

Optimization of Plant Layout Using SLP Method

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ABSTRACT: In this paper, ongoing engine reconditioning process layout of an automobile industry are studied and a new layout is developed based on the systematic layout planning pattern theory to reduce engine reconditioning cost and increase productivity. Since it is an automobile assembly plant, the company has both processes as well as product layouts. The number of equipment and travelling area of material in engine reconditioning have been analyzed. The detailed study of the plant layout such as operation process chart, activity relationship chart and the relationship between equipment and area has been investigated. The new plant layout has been designed and compared with existing plant layout. The new plant layout shows that the distance and overall cost of material flow from stores to dispatch area are significantly decreased. The implementation of proposed model will help in the overall improvement of production performance of the engine reconditioning unit of the corporation.

KEYWORDS: Plant layout, Systematic Layout Planning, Flow analysis, Activity relationship chart, SLP

I. INTRODUCTION

The paper titled “Optimization of plant layout for a Maharashtra State Road Transport Corporation (MSRTC)” is aimed at identifying some of the major problems regarding the present layout of the engine reconditioning unit of a public sector transport corporation under the government of Maharashtra, and to develop an efficient layout design, so as to improve the production performance of the firm. Facility planning is very important in manufacturing process due to their effect on achieving an efficient product flow. Proper analysis of facility layout design could improve the performance of production line such as decrease bottleneck rate, minimize material handling cost, reduces idle time, raise the efficiency and utilization of labour, equipment and space. The basic industrial layout planning is applied to a 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 product flow through the plant. The study addresses these problems by designing a product layout with the principles of systematic layout planning for enhanced productivity and higher product outputs at the scheduled time or at a shorter cycle time.

II. LITERATURE REVIEW

Many types of research have been done in facility planning area. Effective facility planning can reduce significantly the operational costs of a company by 10- 30%. Proper analysis of facility layout design could result in the improvement of the performance of production line. This can be realized by optimizing the capacity of a bottleneck; minimizing material handling costs; reducing idle time; maximizing the utilization of labor, equipment and space. Wiyaratn and A. Watanapa study plant layout of iron manufacturing based on the systematic layout planning pattern theory (SLP) for increased productivity. Alternate layouts can be generated using lean layout concepts such as “group technology” and “systematic layout planning”, which facilitate relocating the equipment according to product processing. The main Production Line Balancing Problems such as queuing, idling time etc can be minimized by Multi-Objectives Model (MOM) and Genetic Algorithm (GA). The outcome of the Mixed Models (MM) assists to reduce the queuing and the idling time through harmonizing the tasks in each workstation. In addition, to balancing the distribution of the new workers in order to get the optimal solutions, as well as improving the ability of PL with the high production rate. The most well known heuristic methods in optimizing layout design are Tabu Search (TS), Simulated Annealing (SA), and Genetic Algorithms (GA). Tabu Search (TS) is a mathematical optimization method, belonging to the class of local

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search techniques. A genetic algorithm (GA) is a search technique used in computing to find exact or approximate solutions to optimization and search problems. Simulated annealing (SA) is a generic probabilistic metaheuristic for the global optimization problem of applied mathematics, namely locating a good approximation to the global minimum of a given function in a large search space.

III. BASIC OPERATION OF MANUFACTURING

In MSRTC Central workshop, Engine reconditioning unit deals with the reconditioning and assembly of diesel engines. They are doing reconditioning work for different types of engines a) 697(TCIC), b)TC Euro1, c) TC Euro 2, d) TC Euro 3.

Presently, around 40 employees are working in this unit. With the present manpower, they can recondition a maximum of 105 engines per month. The basic steps involved in reconditioning an engine are:

- a) O.D.S (Old store)
- b) Stripping (degreasing and dismantling)
- c) Pre-inspection
- d) Auto machine shop
- e) General machine shop
- f) Subassembly
- g) Assembly line (engine section)
- h) Fuel injection pumps section.
- i) Final inspection.

IV. PROCEDURE FOR SYSTEMATIC LAYOUT PLANNING (SLP)

The systematic layout planning (SLP) is a tool used to arrange a workplace in a plant by locating two areas with high frequency and logical relationships close to each other. The process permits the quickest material flow in processing the product at the lowest cost and least amount of handling. Systematic Layout Planning is an organized way to layout planning. It involves of procedures, based on conventions for identifying, rating, and visualizing the elements involved in planning a layout. The detailed procedure for SLP is shown in the figure1.

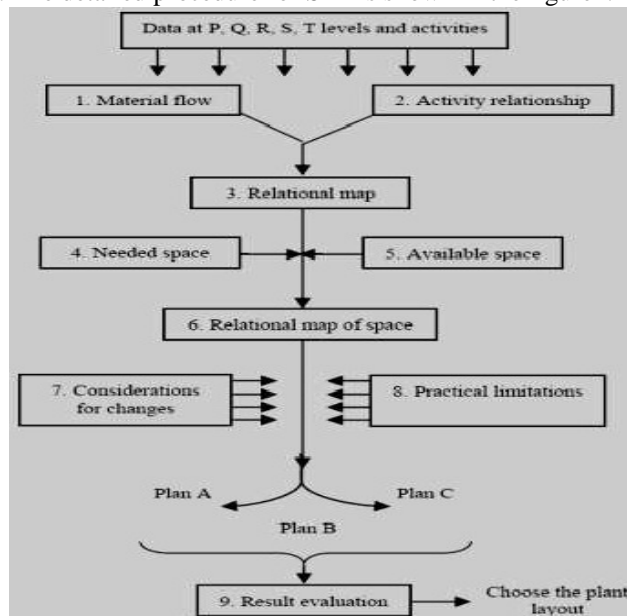


FIGURE 1: SLP PROCEDURE BLOCK DIAGRAM
(In the above figure procedure for systematic layout planning is explained)

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V. PROBLEM DESCRIPTION

In engine reconditioning unit, the work centres are not located in the order of product flow. Hence prolonged movements and several cross movements are existing in the present layout. Also, so many time-consuming activities exist in the present layout due to the lack of proper equipment. The other issues coming under the present layout are work delays, human safety issues, etc. In order to achieve a smooth material flow and to make the working environment more flexible, the existing plant layout needs to be modified. Hence, we can use plant more effectively. Thereby, the cost of production per engine can be reduced also; the productivity of this unit can be raised.

A. EXISTING LAYOUT OF THE COMPANY

The present layout of the engine reconditioning unit of the company is shown in figure 2. In the existing layout; the work centres are not located in the true order of product flow. The data regarding the present layout of the bus body building unit is shown in the table 1.

TABLE 1: PRESENT LAYOUT DATA

No of Work Stations	11
No of Work Centres	20
No of Employees	40
No of engine reconditioned per month	105
Total area of Plant	25380 sq ft
Labour cost	10,000 R.s
Total cost of reconditioning per engine	50,000 Rs
Total flow time per engine	92 Hrs

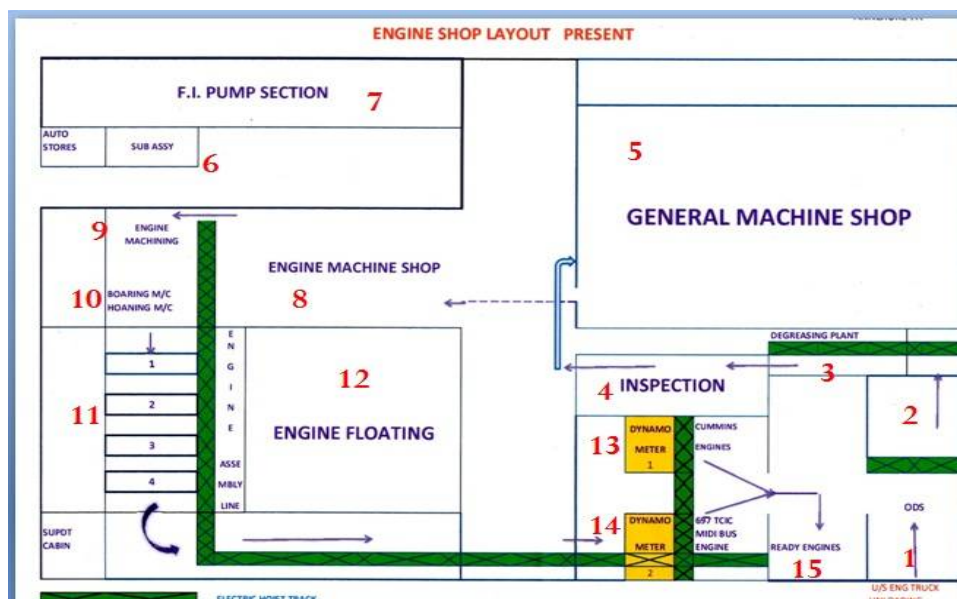


FIGURE 2: PRESENT LAYOUT

In this figure, different workstations are marked by numerical values as for the ease in analysing the material flow between different workstations

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B. ANALYSIS OF EXISTING LAYOUT

In this section, the existing layout is studied in detail to facilitate improvement. As a part of the work the first step to being done is a collection of department details. The precedence diagram is drawn along with this to gain a basic understanding of the material flow and also to identify the major activities and its successors as well as its predecessors. The precedence diagram that has been used is given in fig 3.

TABLE 2: AREAS OF DEPARTMENTS

Sr No	Department name	Area (sq ft)	Sr No	Department name	Area (sq ft)
1.	ODS	1200	9.	Crankshaft Grinding M/c	400
2.	Stripping	1680	10.	Boring/Honing	450
3.	Degreasing	480	11.	Assembly Line	2000
4.	Pre-Inspection	800	12.	Engine Floating	3200
5.	General M/c Shop	4000	13.	Dynamometer 1	1400
6.	Sub Assembly	620	14.	Dynamometer 2	1400
7.	F.I Pump Section	800	15.	Ready Engines	2400
8.	Engine M/c Shop	1350			

As a part of the analysis, distance matrix and flow matrix is to be prepared. The distance matrix has been developed using the rectilinear distance between the departments having material flow. The rows and columns in the matrices indicate the departments and are given numbers from 1-15 in table 2. The flow matrix is developed by calculating the number of trips travelled for per product for the departments having material flow.

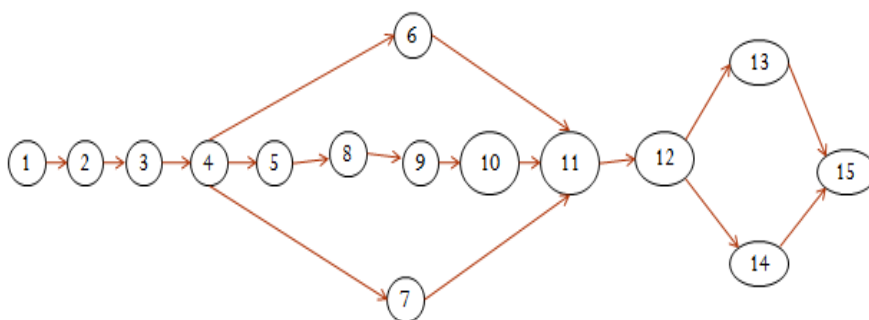


FIGURE 3: FLOW DIAGRAM

In this figure, material flows between different work stations are shown. Arrowhead shows the material flow between workstations and numbers 1-15 represent the station number.

C. DETERMINING MATERIAL HANDLING COST

For analysis, the unit cost of material flow is required. Since this is not available with the company, it is calculated indirectly as below. Total reconditioning cost per engine is Rs 50,000 as given by the company and assuming material handling cost is 20-25% of the total production cost per engine. For analysis taking 20% material handling cost, then material handling cost is Rs 10,000.

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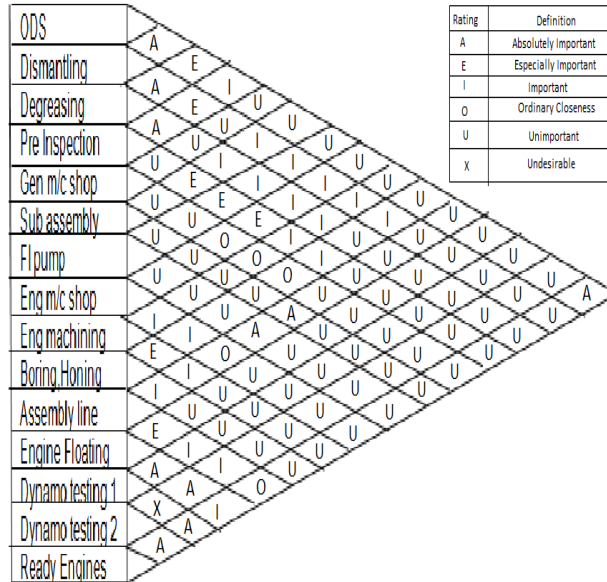


FIGURE 4: RELATIONSHIP CHART

Activity Relationship chart or REL chart gives the information about the closeness between the departments. In REL chart, all pairs of relationships are evaluated and closeness rating (A, E, I, O, U) is assigned to each pair.

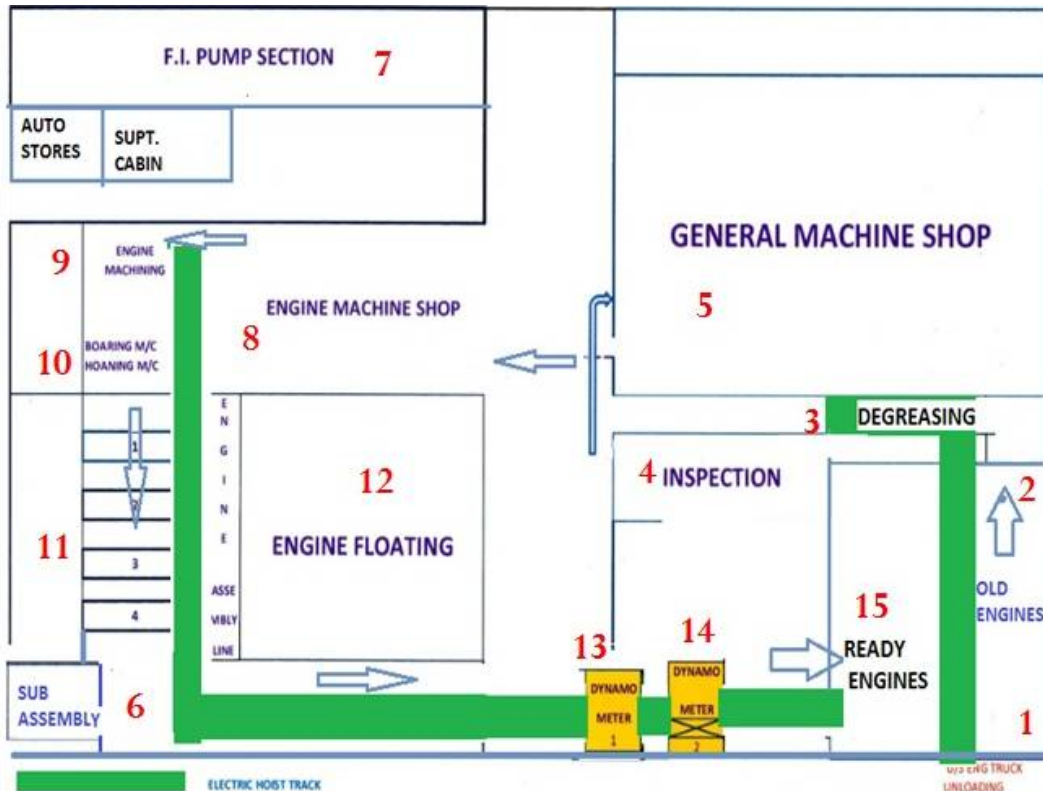


FIGURE 5: MODIFIED LAYOUT

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VI. MODIFIED LAYOUT DESIGN

A. ANALYSIS PLANT LAYOUT BASED ON SLP

According to the study of the manufacturing process, it was found that the long distance could be reduced for moving raw materials and the useless area could be minimised. The way to improve the plant was to apply SLP method to make the workflow continually by arranging the important sequence of the manufacturing. Then the relationship of each activity in closeness area was considered to make the relationship of each activity in the form of a chart as shown in Fig 4, and the closeness value is defined as A = absolutely, E = especially important, I = important, O= ordinary closeness, U= unimportant, X= undesirable. The detailed distances for each activity were described in Table 3, as follows:

The important sequence of each activity was rearranged from the most important one to the least important one. The intensities of flow from each activity to another were developed. Based on modifying plant layout and practical limitations, a number of layouts were developed and the best suitable layout was chosen.

The present layout and modified layout can be analysed in terms of following parameters.

1. Distance
2. Production time (Flow time)
3. Labour cost

TABLE 3: DISTANCE

No	Operation	Distance (ft)	No	Operation	Distance (ft)
1.	ODS	-----	11.	General m/c shop to Boring/honing	50
2.	ODS to Stripping	50	12.	Boring/honing to assembly line	50
3.	Stripping to Degreasing	24	13.	Sub-assembly to assembly line	60 (136)
4.	Degreasing to Pre-Inspection	32	14.	F.I pump to assembly line	177
5.	Pre-Insp to Gen m/c Shop	40	15.	assembly line to engine floating	39
6.	Pre-Inspection to F.I Pump section	70	16.	engine floating to Dynamometer 1	36 (86)
7.	Pre-Inspection to Sub-assembly	120 (130)	17.	engine floating to Dynamometer 2	46
8.	General m/c shop to Eng m/c Shop	45	18.	Dynamometer 1 to Ready engines	30 (60)
9.	Engine m/c shop to crankshaft grinding	10	19.	Dynamometer 2 to Ready engines	20
10.	crankshaft grinding to the assembly line	70		Total distance	969 (1135)

One of the major highlights of the modified layout design is that the locations of work centres are in the true order of product flow. Also, crossover and longer movements are less in the modified layout design when compared with the present layout. Hence, the distance travelled by the material can be reduced to a greater extent in the modified layout. By implementing the proposed design, we can also improve the production performance parameters like flow time, line efficiency etc.

In order to implement the modified layout design, so much of restructuring is not required. One of the major step to be taken as a part of the layout modification is that rearranging the location of work centres as per the modified layout design. Also, the new locations of the store as per the modified layout design will help to access the raw materials very easily. No extra space is required to implement the modified layout design.

1. Distance

In the present layout, the total distance travelled by the material is 1135 ft. While in the case of modified layout, the total distance travelled by the material is 969 ft. The distances travelled by the material came down by 15%, which can be seen clearly in the distance matrix of modified layout.

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2. Production time (Flow time)

In present layout, production time required for reconditioning an engine is 92 hrs. Since the time taken for transportation is also a function of total task time, the reduction in total distance will also reduce the total production time. Thus, an overall reduction in travelling time of material was reduced by 185 min i.e. equal to a total reduction of 3.08 hrs as shown in table 4.

TABLE 4: OPERATION TIME

NO	Operation	Time Taken After (Before)
1.	Pre-Inspection to Sub-assembly	55min (60)
2.	Sub-assembly to assembly line	10 min (120)
3.	engine floating to Dynamometer 1	15min (60)
4.	Dynamometer 1 to Ready engines	20min (45)

3. Increase in no of engines reconditioned

From Table 1 we get that 105 engines are reconditioned per month. Therefore, a total of 3 engines gets reconditioned in 9 hrs. Hence for one engine, a total of 3 hours is required.

Now with the reduction of production time by 3.08 hrs per day, a total of 30 more engines can be reconditioned per month. This will enhance the total production of MSRTC and increase in productivity from 105 engines to 135 engines per month.

4. Labour cost

Since production hours are directly related to labour hours, reduction in total production time will reduce the total labour hours.

VII. COMPARISON OF PLANT LAYOUTS

The results obtained were analysed and compared in terms of several parameters which are shown in table 5. The existing layout and modified layout were compared in terms of parameters such as distance, flow time and production rate.

TABLE 5: COMPARISON OF PLANT LAYOUT

Sr No	Parameters	Existing Layout	Modified Layout
1.	Distance	1135	969
2.	Production time (Flow time)	92 Hrs	88.92 Hrs
3.	Production rate	105	135

VIII. CONCLUSION

The proposed model based on SLP is found to be effective in solving the above-mentioned problems. The production rate increased by 28%, the production time per bus came down by 3.34% and total distance travelled by material came down by 14%. In this paper per unit cost and distance are considered to improve existing layout but there are many other parameters to analyse the layout that may be worker number, the area required, equipment required. Due to Lack of opportunity and practical limitations above two parameters are used in our calculation. The problem of existing layout is the large comparative distance between several departments that's forced to travel a long distance and impedes the smooth material flow and leads to higher cost. In our proposed layout the position of various departments is altered with various others based on activity relationship chart. It is expected that the this proposed model will mostly

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be preferable while setting up a new plant implementation and will help in the overall improvement of production performance of the engine reconditioning unit of MSRTC.

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BIOGRAPHY



Shubham Barnwal, is a student Scholar at Department of Mechanical Engineering, Shri Ramdeobaba College of Engineering and Management, Nagpur. He is actively involved in research projects related to automotives and refrigeration and is an active member of SAE India. He has also participated and contributed in BAJA, a vehicle design and development projects by SAE INDIA. He has also published research paper on Thermal Barrier Coatings and Different processes to apply them He is presently working on portable personal cooling systems for people working in hotter zones so as to establish micro-climate cooling.



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