OPTIMIZATION OF MANUFACTURING PLANT LAYOUT DESIGN IN SIFL USING CRAFT

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Abstract
The plant layout consists of mechanical units, machines, material handling devices the path of the product and raw material movement, production flow and the distances between the departments. The designing of a new plant layout means to achieve remarkable improvement in efficiency, manufacturing cost, lead time, travelling distance and overall production cost and it is done by reallocating the equipment's positions in the layout. This study was carried out by taking the case of forging shop in SIFL. This paper is a combined study of plant facility reallocation with the help of Computerized Relative allocation of Facility Technique (CRAFT) and simulation study carried out by using ARENA simulation software. The best plant layout model identified by CRAFT by trial and error method and the best layout is analyzed using ARENA. The main of this paper is to redesign the plant layout in order to achieve better plant layout utilization and improve efficiency of the plant
Index Terms: Facility Layout; CRAFT Algorithm; Plant Layout optimization

I. INTRODUCTION

Increasing global competition has evolved a manufacturing environment which gleans vast product configuration, reduced lead times, and increased standards of quality and competitive costs. In parallel with a rising trend toward globalization, these manufacturing facilities must be designed to cater for new challenges to survive and grow in the marketplace. Plant layout is the arrangement of desired machinery and equipment of a plant in a way which will permit the easiest flow of materials, at the lesser cost with minimum handling, in processing the product from the raw materials to the dispatched of the finished product. Layout decisions entail determining the placement of departments, work groups within the departments, workstations, machines, and stock-holding points within a production facility. The objective is to arrange these elements in a way that ensures a smooth work flow (in a factory) or a particular traffic pattern (in a service organization).It is important to have a well-developed plant layout for all the available resources in an optimum manner and get the maximum utilization of the capacity.

II. AREA OF STUDY

The area of study is to design and develop a plant layout so as to improve the plant efficiency and machine utilization this study is carried out by taking the case of forging shop layout Steel & Industrial Forgings Ltd., (A Govt. of Kerala Undertaking),Athani, Thrissur, Kerala.

The metal forging industry started with one 10T Forging Hammer and related machinery. During the first phase of expansion one more forging hammer with 6T capacity and other related machinery were added. 16T Hammer added to the forge shop in 2013. Due to the addition of facilities in the same shop, product movement becomes more complicated and time-consuming. This adds cost and affects productivity. The installed production capacity was 7500MT per annum. But during 2015-16, production was 3850MT. This show the problems exists in the production line in SIFL

III. PROBLEM FORMULATION

Finding the most efficient arrangement of each workstation with unequal area requirements

within a facility is the main concern of the facility layout problem the main objective of this facility layout problem is to minimize the material handling costs inside a facility which is subjected to two sets of variables:

A. Workstation and floor area requirements

B. Workstation location restrictions

The present layout is studied in detail which has unutilized spaces. The facility design should be such that it accounts for most of the production.

Figure 1. Represents the existing layout of the plant and the each department is mentioned.

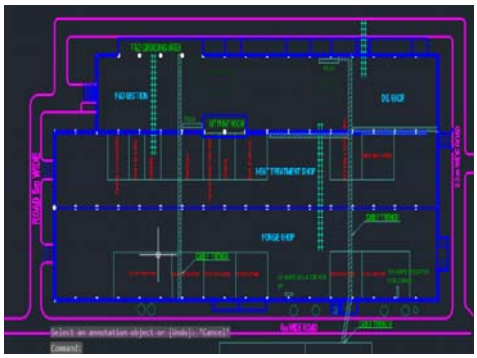

Figure 1. Plant layout

Due to several stages of expansion of production shop, manufacturing units/ machinery location was not in line with the production process. This also added to time delay in product shifting from one location to another.

IV. CRAFT ALGORITHM APPROACH

Computerized Relative Allocation of Facilities Technique (CRAFT) was proposed in 1964by Buffa [1] and it is also called as the computerized heuristic algorithm which takes inputs of the load matrix of interdepartmental flow and transaction costs with a representation of a block layout. The existing layout or new facility or any initial arbitrary layout is considered as a block layout. After that, the algorithm calculates and computes the department allocations and estimate the cost incurred on the layout which is observed as an initial traveling cost of the layout.

For performing the CRAFT operations each department are measured by its area and its centroids are identified, each department have separate color and number

Department	Color	rea-require	rea-define	x-centroid	y-centroid	Sequence
Band saw cutting	1	60	60	47	5	1
Sifcon furnace	2	60	60	38	25	2
6 ton hammer	3	90	90	45.5	25	3
500 ton press	4	60	60	26	25	4
Savitha furnace	5	60	60	14	25	5
16 ton hammer	6	110	110	5.5	25	6
1000 ton press	7	60	60	20	25	7
st stage inspecti	8	60	60	41	5	8
Heat treatment	9	60	60	27	5	9
Shot blast	10	80	80	14	5	10
ond stage inspe	11	30	30	19.5	5	11
Grinding	12	30	30	22.5	5	12
Punching	13	30	30	8.5	5	13
Final inspection	14	30	30	5.5	5	14
cking and despa	15	40	40	2	5	15

Figure 2: Cell area and department details

Present plant layout of the production plant with corresponding cell areas is shown in figure 1 & 2

All the departments are arranged in the exact locations in the craft worksheet. Department can easily identify by its separate color the total area is divided into cells and each cell has same number that represents which department it belongs. Figure 3 represents the craft model of the plant layout.

The workflow from each department to other is studied and a string diagram is designed in order to understand the flow process. The black line in Figure 3. Represents the workflow

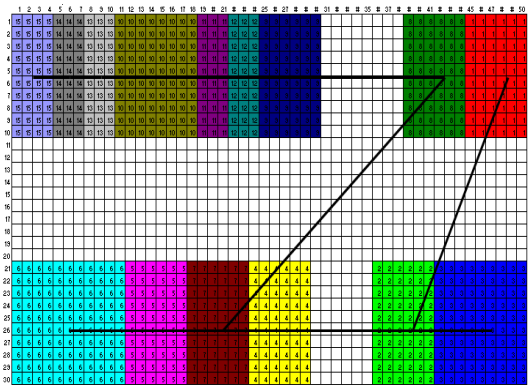

Figure 3. CRAFT model represents the workflow

The total cost (Z) for handling for the present layout is calculated using the formula

Total cost

$$(Z) = \sum_{i=1}^{N} \sum_{j=i+1}^{N} Cij\ fij\ dij \quad (1)$$

Where

Fij is the flow from department *i* to department *j*

dij is the distance from department *i* to department *j* *cij* is the cost/unit of travel

By using the above (1) and by using CRAFT the total handling cost of the present layout is found to be 176,

i.e. total handling cost = 176

For the better improvement of the plant layout, different departmental interchanges are need to change . The departmental interchanges that are possible are based on the

- Department having common border
- Department having equal area

Pair wise interchanges are considered.

For the present problem two departments i.e. 6T Hammer and 16T Hammer are fixed. All others are variable. For the present problem, only one interchange/ iteration is possible.

After performing possible interchanges by trial and error method most successful design was constructed that shown in Figure 4 below.

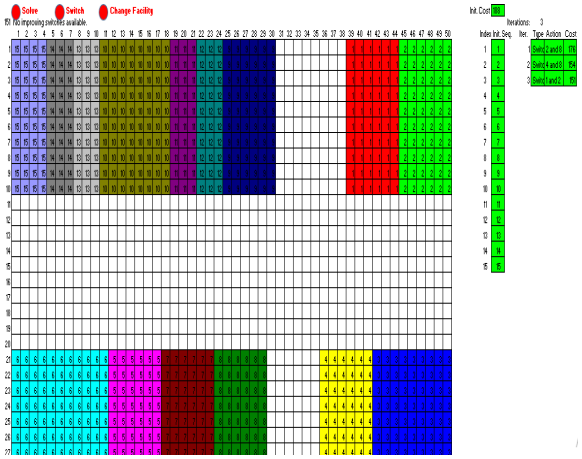

Figure 4. Modified CRAFT model

The total cost of the new layout is 151.Compare the cost of new layout with the cost of present layout. It is found that it is lower than the previous layout.

After completing the simulation, it is found that the modified production plant layout yields the best results compared to the existing layout in terms of travel distance, average machine utilization, average transporter utilization and average flow time. On top of that, no extra space is needed for the modified layout as represents in figure 5. This will enable the smooth process of machine transfers within the production plant. The handling cost of the modified plant layout is lower than the existing layout. Hence the modified layout is economical to the company and it helps the organization to become cost competitive.

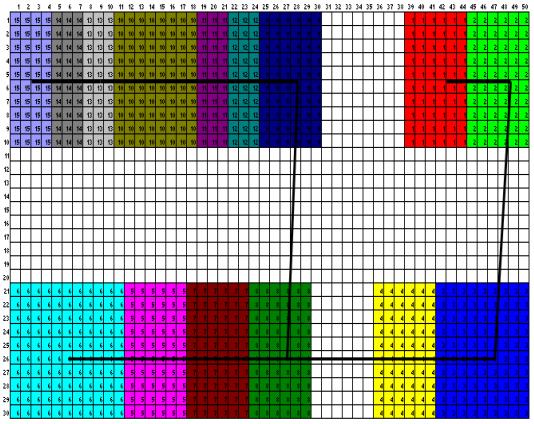

Figure 5.Workflow in modified layout.

Due to less transportation distance of modified layout, the manpower in that department can be reduced.

The comparison of machine utilization on existing and modified layout is shown in the figure 6

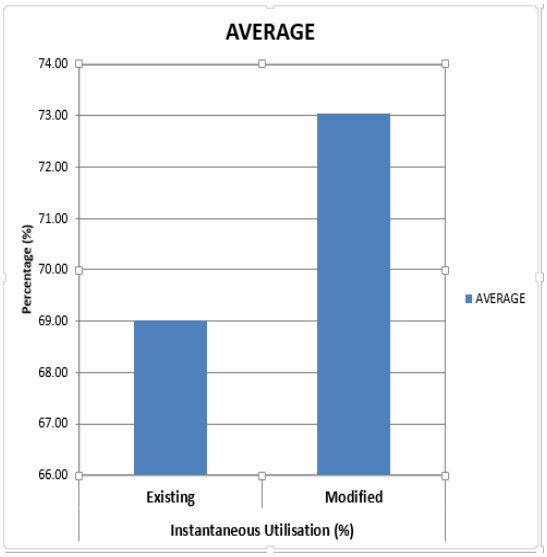

Figure 6. Comparison of Average Values of Instantaneous Utilization of Existing & Modified Plant Layouts

V. CONCLUSION

From the optimization results following conclusions can be made: The operation cost value of the current plant layout of SIFL is 176 after performing three iterations most feasible operation cost value is 151 by changing the position of workstations. The less operational cost value represents an optimized factory layout that performs in most economical way. The study is conducted at Steel & Industrial Forgings Ltd., Thrissur, a Government of Kerala undertaking, established in 1983. This study is

proposed to improve production plant layout efficiency by suggesting an improved modified plant layout. A well-planned department provides the fundament for a profitable production. The production rate and the utilization of machines depend on how well the various machines; production facilities and employee's amenities are located in a plant.

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