CONSIDERATIONS ON THEORETICAL AND PRACTICAL APPROACH TO THE CONCEPT OF GROUP TECHNOLOGY

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Abstract: In this study are presented different approaches in the group technology, which is an important component of the construction of manufacturing cell in a flexible system and reports the main advantages and disadvantages of the used methods until present.

1. INTRODUCTION

Finding a definition for group technology isn't an easy task, since so many people have written about this.

Group technology is the understanding that lot of the problems have similarities[3] and by grouping those similar problems, one solution could solve all the problems. Taking advantage of the form and manufacturing similarities, group technology can reduce the loading time, production time and the time for preparation-closing.

The group of similar parts is known as part family and the group of machineries used to process an individual part family is known as machine cell. It is not necessary for each part of a part family to be processed by every machine of corresponding machine cell. The manufacturing efficiencies are generally increased by employing GT because the required operations may be confined to only a small cell and thus avoiding the need for transportation of in-process parts

As an application of group technology in the manufacturing flexible cell, pieces are grouped in family parts (pieces) and machines in machines groups of the manufacturing cell, and this way appears a time reduction and inter-cells materials exchanges.

The manufacturing classification by the cluster/group technology is made by taking count of the following[8]:

- Similarities of geometry or pieces features that are about to be obtained.
- The total dimension of the material and piece (part) that needs to processed.
- Lot size and type of material.
- Common manufacturing processes based on similarities.

2. APPROACHES IN GROUP TECHNOLOGY

Over time have been developed group methods for parts (pieces) and for machines. All these algorithms are different but they have in common one thing, which is the part-machine matrix.

In the manufacturing process can be considered lots of situations, such as operations order. This has a strong influence for handling cost of the material and the time with transport.

Group tehnology can be implemented by manual or automated techniques. Here is a classification of the methods that can be apply.

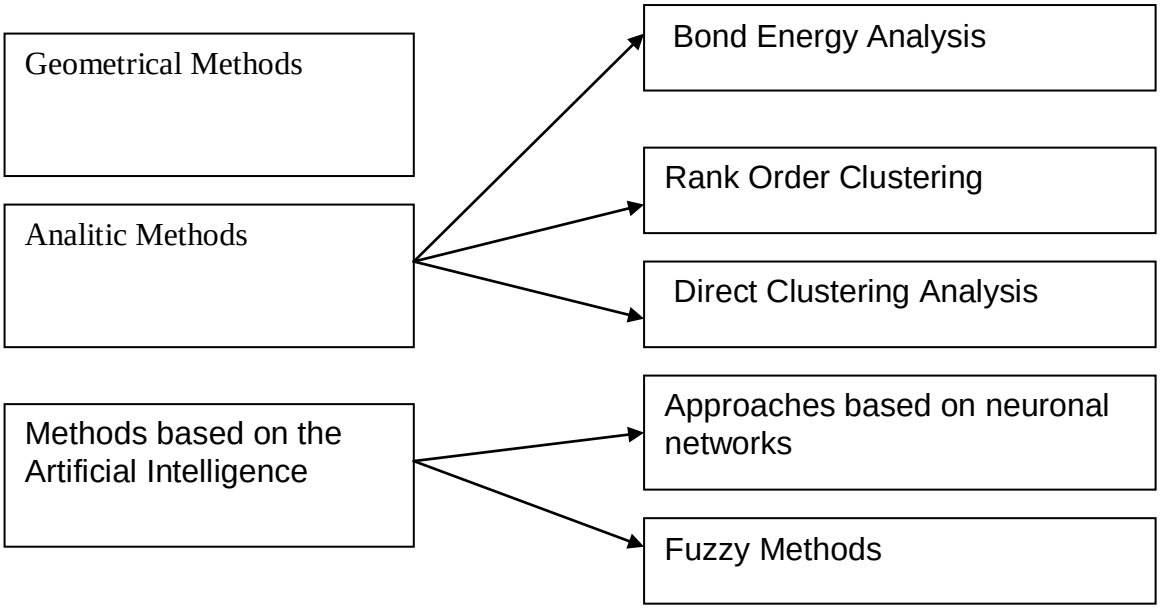

Fig 1 Approached methods in group technology

2.1. CLUSTERING TECHNIQUES BASED ON MATRICES

This group technique of components and working machines are based on the term called incidence matrix. This is a matrix that connects the working machine with the component. Matrix elements are „0" or „1". An "1" in the i row and j column j (a_{ij} = 1) from the matrix shows that the j component j has an operations on the i machine, since an "0" entry shows the opposite, based matrix.

The method based on technic matrix tries to allocate machines to groups and components to some associated families by rearranging the rows and columns of the matrix, so that we could have on the main diagonal entry blocks of 1 value.

By rearranging rows and columns in the incidence matrix, so that we have block with the „1" value on the main diagonal and then to allocate machines to groups and components to some associated families.

In the specific literature there are presented lots of clustering algorithms, such as Bond Energy Analysis by McCormick et al. [1972], Rank Order Clustering by King [1980] , Modified Rank Order Clustering by Chandrasekharan and Rajagopalan [1989], Direct Clustering Analysis by Chan and Milner [1989],

"Rank order an clustering" Algorithm.

In order to find an appropriate cell divison, it is used the technique called production flow analysis. To apply this technique, based on the "rank order and clustering" algorithm it's necessary to define the incidence matrix[4].

Every single column is associated with a number (number 2 power from 2^0 to 2^{m-1}). Starting from right to left. Next step is to sum up the value of the order numbers associated where we have a value of the element that equals 1 from each line alone.

That way, each line will have an associated number. There are ordered descending lines depending on the associated numbers. The same steps are taken for the columns. The result is a matrix, which has on the diagonal blocks, where each block represents a manufacturing cell, which represents a family of parts/pieces.

2.2 HIERARCHICAL CLUSTERING TECHNIQUES

Other examples of clustering (grouping) are based on the hierarchical clustering techniques. These clustering techniques are different between them by the calculation of the distances between groups. So, the method „Single linkage clustering" is the distance between two groups which is given by the shortest way between the two groups. „Complete linkage clustering" method, calculates the distance between two groups which is given by the longest way between the two groups, while the method „Average linkage clustering**"** is defined as the distance between groups as the average distance between the pair elements.

In hierarchical clustering, the facts from the machine-component matrix aren't divided in groups or cells in one single step. Rather, they are first separated in some big cells, from this cells, each one are still divided in smaller groups, and so on until the final groups that are generated and can't be subdivided anymore.

2.3 GRAPH THEORETICAL METHOD

In the first cluster methods using as graph the working machines, are simbolized through nodes and if two machines are processing the same piece/part,[7] the graphs that represent the two machines are connected between them.

This cluster algorithm of the flexible manufacturing systems are also to implement in the graph theoretical context developed by Vannelli and Kumar to find out the duplicated machines.

2.4 APPROACH IN GROUP TECHNOLOGY BASED ON ARTIFICIAL INTELLIGENCE

The approaches based on neuronal networks offers a true alternative to solve the cluster technology problem, having more advantages compared to the conventional approaches.

Adaptive Resonance Theory (A.R.T) is a binary classification which is based on the identification of similarities in the manufacturing process.

The main benefits of the approach based on the neuronal networks compared to the traditional approaches are the easiest way of identification of the manufacturing similarities and computing performance.

In the making of the individual manufacturing processes, manufacturing cluster processes, except the operations that fulfills one particular piece/part. The cluster technology concept allows to optimize the production and material, by reducing the price of the product.

2.5 LINEAR PROGRAMMING IN GROUP TECHNOLOGY

A problem regarding linear programming is an optimization problem where is the attempt to minimize or maximize the linear function in the decision variables.

The main wish in all that means structure and functionality of a manufacturing flexible system is to minimize the costs. Linear programming manage to reduce the total cost by optimizing the movement between the machines and reducing the cost of the machines. In practice, lots of parameters such as time, parts/pieces request and machine availability are not known exactly.

As there are not enough facts to predict unknown parameters, linear programming fuzzy type is inserted as a strong instrument to replace this uncertainty with the knowledge of an expert system.

3. CONCLUSION

Lots of methods and techniques have been developed and studied in the past in this domain. All contribute and make an optimization of the performances from a flexible manufacturing system. It is a priority that these group technologies to clarify the best number of family parts, so that the technological and logical mix that has appeared in the manufacturing systems to be the best ones.

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