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Reconfiguration of Cellular Layout to Reduce Material Handling Cost with Alternative Routing by Using Genetic Algorithm

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Abstract: *Grouping the machines and parts in a cellular manufacturing system based on similarities is known as the cell formation problem. This paper proposes a method for design of cell layout for a manufacturing system under dynamic demand environment for various periods. The proposed method of cell layout has two phases. In the first phase, Rank Order Clustering (ROC) is used to determine the initial cell layout for first period. A software program is used to obtain the solution. The second phase employs an optimization technique (Genetic Algorithm (GA)) has been used to solve the proposed model to develop a better solution. For the purpose of study, three cells are taken in which one cell holding four machines and other two cells holding each three machines. The demand for each period doesn't exceed eleven components. This layout is applied in all the periods. Thus the entire planning horizon uses a single layout even though the demand is different in different periods of the planning horizon. This has lead to better layouts in most cases for a size of ten machines in three cells. The layout method involves development of a layout for the demand scenario for various periods.*

INTRODUCTION

Today's competitive market is characterized by an environment where demand volumes and product mix vary from one period to another. Therefore manufacturers require well designed layouts to improve their operations and reducing manufacturing costs. Cellular Manufacturing (CM) is the application of Group Technology (GT) in manufacturing systems.GT is a manufacturing philosophy, which determines and divides the components into families and the machines into cells by taking advantage of the similarity in processing and design functions. The design for cellular manufacturing involves stages which follow: (1) cell formation by grouping parts into families and machines into cells, (2) creating a layout of the cells within the shop floor (i.e., inter-cell layout); (3) creating a layout of machines within each cell (i.e.,intra-cell layout).The realization of benefits expected from cellular manufacturing largely depends on how effectively the stages of the design have been performed Cellular Manufacturing (CM) is known to offer several major advantages, including reduction in lead times and work-in-process inventories and reduction of setup times due to similarity of part types produced. The cellular layout is effective only when product families are sufficiently stable and production volumes are relatively large or easy to move and reconfigurable machine stations are implicitly.

Scope and Purpose

The aim of this paper is to present a new mathematical model for inter and intra-cell layout problems in cellular manufacturing systems with Dynamic demands. The objective is to minimize the total costs of inter movements in both machine and cell layout problems simultaneously. There are several objectives to measure the effectiveness of CMS such as: Minimum number of intercellular/intracellular moves, greatest proportion of part operations performed within a single cell, Maximum machine

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utilization, minimal total costs by reducing setup times, and WIP (work-in-process), minimal capital investment, minimum number of voids in the cells, effective facility layout including cellular operations, throughput improvement. Equipment set-up and changeover time reduction, reduction in inventory, visual factory concepts, mistake-proofing of processes.

Advantages

- Set up time reduction
- Work-in-process inventory reduction
- Material handling cost reduction
- Reduction in material flow distance
- Improvement in machine utilization

Cellular Manufacturing

Cellular manufacturing is a manufacturing process that produces families of parts within a single line or cell of machines operated by machinists who work only within the line or cell. A cell is a small scale, clearly-defined production unit within a larger factory. This unit has complete responsibility for producing a family of like parts or a product. All necessary machines and manpower are contained within this cell, thus giving it a degree of operational autonomy. Each worker is expected to have mastered a full range of operating skills required by his or her cell. Therefore, systematic job rotation and training are necessary conditions for effective cell development. Complete worker training is needed to ensure that flexible worker assignments can be fulfilled.

Cellular manufacturing, which is actually an application of group technology, has been described as a stepping stone to achieving world class manufacturing status. The objective of cellular manufacturing is to design cells in such a way that some measure of performance is optimized. This measure of performance could be productivity, cycle time, or some other logistics measure. Measures seen in practice include pieces per man hour, unit cost, on-time delivery, lead time, defect rates, and percentage of parts made cell-complete. This process involves placing a cluster of carefully selected sets of functionally dissimilar machines in close proximity to each other. The result is small, stand-alone manufacturing units dedicated to the production of a set or family of parts or essentially, a miniature version of a plant layout.

While the machinery may be functionally dissimilar, the family of parts produced contains similar processing requirements or has geometric similarities. Thus, all parts basically follow the same routing with some minor variations (e.g., skipping an operation). The cells may have no conveyor movement of parts between machines, or they may have a flow line connected by a conveyor that can provide automatic transfer.

Cellular manufacturing is a hybrid system that links the advantages of a job shop with the product layout of the continuous flow line. The cell design provides for quick and efficient flow, and the high productivity associated with assembly lines. However, it also provides the flexibility of the job shop, allowing both similar and diverse products to be added to the line without slowing the process.

Benefits of Cellular Manufacturing

Many firms utilizing cellular manufacturing have reported near immediate improvements in performance, with only relatively minor adverse effects. Cited improvements which seem to have occurred fairly quickly include reductions in work-in-process, finished goods, lead time, late orders, scrap, direct labor, and workspace.

In particular, production and quality control is enhanced. By breaking the factory into small, homogeneous and cohesive productive units, production and quality control is made easier. Cells that are not performing according to volume and quality targets can be easily isolated, since the parts/products affected can be traced to a single cell. Also, because the productive units are small, the search for the root of problems is made easier.

Quality parameters and control procedures can be dovetailed to the particular requirements of the parts or work pieces specific to a certain cell. By focusing quality control activity on a particular production unit or part type, the cell can quickly master the necessary quality requirements. Control is always enhanced when productive units are kept at a minimum operating scale, which is what cellular manufacturing provides.

When production is structured using cellular manufacturing logic, flow systematization is possible. Grouping of parts or products into sets or families reveals which ones are more or less amenable to continuous, coupled flow. Parts that are standardized and common to

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many products will have very low changeover times, and thus, are quickly convertible to continuous, line-flow production. Products that are low-volume, high-variety and require longer set-up times can be managed so that they evolve toward a line flow.

Work flow that is adapted to the unique requirements of each product or part allows the plant to produce high-volume and high-variety products simultaneously. Since the cell structure integrates both worker and product versatility into a single unit, it has the potential to attain maximum system flexibility while maintaining factory focus. Cells can be designed around single products, product groups, unique parts, part families, or whatever unique market requirements are identified.

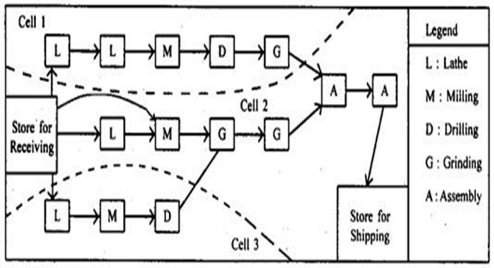

Fig 3.1 Cellular Layout

Objectives and Problem Definition

Objectives

The objectives of this project work are summarized as follows:

- To develop an initial layout for dynamic demand environment.
- To assign the components into cells
- To analyze the material handling cost / period

Problem Definition

Assumptions

- Number of Cells – 3
- Maximum– 4 machines / cell
- Minimum- 3machines/cell
- Total number of machines – 10
- Total number of parts -11
- Distance between cells (300m – 400m – 500m)
- Distance between machines-10m
- Cost for material handling / meter – Rs. 1.
- Batch size 250-300 parts
- Machines position are interchangeable but Replacement cost / machine – Rs. 200.
- Within the cell there is no material handling cost.
- Operator and machining cost are same for all operations.
- The number of cells to be formed is known in advance.
- Only one machine of each type is available.

Methodology

- Data collection of "Demand" for one period.
- Initial layout design using ROC (Rank order clustering)
- Programming in language
- Optimization algorithm is employed to Determine the final layout

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Procedure

- Initial layout is formed by using rank order clustering algorithms.
- Machines are arranged in single row with in the cell.
- Machines are installed in ascending order.
- Assume this (initial layout) as a fixed layout for all periods
- Calculate the inter cell and intra cell material handling cost for the period.
- Machines are rearranged to minimize the inter cell and material handling cost.
- Machines are rearranged within the cell. And the inter cell and intra cell cost are calculated.
- If the above said cost is lesser the objective function, the layout is accepted.

Rank Order Clustering (ROC)

Rank order clustering algorithm is a simple algorithm used to form machine part groups.

This algorithm considers two data: Number of components, and component sequences.

Based on the component sequences, a machine-part incidence matrix is developed.

The rows of the machine component incidence matrix represent the machines which are required process the components. The columns of the matrix represent the component numbers.

Steps in ROC Algorithm

Step 0: Input: Total number of components, component sequences.
Step 1: From the machine component incidence matrix using the component sequences
Step 2: Compute binary equivalent of each row.
Step 3: Rearrange the rows of the matrix in rank wise (high to low from top to bottom)
Step 4: Compute binary equivalent of each column and check whether the columns of the matrix are arranged in rank wise (high to low from left to right).If not go to step 7
Step 5: Rearrange the columns of the matrix rank wise and compute binary equivalent of each row.
Step 6: check whether the rows of the matrix are arranged in rank wise? If not go step 3, otherwise go to step 7.
Step 7: Print the final machine – component incidence matrix.

List of Machines

M/c No Description

1. Lathe
2. Horizontal milling machine
3. Vertical milling machine
4. Shaping machine
5. Boring machine
6. Drilling machine
7. Grinding machine
8. Slotting machine
9. Slitting saw
10. Power hacksaw machine

Table Machine Sequence

PART NO	QUANTITY REQUIRED	MACHINE SEQUENCE
1	1030	1-8
2	990	10-2-5-7
3	980	1-10-4
4	1000	10-2-9

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5	860	1-2-3
6	980	10-2
7	990	2
8	880	4-5
9	870	1-2-3
10	990	1-2-5
11	1100	8-2

Table Total Material Handling cost for One Period

Conclusion and Future Work

For the dynamic environment, the initial layout for the first period demand was obtained by using rank order clustering algorithm and JSP language also assumed this as a static layout for the entire period. Then the material handling cost for the period was also calculated and added. This is the total material handling cost per year.

In the second phase of project, our objective is to reduce the material handling cost than this cost. For that, we have to do following work in future.

1. Develop the mathematical equation for proposed model.
2. Genetic algorithm is proposed to obtain a good solution.
3. Design and implementation to be done by using software languages like C, JSP.

References

1. Shayan. E, (2009) "Software Implementation and Experimentation with a New Genetic Algorithm for Layout Design", Journal of Industrial and Systems Engineering, Vol.3, No.2, pp 116-124,
2. Michael Mutingi and Godfrey C. Onwubolu (2010), "Integrated Cellular Manufacturing System Design and Layout Using Group Genetic Algorithms", National University of Singapore, 2010, pp 206-222.
3. Tamal Ghosh, Pranab K Dan, Sourav Sengupta, Manojit Chattopadhyay (2010), "Genetic rule based techniques in cellular manufacturing (1992-2010): a systematic survey, International Journal of Engineering, Science and Technology, Vol. 2, No. 5, pp. 198-215.
4. Mihajlovic. I, Zivkovic. Z, Strbac.N, Zivkovic. D, and Jovanovic. A (2007), "Using Genetic Algorithm To Resolve Facility Layout Problem" Serbian Journal of Management, No. 2, pp. 35.-46.
5. Norhashimah Morad "Genetic Algorithm Optimization for the Machine Layout Problem" School of Industrial Technology.
6. Murugan. M, Selladurai.V, (2005)," Manufacturing Cell Design with Reduction in Setup Time Through Genetic Algorithm" Journal of Theoretical and Applied Information Technology, pp 76-97.
7. Maheswaran Rajasekharan, Brett A. Peters, Taho Yang (1996), "A Genetic Algorithm For Facility Layout Design In Flexible Manufacturing Systems"
8. Shiyas C.R, Madhusudanan Pillai.V, (2012),"A Non-linear Programming Model for the Machine Grouping and a Genetic Algorithm based Solution Methodology" International Journal of Computer Applications, Vol 38,PP 37-41.

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