output within time.

So solution of all problems improves productivity and profitability of organization. The outcomes like, Mold boxes production is increased to 30%, there is reduction in heat loss up to 50°C, operation are easy and safe, Also reduces time for movement of material to more percentage. All these advantages improve productivity with reduction in overall total cost.

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