Cellular Manufacturing in Carriage Building Press Shop using by Rank Order Clustering (ROC)

M. Sivakumar, M. Claret Stany, T. Balasubramani

Abstract- ***Lean manufacturing has proven to be an effective strategy to increase productivity and cost competiveness in the manufacturing industry. Cellular manufacturing (CM) is one of the tool of lean manufacturing. Cellular Manufacturing is one of the initiatives that major businesses in the U.S have been to adopt in order to remain in an increasingly global market. It is a fairly new application of group technology. For effective analysis of existing layout for Carriage Building (CB) press shop and to propose new layout, its needed to examine operation like material travel distance for each part number, machineries used. In order to valid analysis here Clustering techniques are used.***

Keywords- Lean manufacturing, Cellular manufacturing.

I. INTRODUCTION

This specific process of Lean Manufacturing has been implemented and used by all types of leading manufacturing companies. Lean means "manufacturing without waste." Waste ("muda" in Japanese) has many forms. Material, time, idle equipment, and inventory are examples. Most companies waste 70%-90% of their available resources. Even the best Lean Manufacturers probably waste 30%. 'LEAN' has always been important to manufacturers. When you reduce inventories, assets, overhead, wait times and out-of-specs, you generally increase profits. Eric Molleman et al (2012) discussed this paper describes the evolution of a cellular manufacturing system in a medium-sized company over a 13-year period. The objective of this paper is to analyze the arguments that gave rise to the nearly continuous readjustment of the design of the cellular manufacturing system of this company and the direction in which these adjustments took place. The study indicates that two interrelated factors played an important role in the decision to change the system: the market and manufacturing technology. The following processes carried out in the Carriage Building press shop is given below and as shown in figure 1, Shearing , also known as die cutting ,is a process which cuts the sheet metal without formation of chips. If the cutting blades are straight the process called shearing. A press or a machine press is a tool used to work metal by changing its shape and internal structure of sheet metal. Drilling is a cutting process a drill bit to cut or enlarge a hole circular cross section in a solid materials. The drill bit is a rotary cutting tool often multipoint. Phosphate coating are used on sheet metal parts for corrosion resistance as a foundation for subsequent coating or painting.

Revised Version Manuscript Received on June 30, 2015.

M. Sivakumar, Asst. Professor, Department of Mechanical, Maharaja Institute of Technology, Coimbatore, India.

M Claret Stany, Asst. Professor, Department of Mechanical, Maharaja Institute of Technology, Coimbatore, India.

T. Balasubramani, Asst. Professor, Department of Mechanical, Maharaja Institute of Technology, Coimbatore, India.

Figure 1. (a)Shearing (b) Pressing

Lean manufacturing techniques used for different industry. These lean tools are reduced to non-value added activities, improve the productivity and reduced change over time. Therefore, different lean tools are implement in the Carriage Building press shop.

II.CELLULAR MANUFACTURING

A cellular manufacturing system is a manufacturing system based upon groups of processes, people and machines to produce a specific family of products with similar manufacturing characteristics.The existing value manufacturing layout has the following deficiencies,

1. Long movements
2. More setup time
3. Increase in lead time
4. More occupation of space
5. Criss cross movements
6. More man power

For effective analysis of the existing layout and to propose new layout, it is needed to examine operation details like process sequence, material travel distance of each part number, machineries are used. In order to do a valid analysis here clustering technique is used. One the techniques used for this types analysis is rank order clustering technique.

Rank order clustering is a simple algorithm using a matrix into blocks, where the each final block represents a cell. The rank order clustering technique first proposed by King, is specifically applicable in production flow analysis. It is an efficient and easy-to-use algorithm for grouping machines into cells. In a starting part-machine incidence matrix that might be compiled to document the part routings in a machine shop (or other job shop), the occupied locations in the matrix are organized in a seemingly random fashion. Rank order clustering works by reducing the part-machine incidence matrix to a set of diagonalized blocks that represent part families and associated machine groups.

A-Grouping of Parts Number and Machines

In the Carriage Building components part number, process sequence and the column were assigned to part number as shown in table 1. The rank order clustering here the rows are getting weight age based on the decimal value depending upon the requirements of the operation in the each part number.

The machineries details of existing layout of CB press shop as shown in table 2.

Table 1 Components part number and part code

PART NUMBER	COMPONENTS NAME	PART CODE
5904	BASE CHASSIS	A
5928	FAN FRAME	B
5140	CHESSIS BOTTOM	C
5946	ZIP FRAME	D
2807	BOGIE BLATE	E
5904	SPRING FIXER	F

The process flow sequences for part no 5904 as shown in figure 1. The existing machines layout (fig.2), material travel distance and its parameters are show in table 3 and 4.

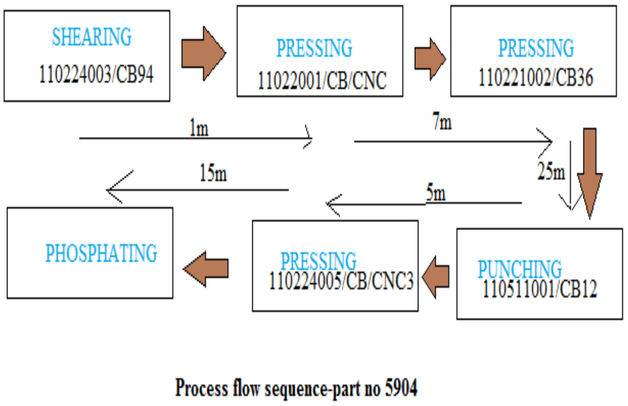

Fig 1 Process flow sequence for part no 5904

A. EXISTING LAYOUT

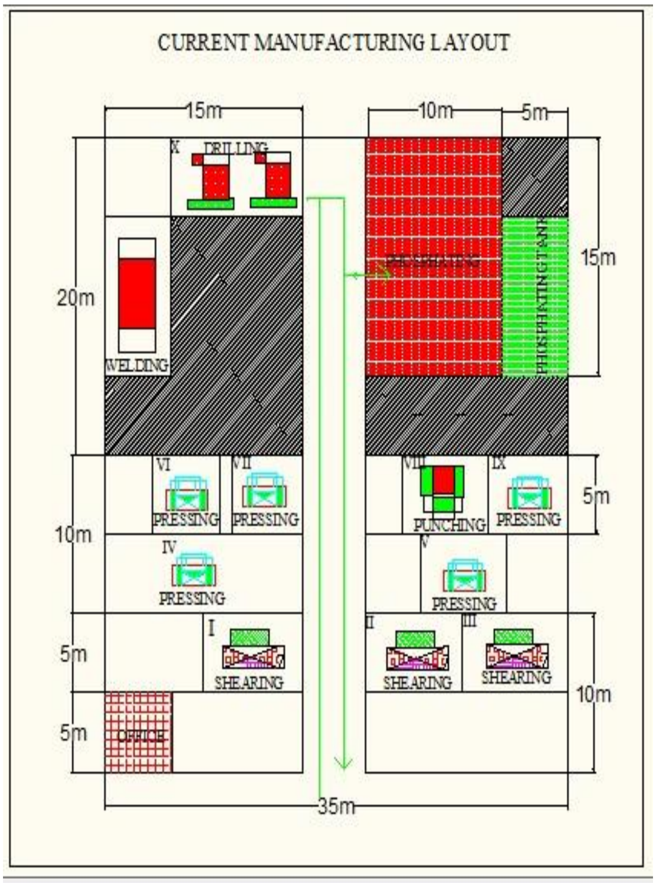

Fig.2 existing manufacturing layout

In existing manufacturing layout consists of material travel distance, raw material travel and operator movements are high. If material travel distance reduced, automatically lead time will be increase.

Table 2 Machineries details of existing layout of CB press shop

SL. NO	Machine No	Machine Code	Manufactures Name	Operation
1	110224003/CB94	I	PEARSON	Shearing
2	110224003/CB33	II	UNITED	Shearing
3	110224001/CB47	III	AMETEEP	Shearing
4	110224004/CB/CNC1	IV	SYNCHRO	Press Brake
5	110224003/CB78	V	GODREJ	Press Brake
6	110224002/CB36	VI	RUSHWORTHI	Press Brake
7	110224001/CB31	VII	RUSHWORTHI	Press Brake
8	110224005/CB/CNC3	VIII	EDWARDS PEARSON	Punching
9	110511001/CB12	IX	ACCUMAX	Press Brake
10	110211003/CN1	X	PUSCO	Drilling

Table 3 Material travel distance for existing layout

Part Code	Material Travel Distance in Meters
A	53
B	55
C	46
D	43
E	32
F	90

Table 4 existing cell layout parameters

SL. NO.	Parameters	Metric Value
1	Area used (Sq. meters)	1400
2	Man power (Nos)	23
3	Number of machines (Nos)	11
4	Average Material Travel Distance (m)	53
4	Raw Material Travel Distance (m)	15
5	Operator Movements (high/Low)	HIGH

B-RANK ORDER CLUSTERIND TECHNIQUE

In rank order clustering method, it might be helpful to convert each binary value into its decimal equivalent (The entries in the first row of the matrix in Table 5 are read as 100101). This is converted into its decimal equivalent as follows:

$(1\times2^5)+(0\times2^4)+(0\times2^3)$
$+(1\times2^2)+(0\times2^1)+(1\times2^0)=32+0+0+4+0+1=37$

It should be mentioned that decimal conversion becomes impractical for the large numbers of parts found in practice, and comparison of the binary numbers is preferred. The rank order clustering iterations are shown in table 5 to 7.
Here 1-represents the operation required and 0- represents the operation not required.

Table 5 Rank order Cluster analysis for iteration I

Rank Order Cluster Analysis For Iteration I								
Machines	$2^5=32$	$2^4=16$	$2^3=8$	$2^2=4$	$2^1=2$	$2^0=1$	Decimal Value	Ranking
Part No.	A-5904	B-5928	C-5140	D-5916	E-2807	F-5904		
I	1	0	0	1	0	1	37	1
II	0	1	1	0	0	0	24	8
III	0	0	0	0	1	0	2	10
IV	1	0	0	1	0	0	36	2
V	0	1	0	0	1	1	19	9
VI	1	0	0	0	0	1	33	3
VII	0	1	1	1	0	0	28	7
VIII	1	0	0	0	0	0	32	4
IX	1	0	0	0	0	0	32	5
X	0	1	1	1	0	1	29	6
XI	0	1	1	1	1	1	31	0

Table 6 Rank order Cluster analysis for iteration II

Rank Order Cluster Analysis for Iteration II							
Machines	Part No.						Binary Value
	A-5904	B-5928	C-5140	D-5916	E-2807	F-5904	
I	1	0	0	1	0	1	$2^9=512$
IV	1	0	0	1	0	0	$2^8=256$
VI	1	0	0	0	0	1	$2^7=128$
VIII	1	0	0	0	0	0	$2^6=64$
IX	1	0	0	0	0	0	$2^5=32$
X	0	1	1	1	0	1	$2^4=16$
VII	0	1	1	1	0	0	$2^3=8$
II	0	1	1	0	0	0	$2^2=4$
V	0	1	0	0	1	1	$2^1=2$
III	0	0	0	0	1	0	$2^0=1$
Binary Value	992	28	28	792	3	658	
Ranking	1	4	5	2	6	3	

Table 7 Rank order Cluster analysis for optimum iteration

Machines	Part No.					
	A-5904	D-5916	F-5904	B-5928	C-5140	E-2807
I	1	1	1	0	0	0
IV	1	1	0	0	0	0
VI	1	0	1	0	0	0
VIII	1	0	0	0	0	0
IX	1	1	0	0	0	0
VII	0	0	0	1	1	0
II	0	0	0	1	1	0
V	0	0	0	1	0	1
III	0	0	0	0	0	1
X	0	0	0	1	1	1
Binary Value	992	792	658	28	28	3
Ranking	1	2	3	4	5	6

The various machine layouts are shown in figure 2 to 5 and its parameters are shown in table 8 and 9.

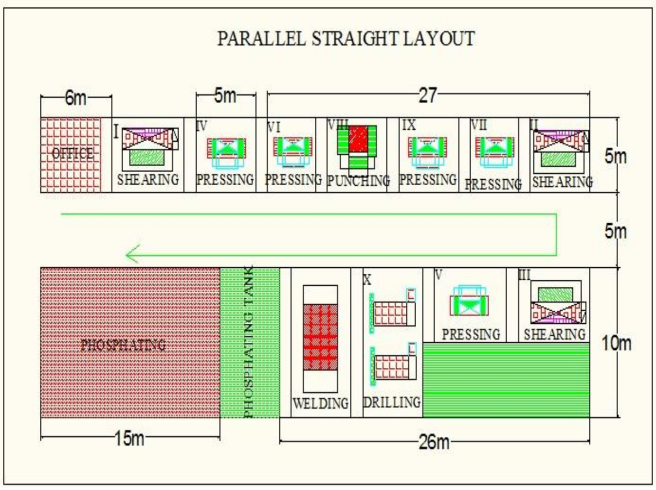

Fig.3 Parallel straight layout

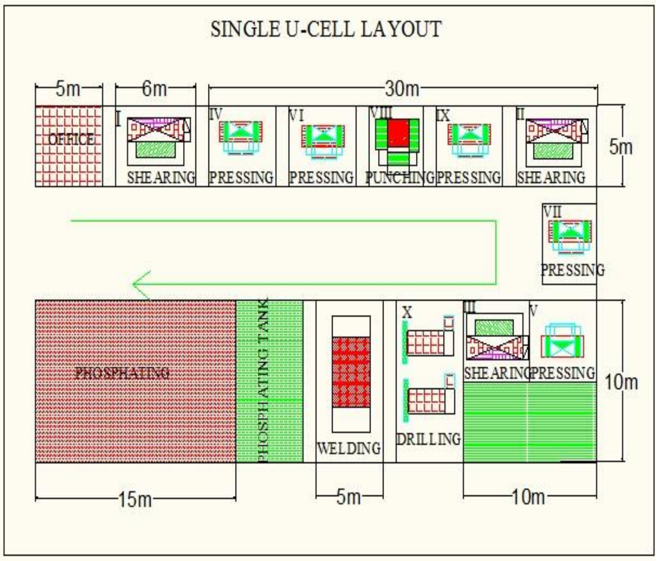

Fig.4 Single U cell layout

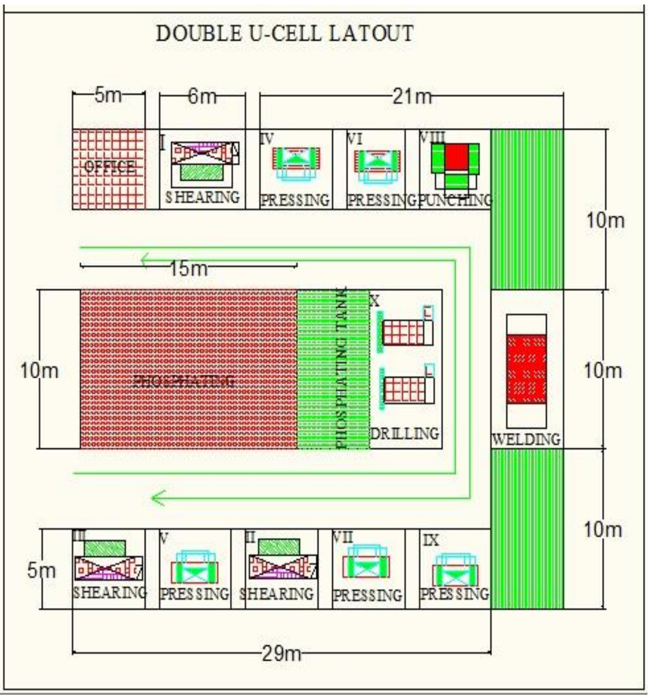

Fig.5 Double U cell layout

Table 8 Material in process travel distance for all cell layout

Part Code	Material Travel Distance (m)			
	Existing layout	Parallel straight	Single U straight	Double U cell
A	53	29	29	38
B	55	26	26	16
C	46	26	26	16
D	43	44	43	42
E	32	29	26	18
F	90	60	51	80

Table 9 Cellular layout parameters

SL. NO.	Parameters	Existing layout	Parallel straight	Single U straight	Double U cell
1	Area used (Sq.meters)	1400	1012	1008	1020
2	Man power (Nos)	23	21	21	20
3	Number of machines (Nos)	11	11	11	11
4	Average Material Travel Distance (m)	53	36	34	37
4	Raw Material Travel Distance (m)	15	86	75	25
5	Operator Movements (high/Low)	HIGH	LOW	LOW	LOW

III.RESULTS

Organizes the entire process for a particular product or similar products into a group or cell, including all the necessary machines, equipment and operators. Resources

Within cells are arranged to easily facilitate all operations. The various cells layout have been proposed. To compare the various cell parameters and all the cells material travel distance have been grouped in a single graph as shown in figure 6. The double U cell layout have been low material travel distance

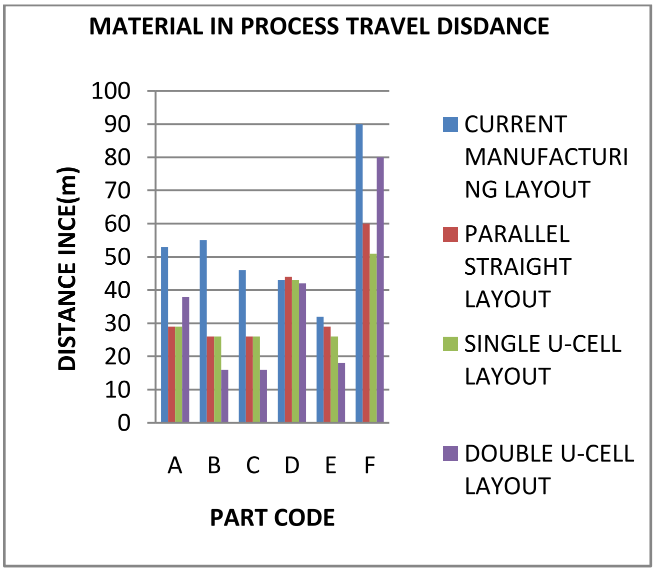

Fig.6 Material travel distance for various cell layout

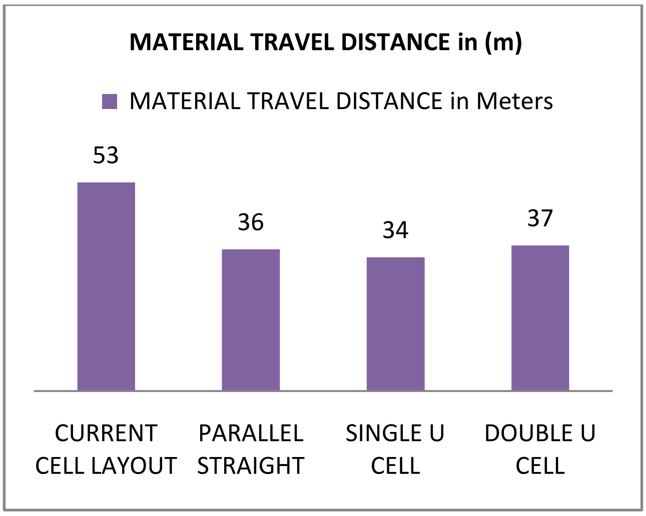

Fig.7 Material in process average travel distance for various cell layout

From the below graph for initial implementation and analysis on comparing the parameters of various cells, the double U cell layout is preferred based on the material in process travel distance and raw material travel distance as shown in figure 7 and 8.

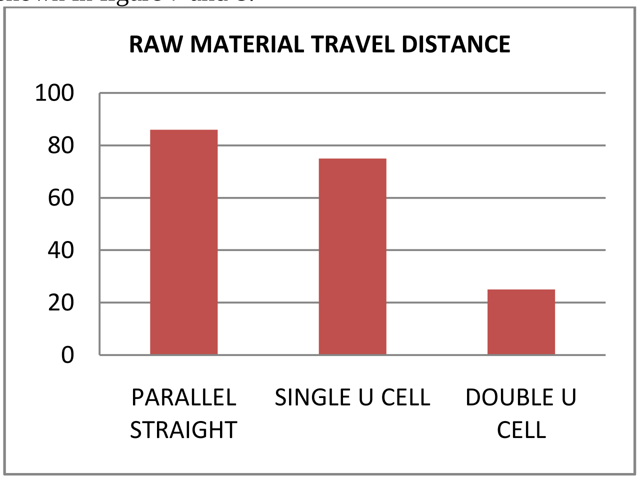

Fig.8 Raw material travel distance for various cell layout

The double U cell layout has been chosen based on the less area occupancy, less worker movements and rearranged with less cost. The double U cell layout was formed; the machine was arranged on the operation sequence.

Table 10 Comparison of existing process layout to double U cell layout

Various layout		Existing cell layout	Double U cell
SL. NO.	Parameters	Metric Value	Metric Value
1	Area used (Sq.meters)	1400	1020
2	Man power (Nos)	23	20
3	Number of machines (Nos)	11	11
4	Average Material Travel Distance (m)	53	37
6	Operator Movements (high/Low)	HIGH	LOW

It is evident from the table 10 on comparing the parameters of double U cell cellular layout proposed with the old process layout. The following significant improvement has been achieved.

IV. CONCLUSION

The various layouts has been proposed and implementing one double U cell type layout, the following significant improvement has been achieved. The reduction in usage of area by 27.14 % from 1400 to 1020 sq.meters. The man power reduced by 13.04 % from 23 to 20 persons. The material in process travel distance reduced by 30.18 % from 53 to 37 meters.

REFERENCE

1. Christian Becker, Armin Scholl (2006) A survey on problems and methods in generalized assembly line balancing, European Journal of Operational Research 168 . pp.694–715.
2. Eric Molleman et al (2012) The evolution of a cellular manufacturing system – a longitudinal case study, Int. J. Production Economics 75 (2002) 305–322.
3. Fawaz A. Abdulmalek, Jayant Rajgopal (2007) Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study, Int. J. Production Economics 107 ,pp.223–236.
4. Haeryip sihombing , Kannan rassiah and Parahsakthi chidambaram (2011) Line balancing analysis of tuner product manufacturing, International Journal of Engineering Science and Technology (IJEST), ISSN : 0975-5462, Vol. 3 No. 6 June 2011.
5. Hosseini Nasab , Aliheidari bioki , H. Khademi Zare (2012) Finding a probabilistic approach to analyze lean manufacturing, Journal of Cleaner Production 29-30. pp.73-81.
6. Hubert k Rampersad and anwar EI Homsi (2008) TPS Lean and six sigma book,sara books private limited, value stream mapping, pp.28-33
7. Kulak, M.B. Durmusoglu, S. Tufekci (2005) A complete cellular manufacturing system design methodology based on axiomatic design principles, Computers & Industrial Engineering 48. pp765–787
8. Matthias Holweg (2007)The genealogy of lean production, Journal of Operations Management 25 .pp.420–437.
9. Mikell P Groover , Automation, production systems and computer integrated manufacturing , third edition,pp. 525-528.
10. Nils Boysen , Malte Fliedner , and Armin Scholl (2007) A classification of assembly line balancing problems, European Journal of Operational Research 183 . pp.674–693 .
11. Nuchsara Kriengkorakot ,Nalin Pianthong (2007) The Assembly Line Balancing Problem :Review articles, KKU Engineering Journal Vol. 34 No .2 , pp.133 – 140
12. Rachna Shah ,Peter T. Ward (2003) Lean manufacturing: context, practice bundles, and performance, Journal of Operations Management 21, pp.129–149.
13. Rahani A, Muhammad al-Ashraf (2012) Production Flow Analysis through Value Stream Mapping: A Lean Manufacturing Process Case Study, Procedia Engineering 41,pp.1727 – 1734.
14. Ravikumar Marudhamuthu, Marimuthu krishnaswamy,and Damodaran Moorthy Pillai (2011) The Development and Implementation of Lean Manufacturing Techniques in Indian garment Industry, JJMIE, Volume 5, ISSN 1995, pp. 527 – 532.
15. Sule Itir Satoglu, M. Bulent Durmusoglu ,Ibrahim Dogan (2006) Evaluation of the conversion from central storage to decentralized storages in cellular manufacturing environments using activity-based costing, Int. J. Production Economics 103 ,pp.616–632.