DESIGN, ANALYSIS AND PERFORMANCE SIMULATION OF CELLULAR MANUFACTURING SYSTEM - A CASE STUDY

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Abstract- Cellular Manufacturing is one such strategy, which has emerge as an important technique to cope up with fast changing industrial demands and for the application of newer manufacturing systems. This research work has been carried out as a case study in an automotive parts manufacturing company with the objective of designing the cells, evaluating it and implementation of cellular manufacturing system. Efforts are made to design, analyze and simulate the performance using “WITNESS” software. Problems in the current layout which is traditional are identified and analyzed through simulation. Then the new layout is created according to cell formations. Then the results are compared with the current layout. The results revealed an improvement of 34.85% in productivity of the cellular manufacturing system. A new material handling system has been implemented to reduce the motion wastes and unwanted transportation.

Keywords- Cellular Manufacturing, Analysis, Simulation

I. INTRODUCTION

Cellular Manufacturing is based on the principle that similar things should be manufactured similarly [5]. In the context of similarity it includes design attributes such as size, shape, etc. and/or manufacturing attributes like length, diameter, surface finish, tolerance, etc. Once if the parts are grouped, then machines, tools and equipments required to process these parts having similarity are grouped together to take the advantages of similarities in manufacturing [4]. Cellular manufacturing (CM) has emerged as an alternative to batch type of manufacturing [1]. Traditional flow line manufacturing and complex job shop layout can be reorganised into cellular manufacturing systems with the help of systematic approach offered by CM methodology. Decomposition of plant operations into subsystems usually plays a vital role in reducing paper work, production lead time, reducing WIP, reducing labour and setup time, delivery time, rework and scrap material and thus improves the work quality [3].

II. LITERATURE REVIEW

M. Murugan and V. Selladurai [1] have carried out a work on optimization and implementation of cellular manufacturing system using three cell formation algorithms. They have examined three array-based clustering algorithms, namely rank order clustering (ROC), rank order clustering-2 (ROC-2) and direct clustering analysis (DCA) for manufacturing cell formation. Nittaya Ngampak and Busaba Phruksaphanrat [2] have carried out a real life case study on Cellular Manufacturing Layout Design and Selection in Electronic Manufacturing Service Plant. Wafik Hachicha, Faouzi Masmoudi, Mohamed Haddar [3] have carried out work on Formation of machine groups and part families in cellular manufacturing systems using a correlation analysis approach. Surjit Angra, Rakesh Sehgal, Z. Samsudeen Noori [4] have carried out a work on Cellular manufacturing—A time-based analysis to the layout problem. In their paper, an approach that orms the cluster based on the processing time is suggested. Bhaba R. Sarker [5] has carried out a work on Measures of grouping efficiency in cellular manufacturing systems. Grouping efficiency is a measure of goodness of machine-part groups in cellular manufacturing systems. Basilis Boutsinas [6] has carried out a work on Machine-part cell formation using biclustering. Part-Machine Grouping (PMG) problem is the key step in cellular manufacturing aiming at grouping parts with similar processing requirements or similar design features into part families and by grouping machines into cells associated to these families.

III. METHODOLOGY

Research work starts with cell formation which is the first step in methodology. After formation of cells analysis has been carried out for the results. Then performance simulation has done for existing and newly formed cells. At last studying the simulation result implementation is carried out at site location. As per new layout machines are placed.

IV. NEED AND OBJECTIVES

This is the case study of XYZ Pvt. Ltd. Company which produces auto components. Company has purchased a new land to start a new machining plant of auto components. Company want to shift their existing two small machining plants to this newer big land. Currently machining of parts is going on with traditional manufacturing. Due to this company is facing various problems like high inspection cost, space, cycle time, WIP inventory, material handling, inventory cost etc. To overcome on these problems
company has decided to use cellular manufacturing system in its new plant.

V. WORK AS PER METHODOLOGY

1. Cell Formation:
Any application of Cellular Manufacturing System commences with the grouping of machines and parts. This action of grouping of machines and parts into cells and part families is known as Cell Design. Here, the main objective of manufacturing cells designing is to develop a production system for the production of part families that are grouped according to similarities on their design or manufacturing features. Cell formation is carried out using Rank Order Clustering method.

![Table 1. Cell Formation using ROC method](image)

![Image](image)
An ideal solution is one, which contains all operations in block diagonal form, with no intercellular movements. A void in the block diagonal form simply means that a certain part of that particular family doesn’t visit some machines in the cell. It doesn’t give an indication that the machine is idle.

\[ \eta = \frac{\alpha}{(1 + \beta)} \times 100\% \quad \text{Where,} \]

\[ \alpha = \frac{\text{Total no. of operations in block diagonal form}}{\text{Total no. of operations}} \]

\[ \alpha = \frac{27}{27} \quad \beta = 0 \]

\[ \beta = \frac{\text{Total no. of voids in block diagonal form}}{\text{Total voids in the matrix}} \]

\[ \beta = \frac{0}{81} \quad \beta = 0 \]

\[ \eta = \frac{1}{(1 + 0)} \times 100\% \quad \eta = 100\% \]

3. Performance Simulation:
Simulation involves the generation of an artificial operation of the system. This observation is used to know the real world process. It is used to describe and analyze the behavior of a system. A simulation study is carried out using WITNESS as simulation software. Both current and proposed system is modelled in order to find out the performance comparison.

3.1 Current layout simulation
A simulation run for 250 no. of parts is done for current layout. The snapshot of the current layout arrangement with machines and sequential flow are shown in fig. 1.

3.2 Proposed layout simulation
A simulation run for 250 no. of parts is done for proposed layout. The snapshot of the proposed layout arrangement with machines and sequential flow are shown in fig. 2.

3.3 Comparison of simulation results

<table>
<thead>
<tr>
<th>Name</th>
<th>% Idle</th>
<th>% Busy</th>
<th>% Idle</th>
<th>% Busy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine 1</td>
<td>48.17</td>
<td>48.92</td>
<td>5.69</td>
<td>86.64</td>
</tr>
<tr>
<td>Machine 2</td>
<td>28.45</td>
<td>48.17</td>
<td>5.78</td>
<td>88</td>
</tr>
<tr>
<td>Machine 3</td>
<td>48.17</td>
<td>48.92</td>
<td>0</td>
<td>88</td>
</tr>
<tr>
<td>Machine 4</td>
<td>28.45</td>
<td>48.17</td>
<td>0.09</td>
<td>86.64</td>
</tr>
<tr>
<td>Machine 5</td>
<td>57.65</td>
<td>38.23</td>
<td>24.1</td>
<td>68.77</td>
</tr>
<tr>
<td>Machine 6</td>
<td>57.65</td>
<td>38.23</td>
<td>18.41</td>
<td>68.77</td>
</tr>
<tr>
<td>Machine 7</td>
<td>57.05</td>
<td>37.93</td>
<td>24.28</td>
<td>68.23</td>
</tr>
<tr>
<td>Machine 8</td>
<td>57.05</td>
<td>37.93</td>
<td>18.77</td>
<td>68.23</td>
</tr>
<tr>
<td>Total Eff.</td>
<td>47.83%</td>
<td>43.31%</td>
<td>12.17%</td>
<td>78.16%</td>
</tr>
</tbody>
</table>

Table 2 shows the comparison between traditional and cellular system. It shows % idle and % busy of machines. Simulation study shows that there is a drastic change in performance of current system and cellular system. Due to cellular layout machines are arranged as per the operational sequence, hence total cycle time and transportation time has been reduced. This system is more efficient than previous due to cellular system. It is concluded that there is a change with 34.85 % more efficient than previous.
CONCLUSION

An attempt has been made to increase productivity of the industry. Cellular manufacturing system has been implemented to reduce motion, transportation wastes, workers salary and their requirement etc. The simulation study of current layout and proposed layout is carried out so as to compare the performance. The cellular implementation reduces 8 numbers of workers and increases system performance by 34.85%. At the end implementation of cellular system gives company a benefit of Rs. 15, 41,600 approx per annum.

REFERENCES


