Effective Improvement of a Plant Layout Using Pugh Matrix Approach

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Abstract - *In this present competitive global manufacturing scenario, it is important to assess the manufacturing cost. Along with machines, equipments, well designed product, advanced precision tooling, and material handling equipment, an efficient plant layout design is required to make effective utilization of these manufacturing facilities. A functional and systematic arrangement of different departments, facilities and services followed by optimal utilization of all resources is essential for a well-organized plant layout. This research paper is aiming to study and improve the current plant layout of the ANSA Technologies and generate three effective plant layouts which are evaluated through Pugh Matrix Approach. Material flow diagram, flow process chart and string diagram for the current plant layout and the three proposed layouts is prepared and are systematically compared to determine the most efficient option for the plant.*

Key Words: *Plant Layout, Pugh Matrix, String Diagram, Flow Process Chart*

1. INTRODUCTION

Plant layout is defined as "The physical arrangement of manufacturing facilities such as machines, equipment's, tools, employees, work stations, material handling, and material storing department in such a manner so as to have minimum material handling at lowest cost and with the minimum amount of handling of work in process, from the raw material receipt to final product, delivery to end customers". The main aim of the layout is to reduce the total throughput time and minimum movement of the material. This can be achieved by eliminating redundant movements of the material during the manufacturing activities. Thus for an effective plant layout care needs to be taken while designing. The plant layout must accommodate space for support functions. Hence, while designing, principles of plant layout have to be adhered. When the term plant layout design comes into picture it also refers to the new layout to be proposed. In order to increase productivity the new layout has to facilitate minimum material travel for transformation of the raw material to finished goods.

2. LITERATURE REVIEW

Amrita et al. studied the plant layout of the coupling manufacturing industry which was located at Pune, Maharashtra and deigned a better more efficient layout thus saving Rs 364.625/-per day of the material handling cost. Major problems faced by the plant layout were mainly, manufacturing delay and extra transport cost. To increase the production, product quality and to minimize the material handling movement within entire industry a new layout was designed. Orviue Sutari proposed layout for the Nacelle and Nose cone manufacturing industry reduced a total distance of 339.05m to produce one set of nacelle and nose cone and that results in increased productivity. An effective plant layout design ensures that there is a smooth and single line flow of material which can be obtained by eliminating backtracking of material travel. If there is a backtracking of material movement there will a chance of mixing up of product, and also unwanted interaction with the other paths, thus resulting in a more work in process.

3. TOOLS AND TECHNIQUES

3.1 String Diagram

A string diagram can be used to plot the movement of material and this is done especially when a work study person wants to find out easily just how far the materials travel. During a specified sequence of events relating to the movements of material, men, equipment etc., a thread is used to measure overall distance travelled. A measured length of thread is then taken and tied round the pins at the string points of movement. Hence, it is necessary that the string diagram be drawn correctly to scale including all the equipment's and doorways, pillars and partitions, which affect path of movement.

3.2 Flow Process Chart

The process flow chart is a chart used for recording the process in a compact manner. This chart is setting out the sequence of the flow of a product for recording all events under review using appropriate process chart symbols. This chart represents each activity that occurs during a

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series of actions. The process flow chart was prepared for both existing and proposed layouts.

3.3 Material Process Chart

The material flow diagram is the representation of the physical route or flow of men, material, equipment, vehicle and communication associated with a process. The material flow diagram has been prepared for both current and proposed layouts.

3.4 Outline Process Chart

An outline process chart is a chart which gives an overall picture by recording sequences of only the main operations and inspections. Only the principle operations are carried out and the inspections made to ensure the effectiveness of the process are recorded, irrespective of where they are performed. While preparing this chart, only the symbols for "operation" and "inspection" are used.

4. CONCEPT GENERATION & DESIGN

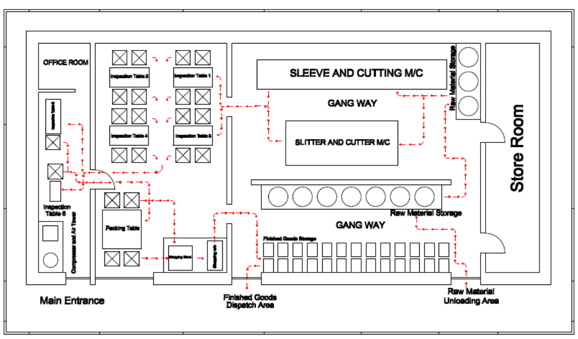

Fig - 4.1: ANSA Technologies Previous Plant Layout

The plant layout design plays a vital role, in order to increase productivity, quality and to reduce total throughput time.

For the ANSA Technologies, Previous Plant Layout has been shown in figure 4.1. Three concepts namely concept A, B and C are generated by arranging machines, departments and equipments. These concepts are evaluated through Pugh Matrix approach by setting certain plant layout criteria.

4.1 Proposed Plant Layout Concept A

In this proposed concept, as shown in figure 4.2, the entire floor space available is divided into three zones with the slitting & cutting machine and sleeving & cutting machines positioned in one zone and raw material, finished goods in another. The remaining available zone is employed for inspection and packing purpose. These sections are arranged in a manner to ensure a straight line flow of material movement. The major advantage of this layout design is flexibility in material handling, changing of process and operation. In the inspection region, inspection tables 4 and 8 are smaller than other tables. Hence two carton boxes are placed and minimum numbers of workers are allocated to these tables. For the remaining inspection tables, four carton boxes are placed wherein two carton boxes are used to load the rejected products and another two for defect free quality products.

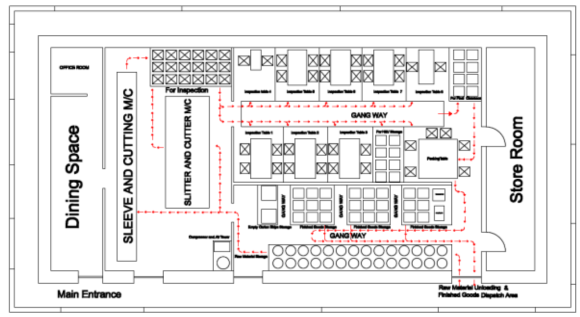

Fig - 4.2: Proposed concept A

4.2 Proposed Plant Layout Concept B

This concept differs from the earlier one wherein the position of raw material and finished goods storage are interchanged as show in CAD drawing 4.3. Also the gangway width is more than concept A. The wrapping stand and strapping machines are positioned near the finished goods storage in concept A. But in this concept they are in the inspection section and also positioned closer to the packing table. The belt conveyer system is introduced in this concept as shown in CAD drawing 4.3, and it is installed in the inspection section. The conveyer moves continuously. The products from the production section are loaded into the boxes. These boxes are kept on the conveyer and picked up by workers near the inspection area. After inspection, the boxes are moved towards the packing table.

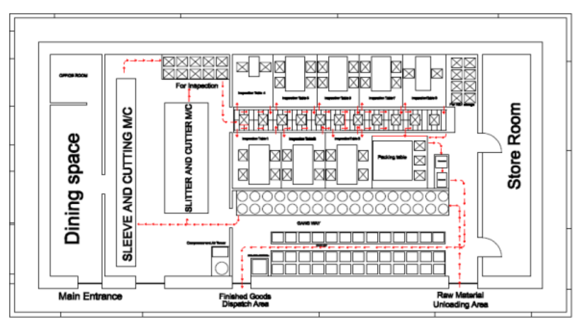

Fig - 4.3: Proposed concept B

4.3 Proposed Plant Layout Concept C

In this concept two carton boxes are placed at left side of the inspection tables and two are at the wall side as shown CAD drawing 4.4. By this arrangement, it is possible to provide more space between inspection tables.

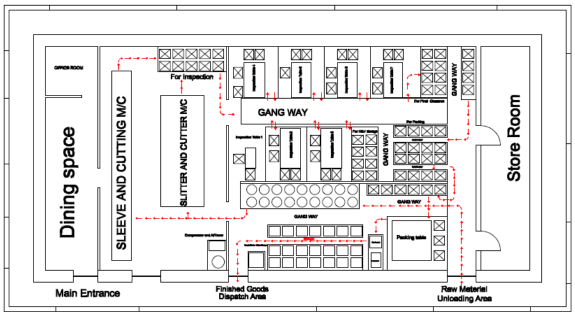

Fig - 4.4: Proposed concept C

The packing table is positioned near the finished goods inventory. Moreover wrapping stand and strapping machine are located closer to the packing table. The gang way width is more when compared with other two concepts A and B.

5. CONCEPT SELECTION

Concept selection is the activity in which various concepts are analyzed and sequentially eliminated to identify the most promising concept. It is a decision making matrix. This method was developed by Stuart Pugh (PM) in 1980s and often called as Pugh Concept Selection. For the evaluation of plant layout design, the following criteria are considered.

1. Single line material flow

2. Availability of space between each inspection table

3. Minimum material handling

4. Ease of material handling

5. Work in process

6. Gangway width

7. Maintenance

8. Safety

9. Cost

5.1 Concept Selection by Pugh Matrix Approach

The Pugh Matrix (PM) is a type of Matrix Diagram that allows for the comparison of a number of design candidates leading ultimately to which best meets a set of criteria. The Pugh Matrix is easy to use and relies upon a series of pair-wise comparisons between design candidates against the number of criteria or requirements. And it also has the ability to handle a large number of decision criteria.

Table - 1: Pugh Matrix Approach for Concept Selection

Concept Selection Matrix (Pugh Matrix)			
Selection Criteria	Concepts		
	concept A (Reference)	concept B	concept C
Single line material flow	0	0	0
Availability of space between each inspection table	0	0	+
work in process(optimum)	0	0	+
Minimum material handling	0	0	+
Ease of material handling	0	0	+
Gang way width	0	0	+
Maintains	0	-	0
Safety	0	0	+
Cost	0	-	+
sum + 's	0	0	7
sum 0's	9	8	2
sum -'s	0	2	0
Net score	0	-2	7
Rank	2	3	1
Continue?	No	No	Yes

In Pugh Matrix Approach these steps are followed:

- Define the selection criteria which are used for comparing the generated concepts.
- Choose a reference concept, against which all other concepts are rated and ranked.
- Rate the concepts. The rating is assigned as better (+), same as (0) and worse than (-) in each cell to rate each concepts in comparison to reference concept related to the particular selection criteria.
- Rank the concepts. In ranking process all the negative, positive and zero are added and then sum of the entire negative, positive and zero are entered to respective cells.

For the ANSA Technologies plant layout, the concept C has been chosen because it has higher net score when it is compared with other concepts A and B as observed in table 1.

6. RESULTS

The proposed plant layout design was implemented in the ANSA Technologies leadings to improvement in:

6.1 Productivity: After implementing the proposed plant layout "C" in the ANSA Technologies, all the non-value added activities are eliminated and a direct path is provided between inspection and packing section. By this the material travel and throughput time is reduced leading to increased productivity.

6.2 Product Mix-Up Eliminated: In the previous plant layout, there was a backtracking of material movement between the inspection and packing section, which resulted in product mix-up. However, the proposed plant layout is designed and implemented in such a way that the flow of material movement is in a single line. This results in eliminating the back tracking between the inspection and packing section, which eliminates product mix-up.

6.3 Space Provided Between Inspection Tables: In the previous plant layout, there was an obstruction in material movement in between the inspection tables because of improper spacing of inspection tables. After implementing the proposed plant layout "C", the proper space provided between the inspection tables results in an easy to movement of material, men and equipment between them.

6.4 Safety: In ANSA Technologies, the safety precautions like mask, gloves and head cap have been made mandatory for all the workers.

After the implementation of the proposed layout, the material travel distance for both Slitting machine and the Sleeving machine are reduced by 2.69 % and 3 % respectively as shown in figure 5.1. This results in an overall reduction of 2.81 % in the material travel across the factory.

Table – 6.1: Reduction in Material Travel Distance

Parameter	Previous Layout Material Moved Per Unit (m)	Proposed Layout Material Moved Per Unit (m)	Reduction In Material Travel (%)	Distance Saved (m)
Slitting & cutting machine	3,130.75	3,046.33	2.69	84.42
Sleeving & cutting machine	3,139.92	3,048.04	3	91.88

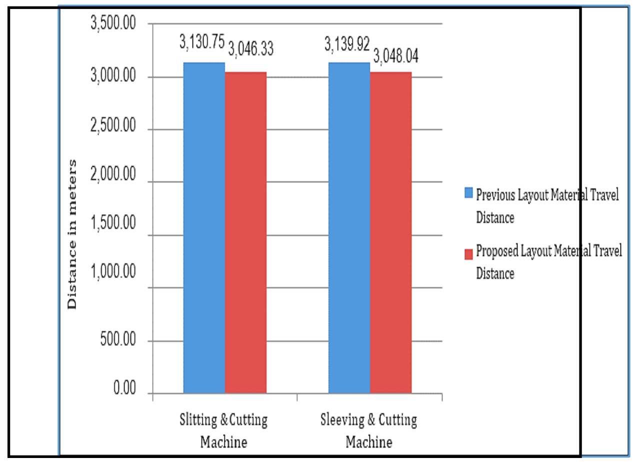

Fig – 6.1: Material Travel Reduction

7. CONCLUSIONS

The success of any industry depends on the efficiency of the plant layout design, which should not only be easy to run and maintain but also can easily adapt to the customer demands as well as numerous technological changes. Different options of plant layout have been examined in detail for this paper. Through different techniques of method study, wide range of data has been recorded and analyzed followed by systematic comparison between the previous layout and the proposed layouts. Based on the results of these scrutiny, concept C gives the most efficient option by reducing the overall machine travel distance by 2.81 %. The reduction though small will decrease the time and fatigue of the workers tremendously for the short duration by repetitive work performed in the ANSA Technologies.

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