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# Productivity enhancement techniques used in casting industries

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**Abstract**
The objective of this research paper is to study the exits productivity of a casting industry and find the way to enhance the productivity for that casting industry. Here we have focused on the industries; those are producing different metallic components by various casting processes. This research work is used changes in movement of material to better utilization of plant area which improves the productivity. With the Effective material handling system we can reduce the time required to material movement within plant. With providing Good ergonomics environment we can achieved efficient & effective performance of labour. Objectives of this study is to identify problems in the casting industry and improved it in terms of reduction in production time, number of manual process and back flow of materials by proposing an efficient plant layout and design of components used for loading of material used in casting process. This research used systematic plant layout technique, concept of semi automation /automation in casting process, material handling system, ergonomics and rework reduction methods. Overall productivity can be enhanced by solving these problems of ergonomics, manual process, material handling, ineffective utilization of plant area, back flow of materials, etc.

**Keywords:** plant layout, material movement, ergonomics, semi-automation, automation, material handling

## 1. Introduction

Productivity is the measure of the rate at which outputs produced per unit of input. It is also known as the ratio of the amount of outputs produced to the amount of inputs used. Productivity measures are used at the level of firms, industries. Productivity can be expressed as number of parts produced per employee. In principle, inputs can be broadly defined to cover people's time, their skills, land, raw materials, machinery and equipment, energy (for example, electricity) and so on.

Productivity in general is a ratio of output to input in the production of goods and services. Productivity is increased by lowering the amount of labor, capital, energy or materials that go into producing any given amount of economic goods and services. Increases in productivity are largely responsible for the increase in per capita living standards.

But, most commonly, inputs are defined in terms of:

- Man (labour)
- Money (Capital)
- Machine
- Material
- Time

Productivity is an ability to produce a good or service. More specifically, productivity is the measure of how effectively available resources are used to complete timely objectives as stated in terms of quantity. Productivity is useful as a relative measure of actual output of production to the actual input of resources, measured across time or against common entities. As output increases for a given input, or as the amount of input reduced for a constant level of output, an increase in productivity occurs. As we all know that all the company always want to improve their productivity continually by solving the highly occurred problem which directly affect to the productivity. So company wants to produce more output by effectively utilizing the available resources and company's owner want to same. Biggest problem which are associated such as, back flow of material, material handling problem, ergonomics, storage problem, ineffective layout, etc.

As we all know that all the company always want to improve their productivity continually by solving the highly occurred problem which directly affect to the productivity. So company want to produce more output by effectively utilizing the available resources and company's owner want to same. Biggest problem which are associated such as ineffective layout, back flow of material, material handling problem, ergonomics, storage problem, loading problem in hardening furnace, etc. so applying knowledge of engineering and trying to solve the problem as far as possible and improving productivity.

### 1.1 Objectives

The main objectives of productivity improvement are as follow

1. To achieve high productivity by better utilization of resources.
2. Reduce of back flow of material.
3. Avoiding delay in delivery time.
4. Reduced processing time
5. To reduce the worker fatigue-by effective & efficient work plan, Easy material handling systems.
6. Less waste of time and materials.

## 2. Literature Review

According to Prof. DR S.M. sane, Promod p. shewale, Manmath S. shete, 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. 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. The basic industrial layout planning is applied to systematic layout planning (SLP) method in which showed steps 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.

### 2.1 Productivity

Productivity is a measure of the rate at which outputs of goods and services are produced per unit of input (labour, capital, raw materials, etc.). It is calculated as the ratio of the amount of outputs produced to the amount of inputs used. Improving productivity can have connotations of economizing on the use of inputs - for example, adopting efficient production processes that minimize waste. Equally, improving productivity can have connotations of yielding more output - for example, using resources in activities or with technologies that generate more output.

ILO defines total productivity 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, manufacturing a product and providing services.

The basic objective behind productivity measurement is:

1. To study performance of a system over time.
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.

Simply the productivity is defined as:

P=O/I

P= Productivity,

O= Output from the system,

I = Effective Utilization of the input resources

European Productivity Council states that "productivity is an attitude of mind". It is a mentality of progress of the constant improvement of that which exists. It is certainty of being able to do better than yesterday and continuously. It is constant adoption of economic and social life to changing conditions. It is continual effort to apply new techniques and methods. It is faith in human progress in the words of Peter Drucker "productivity means a balance between all factors of production that will give the maximum output with the smallest effort"1.

### 2.2 Productivity improvements have essentially these 10 steps:

1. Management commitment.
2. Training and empowerment
3. Material saving
4. Work Study
5. Times and methods
6. Measuring performance
7. Line Balancing
8. Quality
9. Personnel Management
10. Better equipment utilization

## 3. Problems identification

### 3.1 Manual Process

At starting state in the casting company whole process is done manually. There is no semi or fully automation used for effective and efficient production. Manual process required skill workers. The manual processes required more time in doing works. In manual production product cycle time of is more hence the productivity is less.

### 3.2 Storage Problems

In casting industries there is a problem of storage of semi finished and finished goods as well as material cut from casting parts (Riser, runner, gating system etc.) in to the existing plant area. So there should be specified and selective place to semi & finished parts stored properly.

### 3.3 Material Handling Problems

Material handling is the major problem in the metal casting industries. There is the problem of equipment handling, material are required to move from one place to another, so man power & more time both are consumed which decrease the production rate hence low productivity.

### 3.4 Material Movement

If flow of material is improper and required more time for material movement in the plant area. Back flow is exists in material movements. So results more time consumption which directly reduces productivity.

### 3.5 Unproductive Layout

If the existing layout of company is not highly effective for achieving higher productivity. It may be possible that there is ineffective utilization of plant area.

### 3.6 Ergonomics Problems

Here we considered environmental temperature conditions as well as working space. In general there is no problem of rising temperature exists but at the time of metal pouring temperature is increased 50°C and more. So working efficiency of worker is reduced as temperature increased as well as improper placement of machines may trouble for worker during the working.

**Data collection way**

1. By study the way of process.

2. Data regarding storage will be collected by study the storage way.
3. Data regarding material handling will be collected by study the material handling equipments and its effectiveness used in industries.
4. By make the flow diagram of raw material, semi and finished goods and storage
5. By drawing the plant layout and operational process chart.
6. Study the ergonomics environment in industry.

## 4. Methodology to overcome problems

### 4.1 Concept generation of automatic/semi automatic machine

Here shown semi automatic machine concept which useful for mould making process. This machine requires a robust structure and a hydraulic press.

In casting industries now these days sand filling is done automatically so that mould box can be prepared with less worker fatigue and with minimum possible time. CNC turning and milling are used to machining the casting which increased production rate as well decrease the cost. Automation means automatic control or a process which is runs with minimum operator involvement. Some of the various levels of automation are mechanical methods, electrical relay, feedback control with a controller and computer control. Common applications of automation are for controlling temperature, flow and pressure. Machine tools were automated with numerical control (NC) in the 1950s. This soon evolved into computerized numerical control (CNC).


**Fig 1:** Semi automatic machines

### 4.2 Concept generation of material storage

Storage equipment is usually limited to non-automated examples, which are grouped in with engineered systems. Storage equipment is used to hold or buffer materials during "downtimes," or times when they are not being transported. These periods could refer to temporary pauses during long-term transportation or long-term storage designed to allow the buildup of stock. The majority of storage equipment refers to pallets, shelves or racks onto which materials may be stacked in an orderly manner to await transportation or consumption.

#### 4.2.1Engineered Systems

Engineered systems cover a variety of units that work cohesively to enable storage and transportation. They are often automated. A good example of an engineered system is an Automated Storage and Retrieval System, often abbreviated AS/RS, which is a large automated organizational structure involving racks, aisles and shelves accessible by a "shuttle" system of retrieval. The shuttle system is a mechanized cherry picker that can be used by a worker or can perform fully automated functions to quickly locate a storage item's location and quickly retrieve it for other uses.

Examples of storage equipment include: Racks, such as pallet racks, drive-through or drive-in racks, push-back racks, sliding racks stacking frames shelves, bins and drawers etc.

### 4.3 Concept generation of small/heavy material handling equipment

In casting industries during the production process a number of equipments and machines are used for transport heavy as well as small casting from one place to another place.

According American materials handling society "Materials handling is the art and science involving the moving, packaging and storing of substances in any form."

**Some of the other definitions are as**

- Materials handling is the movement and storage of materials at the lowest possible cost through the use of proper methods and equipment.
- Materials handling is the moving of materials or product by any means, including storage, and all movements except processing operations and inspection.
- Materials handling is the art and science of conveying, elevating, positioning, transporting, packaging and storing of materials.

#### 4.3.1 Different types of material handling equipment

Material handling equipment encompasses a diverse range of tools, vehicles, storage units, appliances and accessories involved in transporting, storing, controlling, enumerating and protecting products at any stage of manufacturing, distribution consumption or disposal.

#### 4.3.2 Categories of material handling equipment

These are the main material handling equipment:

A. Cranes
B. Conveyor systems
C. Robotic delivery systems
D. Automatic guided vehicles (AGV)
E. Industrial trucks
F. Bulk material handling

**A. Cranes**

Cranes are an ancient technology but they became widespread following the Industrial Revolution.

Industrial cranes were used to handle heavy machinery at the company. Electric cranes, especially the overhead type, were introduce in factories at the end of the 19th century.

**The important categories of cranes are**

Overhead crane or bridge cranes-travel on a rail and have trolleys that move the hoist to any position inside the crane frame widely used in factories.

- Mobile crane usually gasoline or diesel powered and travel on wheels for on or off-road, rail or continuous track. They are widely used in construction, mining,

excavation handling bulk materials.
- Fixed crane in a fixed position but can usually rotate full circle. The most familiar example is the tower crane used to erect tall buildings.

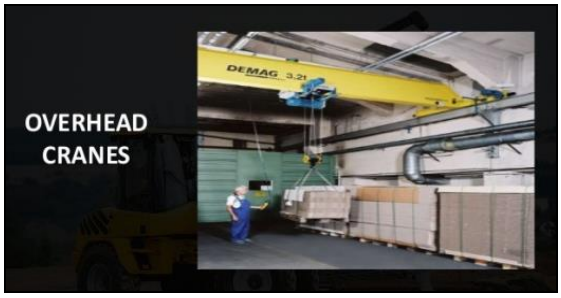
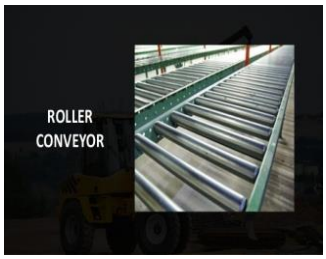



**Fig 2:** Over head crane

**B. Conveyor systems**

Conveyors are used when material is to be moved frequently between specific points over a fixed path and when there is a sufficient flow volume to justify the fixed conveyor investment. Different types of conveyors can be characterized by the type of product being handled: unit load or bulk load; the conveyor's location: in-floor, on-floor, or overhead, and whether or not loads can accumulate on the conveyor.

Belt conveyor




Roller conveyor

**Fig 3**

**C. Robotic delivery systems**

Robots are used to transfer the parts from one point to another point precisely. They can work in any condition.

**Fig 4:** Pick and palace robots

**D. Automatic guided vehicles (AGV)**

Automated guided vehicles (AGVs) are industrial trucks that can transport loads without requiring a human operator.

**Fig 5:** Unit load AGV

**E. Industrial Trucks**

Industrial truck refer to the different kinds of transportation items and vehicles used to move materials and products in materials handling. These transportation devices can include small hand-operated trucks, pallet-jacks, and various kinds of forklifts. These trucks have a variety of characteristics to make them suitable for different operations. Some trucks have forks, as in a forklift, or a flat surface with which to lift items, while some trucks require a separate piece of equipment for loading. Trucks can also be manual or powered lift and operation can be walk or ride, requiring a user to manually push them or to ride along on the truck. A stack truck can be used to stack items, while a non-stack truck is typically used for transportation and not for loading.

**There are many types of industrial trucks**

- Hand trucks
- Pallet jacks
- Pallet trucks
- Platform trucks
- Order picker
- Side loader

**Fig 6:** Pallet truck

**F. Bulk material handling equipment**

Bulk material handling refers to the storing, transportation and control of materials in loose bulk form. These materials can include food, liquid, or minerals, among others. Generally, these pieces of equipment deal with the items in loose form, such as conveyor belts or elevators designed to move large quantities of material, or in packaged form, through the use of drums and hoppers.

- Conveyor belts
- Stackers
- Reclaimers
- Bucket elevators
- Grain elevators
- Hoppers

For handling different material at a time cutting area the small boxes with different material code (colour) as shown need to place in order to avoid mixing of material. And it is easy to move that material with the help of crane within the plant at very small time duration.

**Fig 7:** Boxes for different types material

To move the material within plant use of trolleys reduce the worker fatigue with easy handling with minimum time duration.


**Fig 8:** Different types of material handling equipment

### 4.4 Proper flow of material

**Definition**

A flow diagram is graphical presenting, describing or analyzing a process and movement of material men etc.

The flow material indicate the sequence of the events that show the movement of material, men etc.

### 4.5 Plant layout

**Changing in layout place of existing**

As the change in layout the change of place of machines and equipments is change. So there is new flow of material is exists. As seen from the solution of change in layout the flow of material is generally inward to out ward by the "U shape "line of flow is exists. This reduces the possibility of back flow.

**Plant Layout**

Plant layout refers to the arrangement of physical facilities such as machines, equipment, tools, furniture etc. in such a manner so as to have quickest flow of material at the lowest cost and with the least amount of handling in processing the product from the receipt of raw material to the delivery of the final product.

**The principal factors are**

- Location, with respect to the marketing area
- Raw material supply
- Transport facilities
- Availability of labor
- Availability of suitable land
- Environmental impact and effluent disposal
- Local community consideration
- Climate
- Political and strategic consideration

**Objectives of good plant layout**

A well designed plant layout is one that can be beneficial in achieving the following objectives:

- Proper and efficient utilization of available floor space.
- Transportation of work from one point to another point without any delay
- Proper utilization of production capacity.
- Reduce material handling costs
- Utilize labor efficiently
- Reduce accidents
- Provide for volume and product flexibility
- Provide ease of supervision and control
- Provide for employee safety and health
- Allow easy maintenance of machines and plant.
- Improve productivity

**Types of layouts**

**Process layouts (Job shop)**

Process layout (also called a job-shop or functional layout) is a format in which similar equipment or functions are grouped together, such as all lathes in one area and all stamping machines in another.

A part being worked on then travels, according to the established sequence of operations, from area to area, where the proper machines are located for each operation. This type of layout is typical of hospitals, for example, where areas are dedicated to particular types of medical care, such as intensive care units.

**Product layouts (Flow shop)**

A product layout (also called a flow-shop layout) is one in which equipment or work processes are arranged according to the progressive steps by which the product is made. The path for each part is, in effect, a straight line. Production lines for shoes, chemical plants, and car washes are all product layouts.

**Hybrid layouts (Cellular)**

A Hybrid (cellular) layout groups dissimilar machines into work centers (or cells) to work on products that have similar shapes and processing requirements.

A group technology (GT) layout is similar to a process layout in that cells are designed to perform a specific set of processes, and it is similar to a product layout in that the cells are dedicated to a limited range of products.

**Fixed-Position layouts**

In a fixed-position layout, the product (by virtue of its bulk or

weight) remains at one location.
Manufacturing equipment is moved to the product rather than vice versa.
Construction sites and movie lots are examples of this format

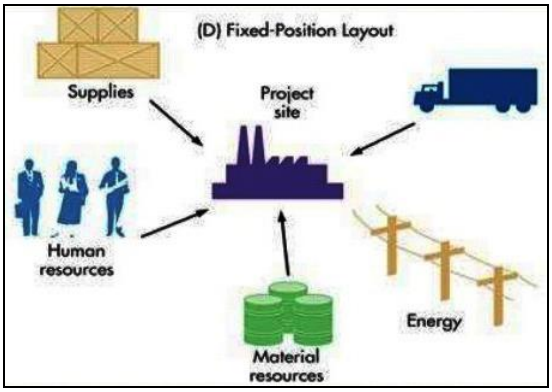



**Fig 9:** fixed - position layout

### 4.6. Ergonomics

The International Ergonomics Association defines ergonomics or human factors as follows:
Human Factors is employed to fulfill the goals of occupational health and safety and productivity. It is relevant in the design of such things as safe furniture and easy-to-use interfaces to machines and equipment. Proper ergonomic design is necessary to prevent repetitive strain injuries and other musculoskeletal disorders, which can develop over time and can lead to long-term disability. Human factors and ergonomics is concerned with the "fit" between the user, equipment, and environment. It accounts for the user's capabilities and limitations in seeking to ensure that tasks, functions, information, and the environment suit that user.
As discussed above problems the problem of higher temperature exists at the time of pouring. So by providing proper roofing condition there is possibility of temperature reduction. Here provides alternate solutions for roofing condition. This shows below.

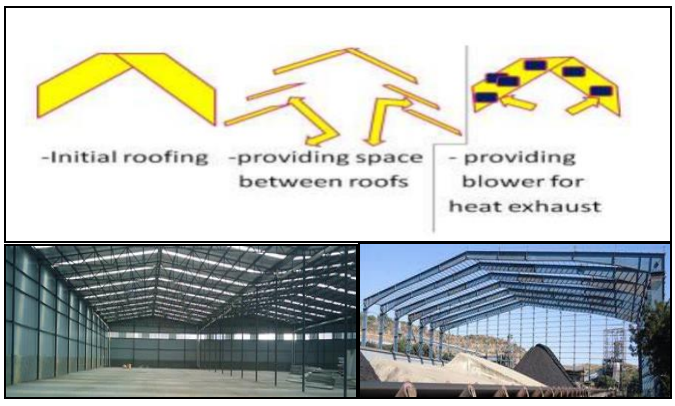



**Fig 10:** Types of roofing

The purpose of Human Factors and Ergonomics in Manufacturing Industries is to facilitate discovery, integration, and application of scientific knowledge about human aspects of manufacturing, and to provide a forum for worldwide propagation of such knowledge for its application and benefit to manufacturing industries. The study covers a broad spectrum of ergonomics and human factors issues with a focus on the design, operation and management of modern manufacturing systems in the shop floor for enhancement and integration of human skills with hardware performance for improved market competitiveness, management of change, product and process quality, and human-system reliability.
Human factors and ergonomics is the application of psychological and physiological principles to the engineering and design of products, processes, and systems. The goal of human factors is to reduce human error, increase productivity, and enhance safety and comfort with a specific focus on the interaction between the human and the thing of interest.

## 5. Conclusion

**By using semi automatic moulding machine**

1. Avoiding skill worker requirement
2. Time reduction per mould making 5 to 6 minutes expected
3. Reduction in man power
4. Avoiding marking & adjustment of the cope and drag part

**By implementing alternate solution in plant layout changing we can solved these problems**

1. Material movement.
2. Material handling.
3. Storage problem.

Implementing best plan possibility of back flow is neglecting, as well as overall production time is reduced due to reduction of time consumption.
By using suitable material handling equipment we can stored the products in perfect manner at right and proper place which can solved our these problems.
Location of a plant is an important decision because it influences the cost of production and distribution to a great extent.
Location may contribute to even 10% of cost of manufacturing and marketing.
A firm may fail due to bad location or its growth and efficiency may be restricted.
Same benefits are achieved as stated above as well as, fulfill the requirement of implementation of investment die casting is achieve. Fewer changes are required for this implementation. So produce more output by doing fewer changes.
As we can see that there are many factors that are involved with productivity enhancement, it is not an easy road to follow, it needs commitment of the highest level to achieve real improvements. Many companies are increasing their capacity to produce more, but there is a huge need to improve productivity, this is where the real future is.
Productivity enrichment can be done by using small mechanization like conveyor system, automatic sand filling mechanism, small boxes for material handling or storage, material handling trolleys, trucks and effective ergonomics solving problems such as time reduction for mould box preparation and reduction in man power.
Material handling problems can be solved by using modern equipments and machines.

Ergonomics also affecting workers efficiency of doing work, by changing roofing structure, temperature is reduced. Approximate $5^0$-$10^0$C temperature is reduce after providing 5-10 blowers or self propelled fan. Workers doing work with good effort. “By providing trolleys and boxes to solve material handling problems. It also reduce the time for material movement from furnace to cutting machine and make ease transportation of material or parts with the help of trolleys within plant which reduce work force and increase the productivity.

Ergonomics is a combination of numerous disciplines, such as psychology, sociology, engineering, biomechanics, industrial design, physiology, anthropometry, interaction design, visual design, user experience, and user interface design. In research, a human factor employs the scientific method to study human behavior so that the resultant data may be applied to the four primary goals. In essence, it is the study of designing equipment, devices and processes that fit the human body and its cognitive abilities. The two terms "human factors" and "ergonomics" are essentially synonymous.

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