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Implementation and Selection of Optimum Layout Design in Cellular Manufacturing for Process Industry –A Case Study

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Abstract— Laying out a factory involves deciding where to put all the facilities, machines, equipment and staff in the manufacturing operation and layout determines the way in which materials and other inputs flow through the operation. The objective of this work is to find the best layout designs with an intention of minimize the material movement and cost to improve the over efficiency of a diligence and such extension of our work is we planned to implement this optimized layout design in any of the industry to achieve some good results in their production. In this paper we proposed to make a deliberate case study in a process industry to study the existing layout design. We have design the optimum layout considering different layouts like with an aim of minimize the cost by reducing the total travelling distance of materials and change the existing layout design for selected process industry this optimum layout design is executed using through ARENA simulation software with different form of machine layouts.

Keywords— Lean Manufacturing, Layout design, Machine Layout, Manufacturing Operations, Factory Layout, ARENA simulation software, Process industry.

I. INTRODUCTION

Cellular manufacturing (cm) system is an application of the group technology philosophy that allows decomposing a manufacturing system into subsystems which makes its management easier than the entire manufacturing system. It is a model for workplace design, and has become an integral part of lean manufacturing systems [1]. It is based upon the principles of group technology. And this approach that helps build a variety of products with as little waste as possible a cell is a group of workstations, machine tools, or equipment arranged to create a smooth flow so families of parts can be processed progressively from one workstation to another without waiting for a batch to be completed or requiring additional handling between operations. Put simply, cellular manufacturing group's together machinery and a small team of staff, directed by a team leader, so all the work on a product or part can be accomplished in the same cell eliminating resources that do not add value to the product [2]. The primary purpose of cellular manufacturing is to reduce cycle time and inventories to meet market response times. Some of the other benefits include, space reduction, quality improvement, labor cost reduction, and improved machine utilization. Lean Manufacturing concepts with various cellular manufacturing techniques were have been implemented the important bottlenecks in the material handling system, equipment & space, WIP inventory, cost and other factors are have been studied and rectified. It is seen that the manufacturers face heightened challenges such as rising customers expectation, fluctuating demand, and competition in markets one way to stay competitive in this globalized market is to become more efficient [3].

II. LAYOUT MODIFICATIONS AND PROBLEM DEFINITION

The facility layout in cellular manufacturing systems involve the arrangement of cells within the floor space, so as to minimize the inter-cell layout movement. The machine layout in cellular manufacturing systems involves the arrangement of machines within the cells so as to minimize the intra-cell movement. Three basic types of machine layout is identified by Hassan.M.M.D [4] are a) single row layout: in this layout, different types of machines may be arranged in a single row as close as possible to the sequence of operations. The layout may be assuming several shapes such as linear, semi-circular or u-shaped. b) Multi-row layout: the machines are arranged in more than one row in this type of layout. The machines in each row interacts with each other and as well as with the machines in other rows. c) Loop layout: in this layout, the machines are arranged around an oval path and the movement of parts is usually unidirectional the static machine cellular layout (SMCL) is designed to work with fixed quantitative demand. But today's consumer market there is frequent changes in product mix and demand, which cannot be accommodated by SMCL. And we take the quantitative values of 3 period planning horizons given in table 2 for our calculation purposes, Earlier the layout problem is considered as static one. But today's consumer market, there is frequent demand fluctuations, which cannot be accommodate by static environment. The implementation of cells could, however, have some disadvantages as compared to traditional functional and product layouts. Implementing manufacturing cells needs high investment in machine installation, results in lack of flexibility in handling the demand changes, imbalanced utilization of machine and labour etc., Then the proposed model is to minimize the sum of various costs such as intracellular movement costs, intercell movement costs and machine procurement costs, setup cost, cutting tool consumption costs, machine operation costs, production planning-related costs, Lokesh Kumar Saxena [5]so, we planned to create an idea to take one problem as transportation cost. From a system designer's point of view the movement of inters and intra cell in dynamic environment is very desirable to achieve an optimal solution with respect to all the criteria considered individually by researchers, but this is impossible because of the conflicts between various criteria. To solving this type of problems, it is reasonable that investigated a set of solutions and solving the mathematical model to find Pareto-optimal solutions Aydin Aghajani[6] then this paper make us to compare the model with column chart. The proposed layout should provides reduction in total transportation time as well as an increase in productivity the number of products transferred between departments or the required number of transporters or workers can be optimized again by using the simulation technique in this paper the author take a reference as one factory problem and they provide a solution for their flow of information using ARENA software Bayram Kahraman[7]. The conclusions given by the author make as to find the solutions for different layout problems in cellular manufacturing systems. Danny J. Johnson [8] made the framework is detailed enough to provide guidance to the industry practitioner on how to reduce manufacturing throughput time, while being general enough to apply to most manufacturing situations. Nikola Suzić.et.al [9] insists how to satisfy customer needs becomes increasingly complex when a product customization element is included the aim of the presented study is to show an application of production flow analysis in the process of converting the mass production company to a mass customization system. Kanagaraj.et.al [10], say about the reliability-based total cost of ownership approach which accounts both direct and indirect costs, as applied to the supplier selection process the mathematical formulation for supplier selection problem fits into the nonlinear integer programming problem, which belongs to the NP-hard category. Yu (Aimee) Zhang and Yong Yin [11], notifies the various similarity coefficients to the cell formation problem were investigated and reviewed. We also proposed a taxonomy which is combined by two distinct dimensions. For the further studies, we suggest comparative studies in consideration of some production factors, such as production volumes, operation sequences.

III. PROBLEM IDENTIFICATION AND DESIGN OF OPTIMUM LAYOUT

The selected industry was located in Madurai this industry was started in 1998 and they are Wholesale Suppliers / Manufacturer / Exporters of sheet metal automobile components, oil seals, water pump seals, filter caps, elements, textile components, silent block components, break plates, industrial washers, brackets, clamps, pulley, sim plates, sheet metal components, metal products, press component for various Automobile industries around tamilnadu and other states in India. we observed here is the arrangement of machines and its layout design its is shown as a model and some of the data's given by the industry from that we executed using ARENA software the results and the software model is shown below the problem here Fig:1 is the machines are arranged in oval shape but the press machines.

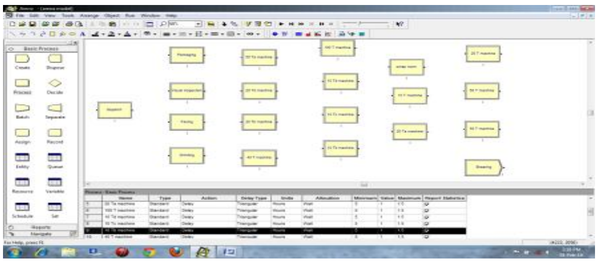

Fig. 1 Arena model of on machine arrangement

TABLE VI
MANUAL CALCULATIONS FOR DEFAULT LAYOUT

Total Material cost = 0.77	Tool cost= 1.22
Material cost = 0.61	Scrap cost = 0.16
Press operator = 0.10	Cutting operator = 0.05
Facing= 0.05	Deburring = 0.05
Material travelling cost = 0.30	Visual inspection = 0.05
Prime cost= 1.01	Over head= 0.10
Administrative OD = 1.11	Profit= 0.12
Final Cost for making one oil shell is =1.34Rs	

Eg: 1)15 to 25mm thickness – 834die, they required 50T (2-30mm thick work piece use) machine for Pressing with sequence of operations as Shearing, Grinding, Facing, Visual inspection, Packaging, Dispatched similarly this layout for all type of dies and other process. Similarly we have made comparisons of different types of layout to find the optimum machines arrangements to reduce the cost and material movements depends on product volume and variety at one extreme, the factory will produce a wide variety of bespoke products in small volumes, each of which is different at the other extreme it will produce a continuous stream of identical products in large volumes between the extremes, the factory might produce various sized batches of a range of different products.

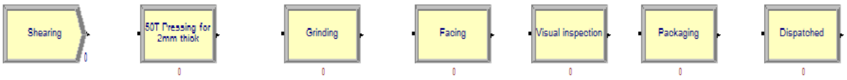

Fig. 2 Arena model of linear machine arrangement

TABLE VII
SOFTWARE CALCULATIONS FOR LINEAR SHAPE LAYOUT

Total Material cost = 0.77	Tool cost= 1.22
Material cost = 0.61	Scrap cost = 0.16
Press operator = 0.10	Cutting operator = 0.05
Facing= 0.05	Deburring = 0.05
Material travelling cost = **0.02**	Visual inspection = 0.05
Prime cost= 1.01	Over head= 0.10
Administrative OD = 1.11	Profit= 0.12
Final Cost for making one oil shell is =1.26Rs	

Eg: 2)15 to 25mm thickness – 834die, they required 50T (2-30mm thick work piece use) machine for Pressing with sequence of operations as Shearing, Grinding, Facing, Visual inspection, Packaging, Dispatched similarly this layout for all type of dies and other process. The same example is used to analysis the cost and same process involved but in different layout conditions now we select the L shape layout design for further analysis of layout with machine arrangements.
In this L type machine arrangement design the travelling distance of material is reduced and the production rate is increased with 147(parts/hr) it is good layout design compare with their default design Fig: 1.The distance between each material is reduced while. We implement this machine layout for the process of making the oil shell in this layout is about (685mm) also this type of layout requires only one supervisor and with two helpers this optimum design to make the product with required time and standard shape with suitable size.

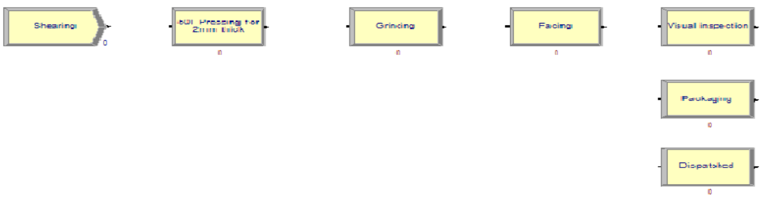

Fig. 3 Arena model of L shape machine arrangement

TABLE VIII
SOFTWARE CALCULATIONS FOR L SHAPE LAYOUT

Total Material cost = 0.77	Tool cost= 1.22
Material cost = 0.61	Scrap cost = 0.16
Press operator = 0.10	Cutting operator = 0.05
Facing= 0.05	Deburring = 0.05
Material travelling cost = **0.10**	Visual inspection = 0.05
Prime cost= 1.01	Over head= 0.10
Administrative OD = 1.11	Profit= 0.12
Final Cost for making one oil shell is =1.29Rs	

Eg: 3)15 to 25mm thickness – 834die, they required 50T (2-30mm thick work piece use) machine for Pressing with sequence of operations which was seen earlier in all type of layout while comparing this U shape layout may not provide optimum result. From the consequence which we got earlier but for the trial and error this will be executed and the results are shown here with the result of software simulation model,

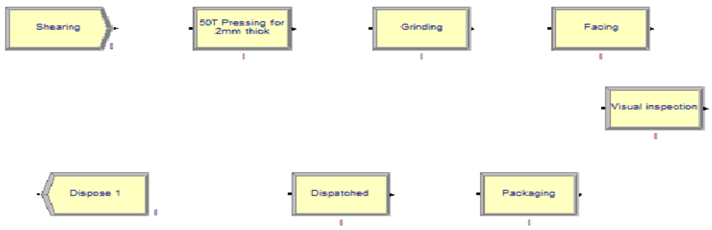

Fig. 4 Arena model of U shape machine arrangement

SOFTWARE CALCULATIONS FOR U SHAPE LAYOUT

Total Material cost = 0.77	Tool cost= 1.22
Material cost = 0.61	Scrap cost = 0.16
Press operator = 0.10	Cutting operator = 0.05
Facing= 0.05	Deburring = 0.05
Material travelling cost = **0.17**	Visual inspection = 0.05
Prime cost= 1.01	Over head= 0.10
Administrative OD = 1.11	Profit= 0.12
Final Cost for making one oil shell is =1.33Rs	

This U type machine arrangement design the travelling distance of material is reduced and the production rate is 134(parts/hr) the distance between each material is reduced while we implement this machine layout for the process of making the oil shell in this layout is about (685mm) in above design. But this machine arrangement requires more distance as more than (1000mm) deals with the placement of machine this expanse extra area. It is not suitable for this kind of industry the arena model with calculations are shown below,

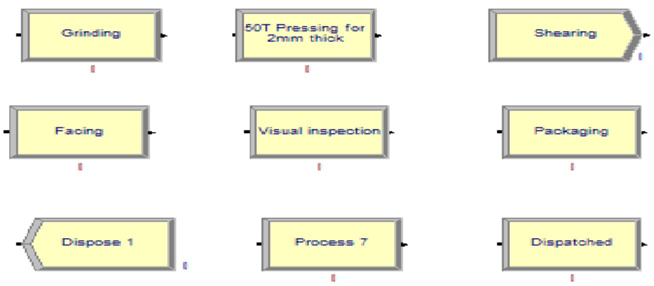

Fig. 5 Arena model of S shape machine arrangement

SOFTWARE CALCULATIONS FOR S SHAPE LAYOUT

Total Material cost = 0.77	Tool cost= 1.22
Material cost = 0.61	Scrap cost = 0.16
Press operator = 0.10	Cutting operator = 0.05
Facing= 0.05	Deburring = 0.05
Material travelling cost = **0.35**	Visual inspection = 0.05
Prime cost= 1.01	Over head= 0.10
Administrative OD = 1.11	Profit= 0.12
Final Cost for making one oil shell is =1.39Rs	

IV. CONCLUSIONS AND FUTURE WORK

In this research the results we are getting from software and manually the analysis of various layout designs in both single-row and multi-row layout the main aim of this study is to identify the exact layout for proper Process industry. And moreover the major dilemma in this layout design is the idol time of machines, cost and the material movement between the each machine. They are clearly explained with the help of software ARENA and the executed results are compared using any of the quality tools here we used column chart to made the assessment between the layouts in fig: 21 the table no 4 mentions the optimum layout with the Rs of 1.26 this graphical representation can easily explain about the layout comparison and their position.

And our future plan is to create different layout for a variety of process industry and provide best layout design with minimum of cost and travelling distance between the machines as well we planned to shrink the labor and layout problems regarding the machine arrangements in the various Process industry.

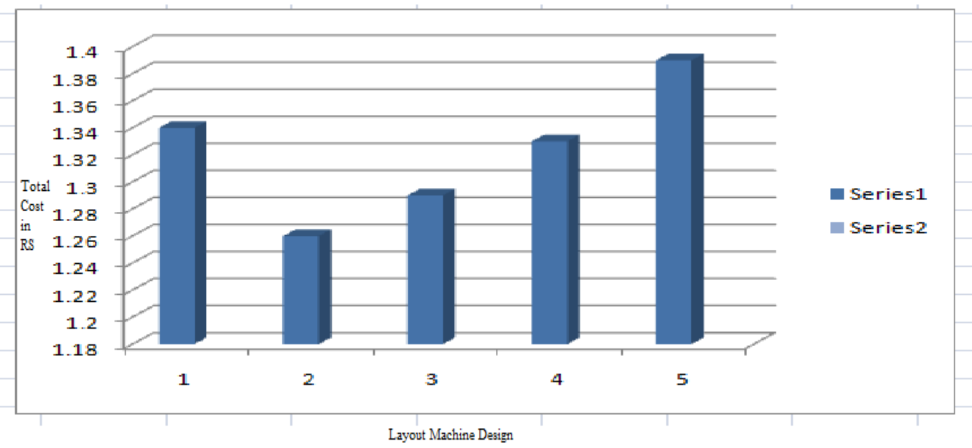

Fig. 6 Column Chart Comparisons between Layouts

REFERENCES

[1] Web Source: E-Book-1 http://books.google.co.in/books?hl=en&lr=&id=lmLv68XlCZUC&oi=fnd&pg=PP13&dq=cellular+manufacturing+system&ots=Aj6Xtx4xP7&sig=ZFG_AgXdyIbdmj2BlqY4ZE_uFko#v=onepage&q=cellular%20manufacturing%20system&f=false.

[2] Web source: E- Book-2 http://onlinelibrary.wiley.com/book/10.1002/9780470172476//

[3] Web Source: E-Book-3 http://books.google.co.in/books/about/Cellular_Manufacturing.html?id=1Pie6US1Y2MC&redir_esc=y

[4] Hassan.M.M.D., *Machine layout problem in modern manufacturing facilities*.

[5] Lokesh Kumar Saxena&Promod Kumar Jain,*Dynamic cellular manufacturing systems design a comprehensive model*, Received: 31 May 2009 / Accepted: 12 July 2010 Published online: 5 August 2010# Springer-Verlag London Limited 2010.

[6] NikbakhshJavadian&AydinAghajani&Javad Rezaeian&Mohammad *A Multi-Objective Integrated Cellular Manufacturing Systems Design With Dynamic System Reconfiguration*, Received: 4 January 2010 / Accepted: 10 January 2011 / Published online: 2 February 2011# Springer-Verlag London Limited 2011.

[7] RahimeSancar Edis1, Bayram Kahraman2, ÖzlemUzun Araz3, M. Kemal Özfirat2,*A Facility Layout Problem In A Marble Factory ViaSimulation,Mathematical and Computational Applications*, Vol. 16, No. 1, pp. 97-104, 2011.© Association for Scientific Research.

[8] Danny J. Johnson, "*A Framework for Reducing Manufacturing Throughput Time*", Published in International Journal of Manufacturing systems Volume 4, Issue 22 (Jan 2014).

[9] Nikola Suzić,Branislav Stevanov ,Ilija Ćosić ,Zoran Anišić ,Nemanja Sremčev, "*Customizing Products through Application of Group Technology: A Case Study of Furniture Manufacturing*", Published in International Journal of Mechanical Engineering 58(2014)12, 724-731.

[10] G. Kanagaraj & S. G. Ponnambalam & N. Jawahar, "*Reliability-based total cost of ownership approach for supplier selection using cuckoo-inspired hybrid algorithm*", Published in International Journal of Advanced Manufacturing Technology Received: 13 April 2013 /Accepted: 9 December 2013 # Springer-Verlag London 2014.

[11] Yu (Aimee) Zhang and Yong Yin, "*Application Similarity Coefficient Method to Cellular Manufacturing*", Published in International Journal of Manufacturing the Future, Concepts - Technologies - Visions , ISBN 3-86611-198-3, pp. 908, ARS/PlV, Germany, Jan 2014.

[12] Shahram Saeedi1, Maghsud Solimanpur2, Iraj Mahdavi1, Nikbakhsh Javadian1,"*Heuristic Approaches for Cell Formation in Cellular Manufacturing*", Published Online July 2010Received April 22nd, 2010; revised May 16th, 2010,Published in June 10th 2010.

