INTERNATIONAL JOURNAL OF ADVANCE RESEARCH AND DEVELOPMENT
IJARnD
(Volume3, Issue4)
Available online at: www.ijarnd.com

Layout optimization of machining process of the side frame of cotton ginning M/C using FLP

Ketan Agrawal[1], Ashish Paharia[2]

[1]*Student, Takshila Institute of Engineering and Technology, Jabalpur, Madhya Pradesh*
[2]*Assistant Professor, Takshila Institute of Engineering and Technology, Jabalpur, Madhya Pradesh*

ABSTRACT

The objective of this research is Study of the existing layout of a machining process unit and to design a lean plant layout using SLP (Systematic Layout Planning) to increase its productivity and reduce the material handling cost. Factory layout involves the arrangement and selection of machines, material handling devices, material handling path, resulting in the reduction of cost and time involved in manufacturing a product. The facilities layout problem, which is an integral part of facilities design, aims to spatially locate the production units within a facility subject to some design criteria and area limitations, with one or multiple objectives.

In this, a hybrid model that combines a facility allocation technique and a software analysis of the layout is done. Select the best block layout of the machining section with the help of Relative Allocation of Facilities Technique. After selecting the best block layout detailed layout is constructed and this detailed layout is analyzed using ARENA. The installed utilization of the layout is checked. The utilization of the layout is increased by changing the position of the equipment or by introducing a new machine into the layout. With the advent of software which allowed the user to build models and move them around the screen and analysis can be done. Re-layout can also be done until a satisfactory result is obtained.

Keywords: *Activity relationship chart, Systematic layout planning, Simulation, Arena.*

1. INTRODUCTION

The process plant layout problem mainly considers the spatial arrangement of equipment items in plants and the required connections among them. Plant layout has been considered as one of the most important issues in the design stage of process plants due to the increasing competition in process industries; restrict environment regulations and product specifications.

Plant layout is the arrangement of physical facilities such as machinery, equipment, furniture etc. within the factory building 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 material to the assembly section of the finished product.

The manufacturing industry is always under the pressure from their shareholders to improve productivity. Industries are not only being compared to their competitors but also within their own group of companies. The facility layout of manufacturing consists of configuring the plant site with lines, buildings, major facilities, work areas, aisles and other pertinent features such as departmental boundaries.

The **systematic layout planning** (SLP) is a tool used to arrange a workplace in a plant by locating 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.

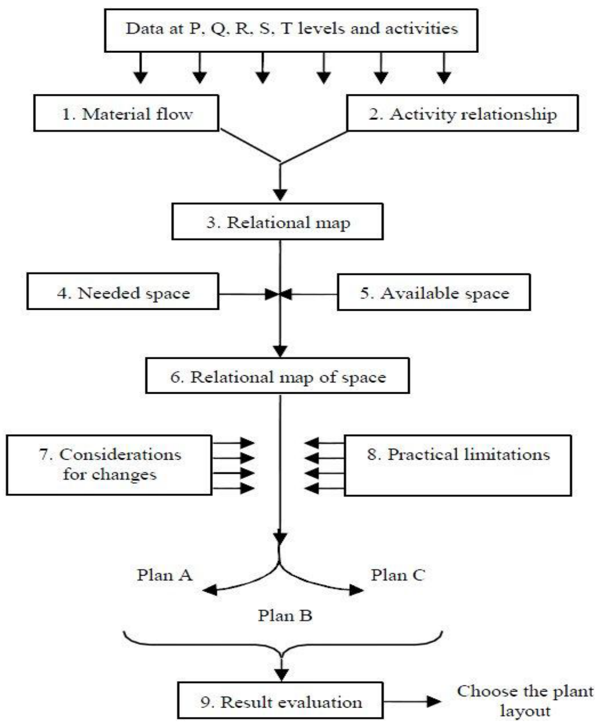


Fig. 1 Procedure of SLP

Many researchers have been done in finding the optimum facility design either using heuristic methods or simulation technique. Facility layout can be tackled by graph theory approaches considering units and connections as nodes and arcs and maximizing the adjacencies among nodes (Kim and Kim, 1995; Caccetta and Kusumah, 2001). Chee (2009) was developed two layout designs using SLP and both designs has two simulation models evaluated by ARENA software. The results are compared in terms of traveling distance, traveling time, traveling cost, output, average resource utilization, average waiting time and total time spent in the system. A facility is an entity that facilitates the performance of any job. It may be a machine tool, a work center, a manufacturing cell, a machine shop, a department, a warehouse, etc. (Heragu,1997). Facilities layout is important in a manufacturing system as it contributes significantly to productivity in terms of cost and time (Raman, D., 2007). The most important example of this approach can be systematic layout planning-SLP procedure, suggested by Muther **(**Muther, 1988**)**. In recent years, with the improvement of the computer performance and the development of the digital analysis methods, computer-aided system layout planning (CASLP) method appears based on applying computer and its related technologies to SLP method **(**Lan et al., 2005**)**. The changes of production planning, technological process, production organizational mode and material handling will all affect the facility distribution scheme of a production line **(**JIA et al., 2006**)**. Sahin et. al. (2009) investigated the two approaches for the facility layout problem. The first one is the quantitative approach aiming at minimizing the total material handling cost between departments based on a distance function. Ermin et. al. (2007) developed the overall factory layout in spite of limitation in size, position and unit relationship. He also modified SLP to use this procedure for different shapes and hexagons.

Several facility planning techniques could be used to develop a new layout or improve the current layout such as Systematic Layout Planning (SLP), Pairwise Exchange Method (PEM), Graph-Based Theory (GBT), Dimensionless Block Diagram (DBD), Total Closeness Rating (TCR), etc. In this study, three facility planning methods have been used to design the sustainable layouts which are SLP, GBT, and PEM.

2. BACKGROUND OF ORGANISATION

XYZ Company is a machining process factory that has a part which name is side frame of cotton ginning machine. The part machined by four machines and inspected on two places between machining process. XYZ Company has facing problems in machining process of the part is more transportation of part between machines. Due to that reason productivity of industry is less.

At present, XYZ Company machined 12 parts per shift and transportation time 12.5 minutes. Due to more transportation distance, the cost of material handling is also more it is 8,73,000 Rs. Flow process chart of machining process of the side frame of cotton ginning machine is given below in fig. 2.

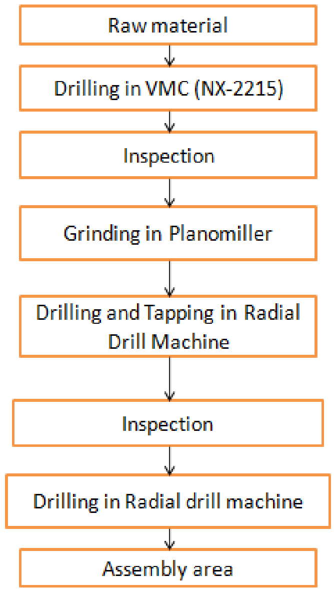


Fig.2 Flow Process Chart of machining

Present Layout of machining process of the side frame of cotton ginning machine is given below in fig. 3. The problems in present layout are given below-

- Transportation distance,
- Material handling cost,
- Total Space cover for complete machining,
- Loading and unloading time.

3. METHODOLOGY

A. Data collection

In that study, examine the current plant layout. There are many elements in the layout and these elements are related to one other. In order to analyze the present layout, the study looks at the machining process and utilization of space, machinery and transfer distance between machines.

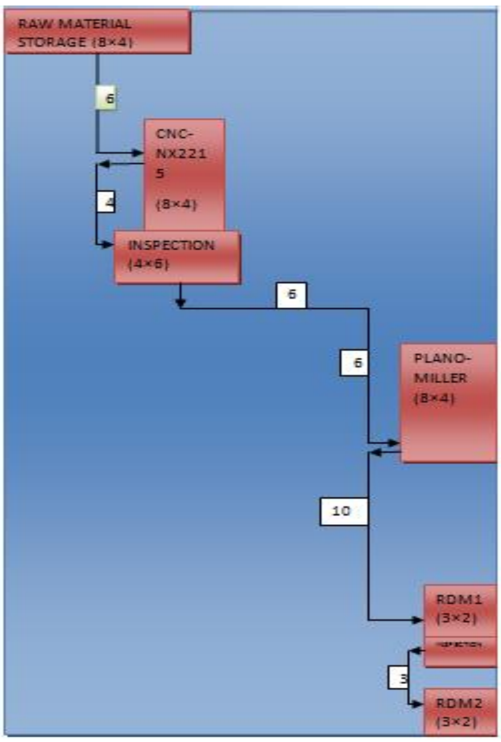


Fig.3 Current Layout

Flow process chart of the methodology is given below in fig. 4.

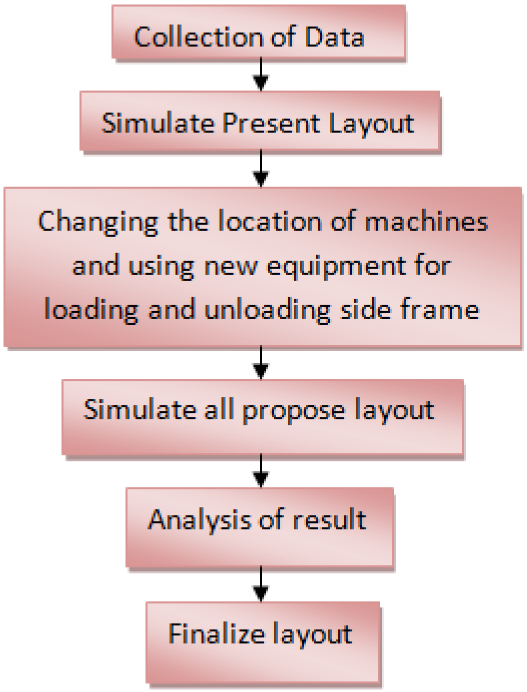
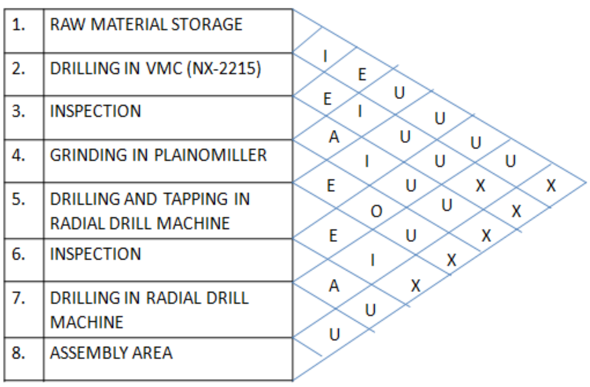


Fig.4 Flow process chart of the methodology

B. Activity Relationship chart

Relationship diagramming is a central technique in Systematic Layout Planning (SLP). The activity relationship diagram converts vowel-letter ratings on the relationship chart to a graphic visualization of desired closeness among activity-areas. An activity relationship chart (ARC) is one that displays the closeness rating among all pairs of activities or departments. In an ARC there are six closeness ratings which may be assigned to each pair of departments.



Ranking in terms of degree of Nearness/Closeness necessary:

A – Absolutely Essential
E – Especially Necessary
I – Important
O – Ordinary
U – Unimportant
X – Not Desirable

C. Transfer Distance

The distance between the machines and inspection sections are given in Table I:

Table I

No	To	From	Distance (meter)
1.	The raw material storage center	Drilling machine (CNC-NX2215)	6
2.	Drilling Machine(CNC-NX2215)	Inspection(1) area	4
3.	Inspection Area(1)	Planomiller machine	12
4.	Planomiller machine	RDM(1)	10
5.	RDM(1)	Inspection (2) area	2
6.	Inspection(2) area	RDM (2)	3

4. ANALYSIS AND FINDINGS

Analyses were carried out based on the methodology adopted. In this section discusses the current machining process, evaluates the current facilities layout according to the systematic layout planning (SLP) procedure and describes the elements considered. In this section on current machining process, some calculation based on the capacity of machining and the cost of material handling will be discussed. The chapter then highlights the difference between the current facilities layout and proposed new layout based on a simulation model using ARENA software.

There are six activities in the current production process, which apply to all of its products. Figure 1 and Table1 shows the current process and the transfer distance. Figure 5 shows the simulation model for the current process of XYZ Company while Figure 7 shows the model of the proposed current process for XYX Company using ARENA software. Each model consists of all machining process and inspections. Figure Shows the best model of machining process of the side frame of cotton ginning machine obtained after we run the simulation that proposes to XYZ Company. The distance of machines are decreasing by the changing the location of machines.

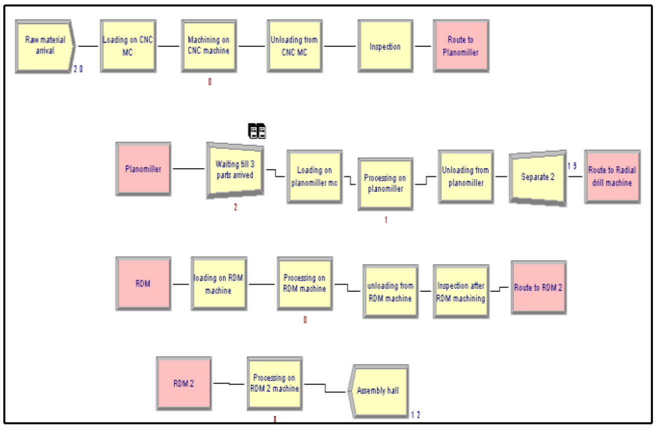


Fig.5 Simulation Model for Current Process

A. Calculation of Material Handling cost of current layout

a. Material Handling Cost for handling the part by Manual Pallet Stacker-

- The rate of manual handling the part in industry = 13 Rs/min
- In Complete production cycle of one part, Handle the part from one station to another station = 4 times
- Total number of parts manufactured in one shift (8hr.=480 min.) = 12 parts
- Total material handling time (/transfer time) of one part = 12.5 min
- Total material handling time in one shift = 12.5 × 12 = 150
- Total material handling cost by manual pallet stacker in one shift = 1950 Rs

b. Material Handling Cost for loading and unloading the part in the machine by Overhead Monorail Crane -

- Loading and unloading each part by crane in 4 machines.
- Total number of loading and unloading by crane in one shift = 4×12 = 48 times
- Total time for Loading and unloading one part in 4 machines by crane = 42 min.(avg.)
- Total time when crane is used for loading and unloading the part in one shift = 504 min
- The rate of material handling by crane=25 Rs/min
- Total material handling cost by crane in one shift=12600 Rs per shift

c. Total material handling cost per month for two shifts =14550×2×30 = 873,300 Rs

B. Proposed Layout

After changing the location of machines found a new layout that is given below in figure 6. In that changed the location of machines, loading and unloading equipment (in place of crane hook using magnetic crane). Also, Use the magnetic plate for holding the part into the Radial Drill Machine.

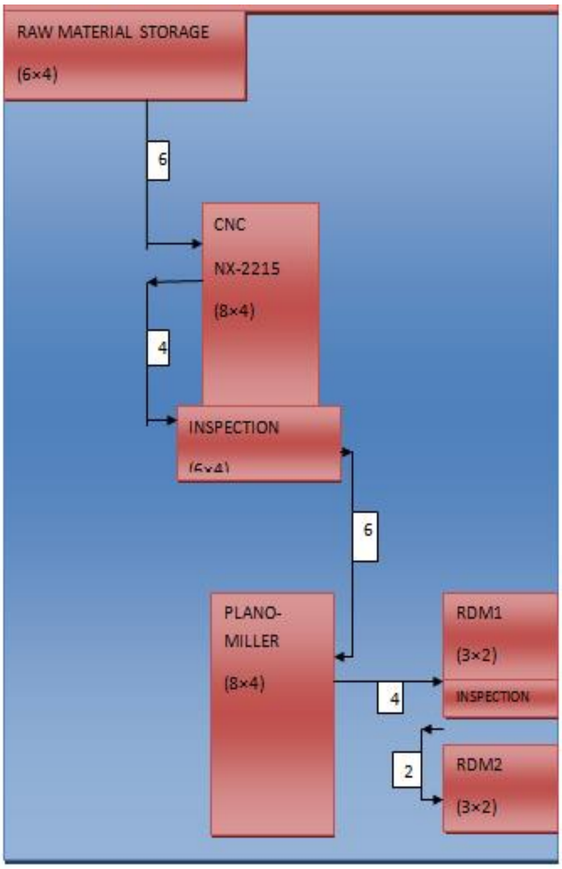


Fig. 6 Proposed Layout of Machining

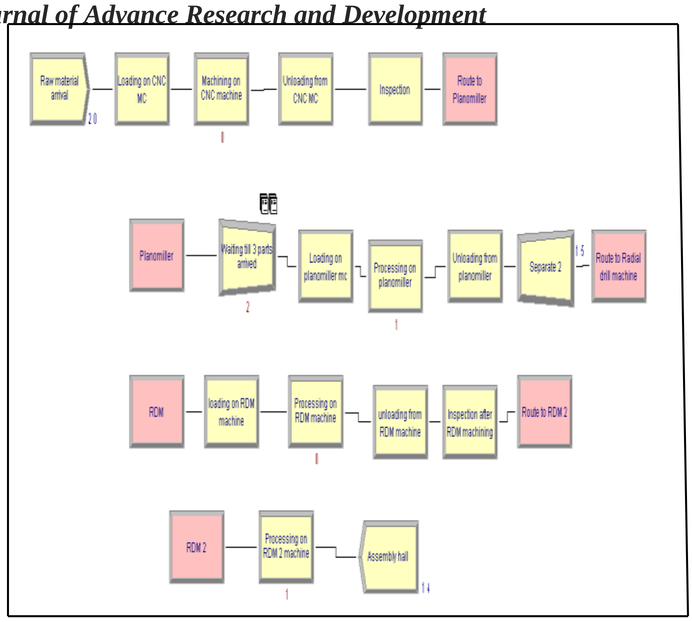


Fig.7 Simulation Model for Proposed Process

In machining process, there are two important factor transfer distance and loading/ unloading time, decrease the both by changing location and equipment after that material handling cost decreases and productivity increases.

- In Proposed layout 1 change the location of RDM1 and RDM2.
- In Proposed layout 2 change the position RDM1, RDM2, and Planomiller.
- In Proposed layout 3, planomiller same in position in proposed layout 2, only changing the position of RDM1 and RDM2.That locate in-front of planomiller.
- Final proposed layout similar to propose layout 3, in that adding magnetic lift and plate for loading and handling.

C. Calculation of Material Handling cost of new proposed layout

a. Material Handling Cost for handling the part by Manual Pallet Stacker-

- Total number of parts manufactured in one shift (8hr.=480 min.) = 14 parts
- Total material handling time (/transfer time) of one part = 6.0 min
- Total material handling time in one shift = 6.0 × 14= 84 min
- Total material handling cost by manual pallet stacker in one shift = 1092 Rs

b. Material Handling Cost for loading and unloading the part in the machine by Overhead Monorail Crane -

- Total time for Loading and unloading one part in 4 machines by crane = 26 min(avg.)
- Total time when crane is used for loading and unloading the part in one shift = 26×14 = 364 min
- The rate of loading and unloading by magnetic lifting crane =30 Rs/min
- Total material handling cost by crane in one shift = 364×30 = 10920Rs

Total material handling cost per month for two shifts = 12,012×2×3 = 720,720 Rs

D. Comparison table of Current Layout and Proposed Layout:

In that table all the data of current and proposed layout are compared:

Table 2 Comparison of Current and Proposed Layout

S. No.	PARAMETERS	PRESENT LAYOUT			FINAL PROPOSE LAYOUT		
1.	Total no. of parts Manufactured	12			14		
		Avg.	Min.	Max.	Avg.	Min.	Max.
2.	Valuable Time in min	211.4	208.8	214.21	194.74	192.03	197.75
3.	Wait Time in min	20.1437	0	42.3738	18.6874	0	41.1059
4.	Transfer time in min	12.5	12.5	12.5	6	6	6
5.	Total time in min	244.05	222.12	266.15	219.43	199.35	243.68
OTHER							
6.	Total Number In Part	26			26		
7.	Total Number Out Part	17			19		
8.	WIP Part	10.0969	0	16	9.4367	0	15
WAITING							
9.	Waiting Time till 3 parts arrived in min	20.2674	0	42.3738	19.8594	0	41.1039
10.	Waiting part till 3 parts arrived, queue	0.9274	0	3	0.9325	0	3
11.	Total Loading and Unloading Time in min	42.5	36	49	25.25	22	28.5
COST							
12.	Total Material Handling Cost Per month for 2 shift	8,73,800			7,20,720		
13.	Space Reduce in square meter				62		

After comparing the data of present and final propose layout clear that improve layout is best as compare to present layout. For easy understanding of comparison, draw bar figure below:

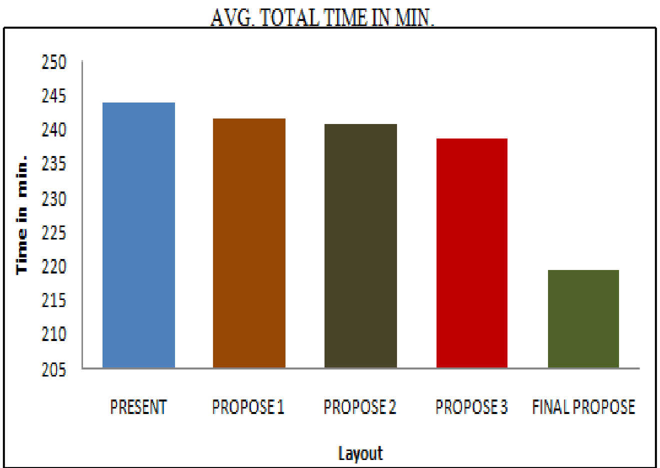


Fig.8 Comparison of Avg. Total Time before and after

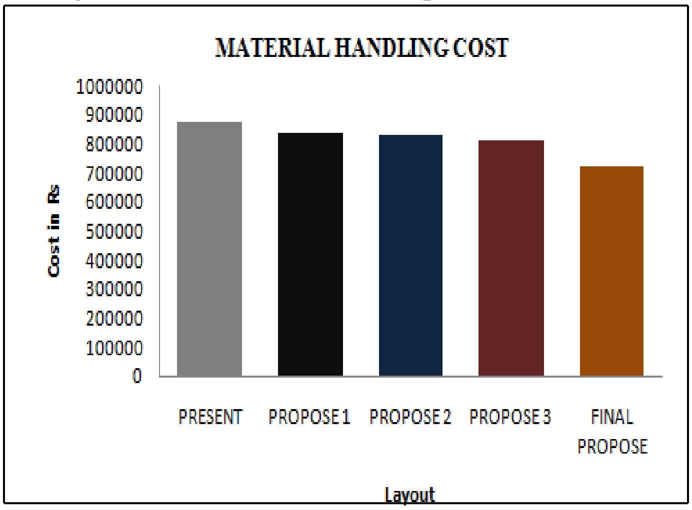


Fig. 9 Comparison of Material Handling Cost before and after

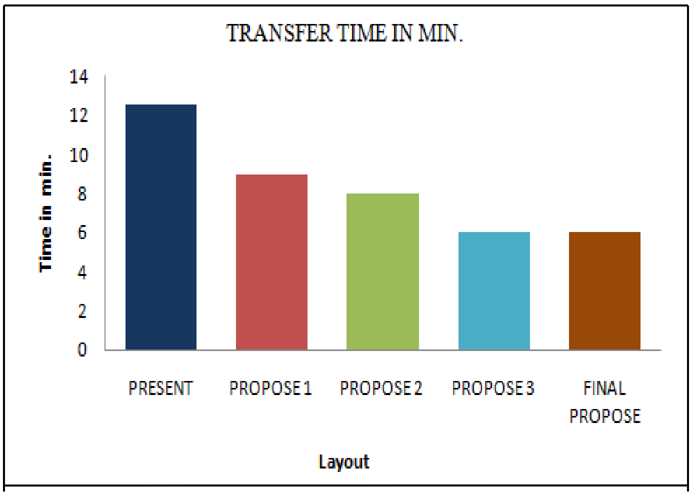


Figure 10 Comparison of Transfer Time before and after

5. CONCLUSION

The goal of this study is to develop a new machining layout for machining process of the side frame of cotton ginning machine of XYZ Company, in view of the need to increase the machining capacity using facility planning and design techniques. The first step is to generate several layouts to raise the probability of finding the sustainable layout with higher efficiency, and the second step is to select the best layout and improve it.

SLP and GBT are two types of construction techniques for facility planning. In this study using SLP for improvement of the layout. Three alternative layouts were generated in this study using SLP. The layout with the lowest transportation distance and material handling cost was selected as a sustainable layout among other alternatives. To avoid lengthy calculation and to increase the precision of the algorithm ARENA software was opted. The input of this program was the order of departments in a spiral way. The output was the improved layout which is the improved order of departments in a spiral way.

After implementing the SLP technique, machining of the side frame of cotton ginning machine increases from 12 to 14 parts and transportation time decreases 12.5 min to 6 min. And material handling cost is also reducing 153,080 rupees. Based on this study, it is found that even the best-selected layout could be improved. Therefore, the result indicates that it is necessary to conduct facility and layout planning before any factory set up to ensure sustainable process and reduce losses.

The atmosphere of the company also affects the productivity. After implementing the SLP technique, the atmosphere of the industry is also good, due to reduce accidents because of reducing handling of the part between machines and sections.

6. REFERENCES

[1] Amrita Kirtane, Nagendra Sohani, Improvement in Plant Layout Using Material Handling Technique, International Journal of Science and Research, ISSN (Online): 2319-7064 ,2013

[2] A. chee, "Facility layout improvement using systematic layout planning and ARENA," Master dissertation Faculty of Mechanical Engineering, Univ. Technology Malaysia, 2009.

[3] Chien TK. An Empirical Study of Facility Layout Using a Modified SLP Procedure. Journal of Manufacturing Technology Management2004; 15(6):455-465.

[4] Ermin Z, Kelou C, Yanrong Z, Overall Layout Design of Iron and Steel Plants Based on SLP Theory. IFIP International Federation for Information Processing 2010; 345:139-147.

[5] Groover Mikell P., Automation, Production Systems, and Computer-Integrated Manufacturing; 3rd Edition, Published July 1st 2007 by Prentice Hall.

[6] Heragu S.S. and Kusiak A., "Machine layout: an optimization and knowledge-based approach." International Journal of Production Research, pp. 615–635, 1990

[7] Karthik .T, Senthilkumar.M, Improvement of Productivity Through Layout Optimization in Pump Industry; International Journal of Lean Thinking,Vol.3,Issue2,Dec 2012

[8] Kelton, W. David, et al., Simulation with Arena, 6th edition. (McGraw-Hill Professional, 2014). ISBN 978-0-07-337628-8

[9] Kim, J.Y. and Kim, Y.D., "Graph theoretic heuristics for unequal-sized facility layout problems." Omega, pp. 391–401, 1995

[10] Koopmans and Beckman, "Assignment Problems and the Location of Economic Activities" Cowles Foundation Discussion Papers from Cowles Foundation for Research in Economics, Yale University; Published in Econometric, vol. 25(1), pp. 53-76, 1957

[11] Montreuil, B., "A modelling framework for integrating layout design and flow network design." Material Handling Research Colloquium, vol. 2, pp. 43–58, 1990.

[12] P. Bahale & Dr.S.S.Deshmukh, Improving Material Handling Efficiency in a Ginning Machine Manufacturing Company, International Journal of Innovative Research in Science, Engineering and Technology: Vol.3, ISSN: 2319-8753, Issue 3 March 2014

[13] Parveen Sharma & Sandeep Singhal, Design and evaluation of layout alternatives to enhance the performance of industry; Journal of Operational Research Society of India; Vol. 53,pp.741–760,2016 ,

[14] Pramod P. Shewale, Manmath S. Shete, S. M. Sane, "Improvement in Plant Layout using Systematic Layout Planning (SLP) for Increased Productivity," International Journal of Advanced Engineering Research and Studies, vol. 1, pp. 259-261, April-June 2012

[15] R muther, "Systematic Layout Planning", McGraw, 1995

[16] Rossetti, Manuel D. *Simulation Modelling with Arena*. John Wiley & Sons, Inc., 2010. ISBN 978-0-470-09726-7

[17] Subodh B. Patil, S. S. Kuber, "Productivity Improvement in Plant using Systematic Layout Planning (SLP) – a Case Study of Medium Scale Industry," International Journal of Research in Engineering and Technology, vol. 3, pp. 770-775, April 2014

[18] Vivekanand s Gogi, Rohith D, Shashi Kiran K, Suhail M Shaikh; Efficiency Improvement of a Plant Layout ; International Journal of Innovative Research in Science, Engineering and Technology ,Vol. 3,2319-8753,pp.11203-11209,2014

[19] Wiyaratn W, Watanapa A, Kajondecha P. Improvement Plant Layout Based on Systematic Layout Planning. IACSIT International Journal of Engineering and Technology 2013; 5.

[20] Wilhelm, M.R. and Ward T.L., "Solving quadratic assignment problems by simulated annealing. IIE Trans." pp. 107–119,1987

[21] Yosra Ojaghia, Alireza Khademia, Noordin Mohd Yusofa, Nafiseh Ghorbani Renania, Syed Ahmad Helmi bin Syed Hassan ; Production Layout Optimization for Small and Medium Scale Food Industry; Journal of CIRP,Vol.26,pp.247-251,2015

