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Productivity Improvement through Strategic Operational Layout in Composite Unit, India

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Abstract:

Strategic layout design involves a systematic physical arrangement of different departments, work stations, equipments, storage areas and common areas in a manufacturing industry. Nowadays in a competitive world, the strategic layout has an effective tool in cost reduction by improving the productivity. Also one of the most influential and most effective methodologies for eliminating wastes [MUDA], controlling quality, and improving overall performance of any system or process in any industry with the complete assurance of large annual profit margins. It has become very important to have a well organized plant layout for all the available resources in an appropriate manner to achieve the maximum output from the resources. To achieve the desired objectives a lot of methods and techniques are developed by many researchers in the domain area.

Key words:

Layout, Wastes, Productivity, Efficiency

Introduction:

To improve the effectiveness and efficiency of an organization, it is important to give a special attention to layout. Layout is an arrangement of different aspects of manufacturing in an appropriate manner to achieve desired production results. A small change in the arrangement of machines or equipments can improve the flow of materials and affect the overall efficiency of the manufacturing process. Strategic layout considers available space, final product, safety and facilities & convenience of operations.

An effective strategic layout ensures that there is a smooth and steady flow of material, manpower and equipment at a minimum cost. Layout decides the best physical arrangement of all resources within the allocated space. Therefore, the main objective of the strategic layout planning is to design an effective workflow and improve productivity, also make equipments and workers more productive. The inability to get manufacturing process right cause to excess inventory, low quality product, unhappy customer, etc. Today's manufacturing layout must be demonstrate adequate

and flexible regardless of constant changes operating system. And this explains why layout is essential base of current industrial facilities and thereby enhancing the efficiency of product output and increase the productivity.

Need for layout decision:

- Inefficient operations
    1. High Cost
    2. Bottlenecks
- Changes in the design of products
- The introduction of new products
- Changes in volume of output
- Accidents
- Ambience

Inputs required for a strategic layout

- Marketing: demand forecast
- Product mix
- Production rate
- Mode of production: continuous/ intermittent
- Logistics: where to produce, capacity
- Aggregate production plan, how much
- Types and numbers of processes and equipments

Objectives of study:

A layout should be suitable to give an ideal relationship between raw material, equipment, manpower and final product at minimum cost under a safe and comfortable terrain. The aim of this work is to minimize workload and workers on the assembly line while meeting a required / maximum output. An efficient and effective layout can cover following objectives:

- The main objective of the layout is to increase the productivity.
- To provide optimum space to organize equipment and facilitate movement of goods and create a safe and comfortable work environment.
- To reduce the movement of workers, raw material and equipment.
- To promote safety of the plant as well as its workers.
- To facilitate extension or change in the layout to accommodate new product lines or technology upgradation.
- To increase capacity of the production of an organization.
- To identify the location of bottleneck and exclude them.
- To reduce the production cost.
- To minimize the total quantum of idle time and equally minimizing the number of operator to do a given amount of work at a given manufacturing line speed.

Different layout Scenarios:

Products variety and volume:

- **Fixed position layout:** It is also called as Static layout/Stationary layout. In this layout the movement of manpower and machines to the product remain stationary. Layout is ideal where the size of job is heavy and large and not applicable for small products or project. It is mainly used in the construction of bulky or fragile projects. Examples: ships, locomotives, aircraft.
- **Process layout:** It is also called as Flexible Flow or Job shop layout. All machines performing similar kind of operation are grouped together at one location. Mainly suitable to job and batch of production. This layout is more suitable for the industry where the products that are gotten from raw material and work in progress entails high variations while processing the individual operations. This layout is more useful in which the manufacturing process is in the batch form as the various products are organized to move from one area to another.
- **Product layout:** It is also called as Flow line layout. The machines and equipments are arranged in one line depending upon the sequence of operation required for the product. It's used for systems with high product volumes and a low variety of products. Product layout has a small cycle of manufacturing which reduce the material handling. In this layout machines and accoutrements are grouped together and thereby enabling supplies to flow material consecutively in a clear and easy to control manner from one point to another as values are being added on them.
- **Cellular layout:** In a cellular layout, machines are grouped into cells, to process families of similar parts. These cells also need to be placed on the organization's shop floor. Thus, one is also generally concerned with so- called intra-cell machine layout problems. In this layout machines and equipment are arranged in order to enhance the steady and uninterrupted movement of materials and tools through the process of production without stoppage and time wastage.

Productivity generally defined as the ratio of an output to the unit of all of the resources used to produce this output. Productivity usually deviates from production. Production concerns an increment in output over a given span of time; productivity is concerned with the ratio of output to an input. Putting in another way, improving productivity has to do with how effectively people combine different resources to manufacture parts and services. With the correct choices, improved production, higher values and elevated incomes can be accomplished for every hour worked.

Layout standardization is a basic requirement of Lean management. If layout gets lean, productivity improves directly in terms of cycle time reduction and reducing non value adding work.

Tasks are to be assigned to workstations in Manufacturing line, so that the predetermined goal is achieved. Minimize of the number of workstations and maximize of the production rate are the most common pretension. Nowadays the actual case of different components manufactured at industries in which productivity improvement is a prime concern; minimize the total production cost and number of non value added work.

Equation used to calculate productivity

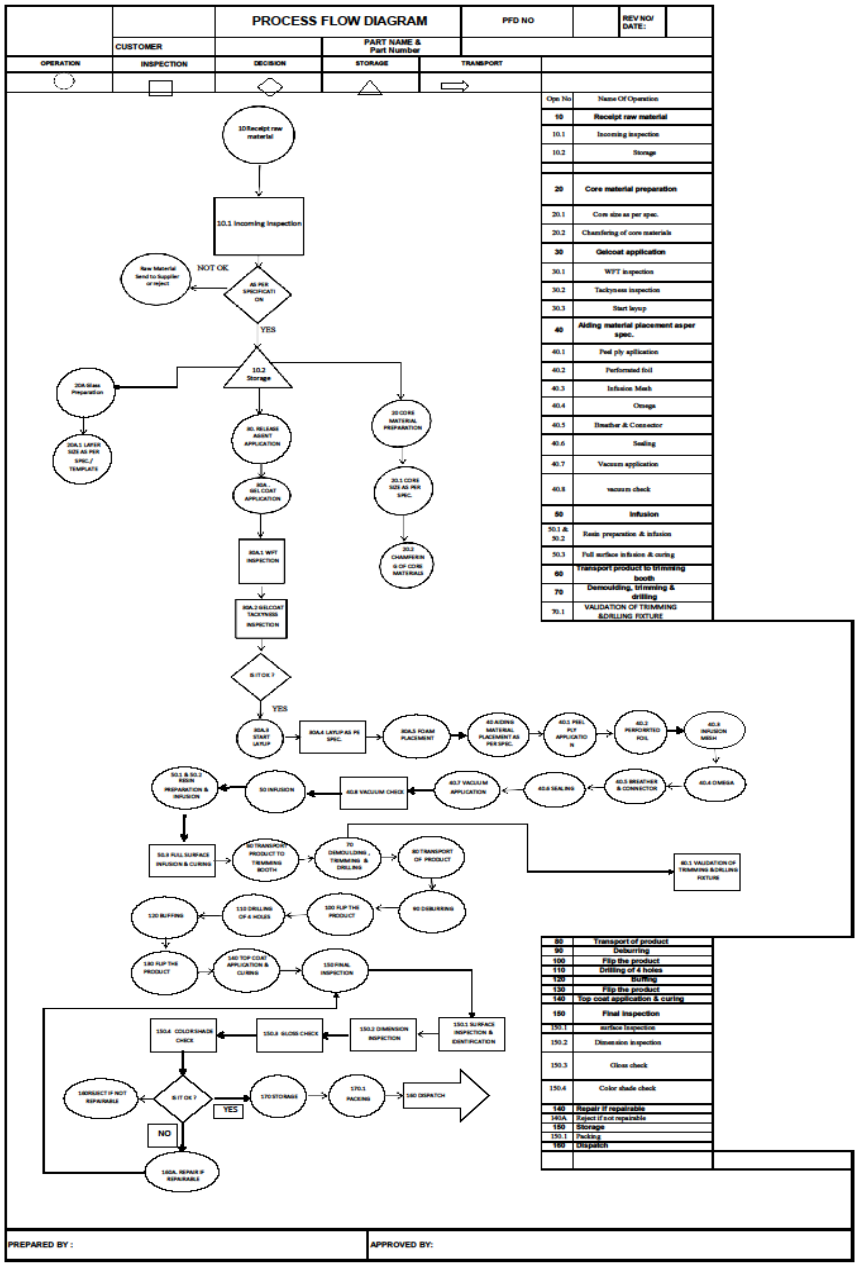
Productivity = Output/Input

Where, Input = Labor ∗ Production time per day (hour)

Equation used to calculate cycle time

Cycle time = Production time per day/ Unit required per day

Take a composite part as an example and see the process flow diagram and to analyze the process timing before and after applying the strategic process layout which are shown below.


PROCESS FLOW DIAGRAM
PFD NO
REV NO/ DATE:
CUSTOMER
PART NAME & Part Number
OPERATION
INSPECTION
DECISION
STORAGE
TRANSPORT
10Receipt raw material
10.1 Incoming inspection
NOT OK
YES
10.2 Storage
Opn No
Name Of Operation
10 Receipt raw material
10.1 Incoming inspection
10.2 Storage
20 Core material preparation
20.1 Core size as per spec.
20.2 Chamfering of core materials
30 Gelcoat application
30.1 WFT inspection
30.2 Tackyness inspection
30.3 Start layup
40 Aiding material placement as per spec.
40.1 Peel ply application
40.2 Perforated foil
40.3 Infusion Mesh
40.4 Omega
40.5 Breather & Connector
40.6 Sealing
40.7 Vacuum application
40.8 vacuum check
50 Infusion
50.1 & 50.2 Resin preparation & infusion
50.3 Full surface infusion & curing
60 Transport product to trimming booth
70 Demoulding, trimming & drilling
70.1 VALIDATION OF TRIMMING &DRILLING FIXTURE
80 Transport of product
90 Deburring
100 Flip the product
110 Drilling of 4 holes
120 Buffing
130 Flip the product
140 Top coat application & curing
150 Final inspection
150.1 surface inspection
150.2 Dimension inspection
150.3 Gloss check
150.4 Color shade check
140 Repair if repairable
140A Reject if not repairable
160 Storage
170.1 Packing
180 Dispatch
PREPARED BY :
APPROVED BY:

Process Timing				
			Before	After
Sr No.	Manufacturing Operation	Manpower/Pc	Time[Min]	Time[Min]
1	Mould Surface Clean	1	10	10
2	Apply coats of release agent	1	10	10
3	Surface preparation for gel coat	1	15	15
4	Gel coat application	2	45	45
5	Wait till gel coat tacky	0	30	30
6	Layup	3	120	120
7	Adding material	3	55	55
8	1st vacuum film sealing	3	25	25
9	1st vacuum check	3	15	15
10	Infusion	2	40	40
11	Cure the laminate for 4 hrs at room temp.	0	240	240
12	Aiding material removal	2	10	10
13	Product De-moulding	2	10	10
14	Product Surface inspection	1	10	10
	Delay time	0	2	0
15	Product trimming	2	120	120
16	Product Drilling	2	120	120
17	Product Preparation for Top Coat	2	15	15
18	Application of Top coat	2	120	110
19	Curing of Top coat	0	35	35
20	Finishing of top coat and edges	2	60	50
21	Identification Sticker Apply surface veil with resin coat on top of sticker	1	10	10
	Delay time	0	2	0
22	QC dimension check	2	30	30
23	Buffing the product	2	25	25
24	check gloss as per QAP	1	15	15
25	Final inspection	1	15	15
	Delay time	0	2	0
26	Packing	3	15	15
	Total MHRS up to final product clearance		**1221**	**1195**

Table 1.1

Before applying the strategic process layout

Productivity = Output / Labor ∗ Time

= 2.5 / 35X10

= **0.00714 pc/labor ∗ time**

After applying the strategic process layout

Productivity = Output / Labor ∗ Time

= 3 / 35X10

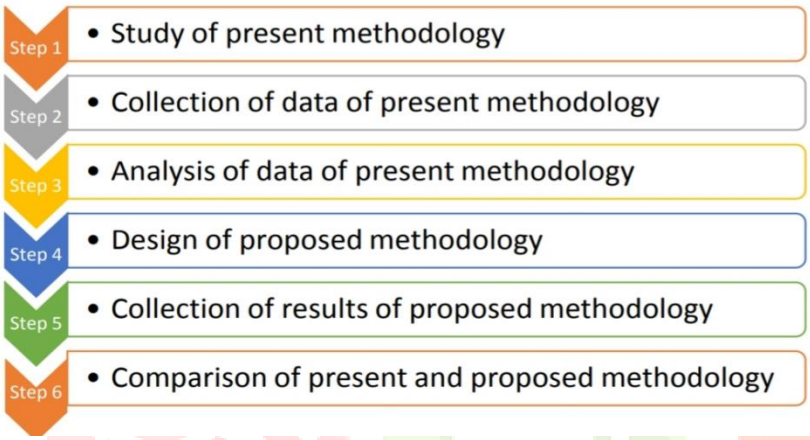
= **0.0085 pc/labor ∗ time**

Before applying the layout the output of the product per day is 2.5 pcs, and after applying the process layout the output of the product per day is 3 pcs.

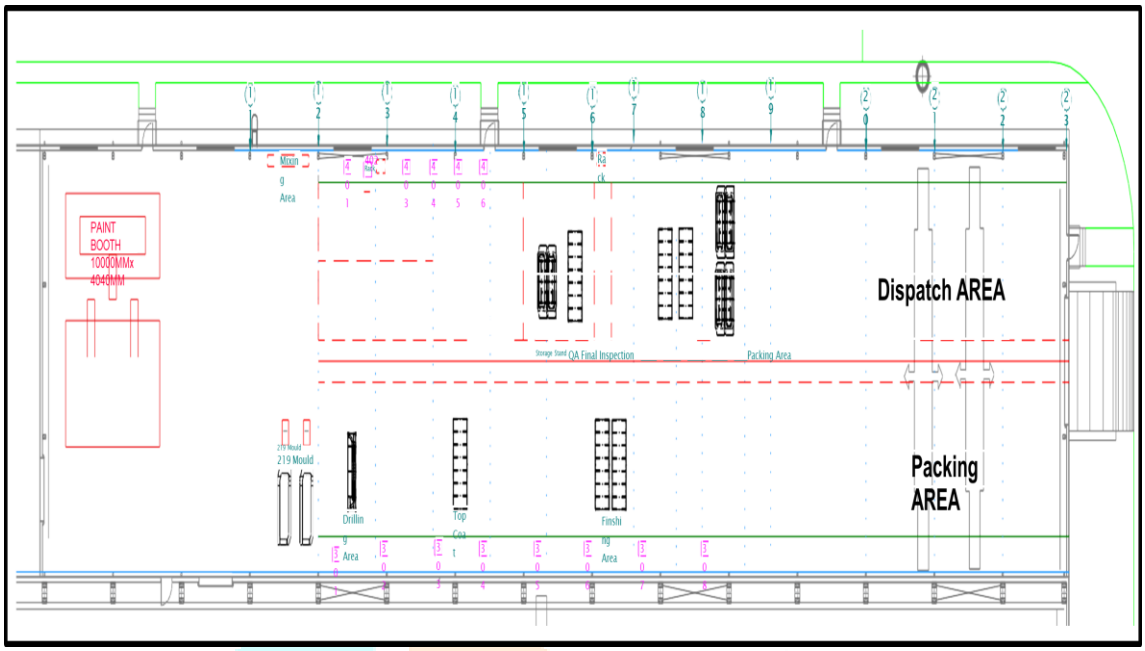
Literature Review:

Many researchers have been done in layouts. Effective strategic layout can reduce the operational costs of a company by 10-30%. Proper analysis of layout design could result in the improvement of the performance of production line. This can be done by optimizing the capacity of a bottleneck, minimizing material handling, reducing cycle time, effective utilization of labor, equipments and space. Strategic process layout is an overall approach concerned with the design, layout and incorporation of people, machines and activities of a system. Strategic layout design defines how to organize , locate and distribute the equipments and support activities in a manufacturing facility to accomplish minimization of overall production time, maximization of company's output in conformance with production and strategic goals. A strategic layout can reduce or eliminate the waste [MUDA]. Layout problem has significant, major and long term impact on material handling inside the plant, total lead time of product to manufacture, work in progress and operating efficiency. A good placement of facilities contributes to the overall efficiency of operations and can reduce up to 50% the total operating expenses (Tompkins et al., 1996).

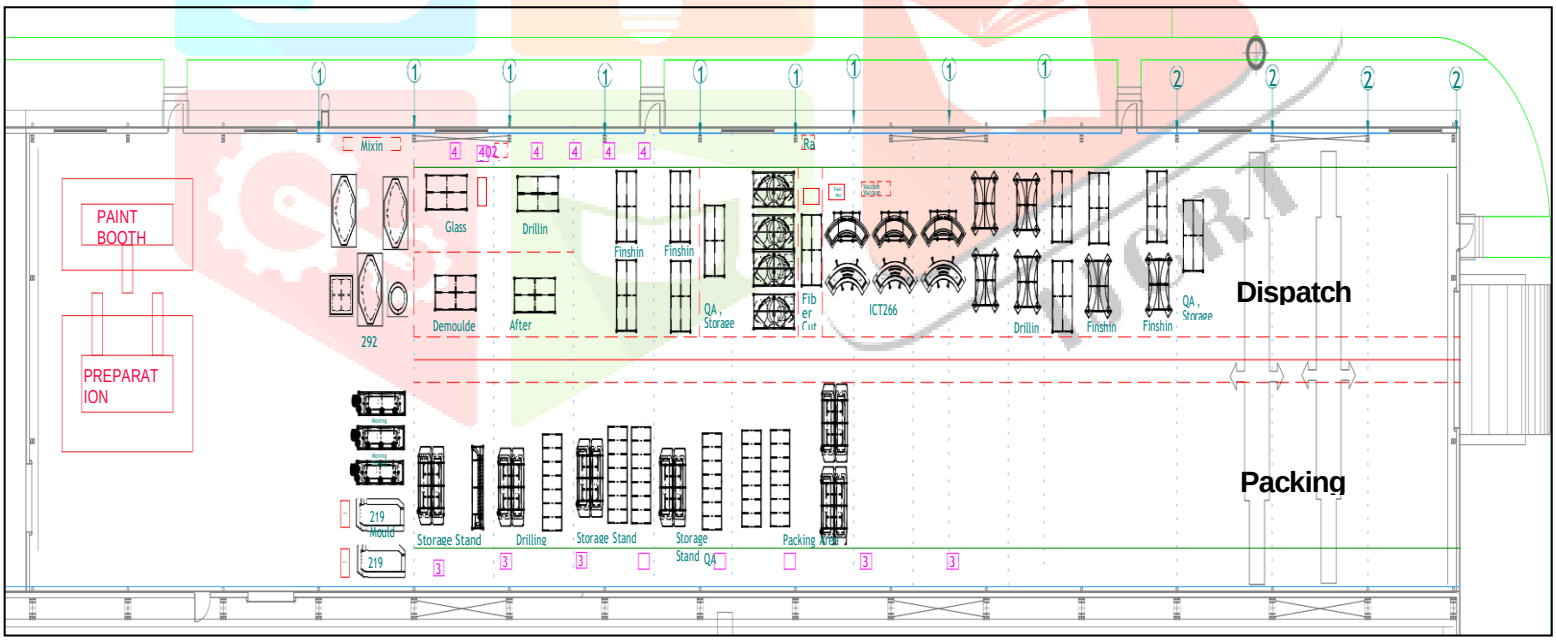
Research Methodology:



Before applying a strategic process layout:



After applying a strategic process layout:



Hypothesis:

A thesis test examine two mutually exclusive claims about a parameter to determine which is stylish supported by the sample data. The parameter is generally the mean or proportion of some population variable of significance to the marketer. The null hypothesis [H0] is the status of the default position that there is no relationship or no difference. The alternative or research hypothesis [HA] is the opposite of null. It represents the relationship or difference. The conclusion of the hypothesis test can be correct or incorrect.

H0: There is no significant difference between process layout and operations.

H1: There is a significant difference between layout and productivity.

Advantages:

- Reduced overhead cost
- Increased utilization of equipments
- Encourages efficient supervision
- High products variety
- Enhanced flexibility
- Increase productivity
- It helps in bottleneck analysis
- It reduces set up time
- It reduces wastes (MUDA)
- Improvise 5S

Disadvantages:

- High work in progress inventory
- Low operations and precious material handling compared to the product layout
- Requires constant inspection
- High production gap
- Requires highly skilled operators

Constraints/Limitations:

- High space requirement. Space requirement is more as compare to product layout.
- Longer production time.
- High production gap.
- It requires changes according to the process.

Conclusion:

From the above study we can summarize that the strategic layout is very much important to improve productivity. And by this study organization can able to achieve the objectives like to provide optimum space to organize equipment, to promote order in production towards a single objective, to make a lean manufacturing process, etc.

This explains the need to have a good strategic operational layout design that will be able to switch from one point to another without major alterations. It will also achieve fast flow of raw materials and work in progress at the lowest cost and less material handling.

From the above table 1.1 we can see that the process layout helps to reduce the time. So that it can improve productivity with the good quality of the product. We can see that all the operations are arranged properly in line which is shown in the design of a strategic process layout..

From the above calculation we can see that because of layout the productivity is increased. Before applying the layout the product made in a day was 2.5 and after applying the layout the product made in a day is 3.

So, it is very important to apply a layout in industry.

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