MATRIX METHOD FOR REARRANGING MANUFACTURING PROCESS

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ABSTRACT
When all machines can do more than one operations it is difficult to find what should be the sequence so that within minimum time and minimum cost product manufactured. Penalty (transfer time and transfer cost) also added when we change job from one machine to another machine. It increases both time and cost of desired machining process. By using matrix method we can generate best operations sequences with minimum time, minimum cost and also penalty (transfer time and transfer cost) from one machine to another machine can be saved by doing more than one operations on one machine. In the dissertation we studied 2 cases using matrix method; manufacturing of idler shaft and idler pipe. We have generated best operating sequences with minimum time, minimum cost and reduced penalties.

Keywords–*GroupTechnology,Penalty,Cellular Manufacturing, Time Reduction, Matrix Method.*

I. INTRODUCTION

Matrix approach was developed to overcome the dependence on the sequence of decision and the problem of artificial constraints. In this concept, a process is generated using only the real constraints (technological ones) by assuming an imaginary machine and tools. The difference between conventional process planning and matrix process planning is that the process planner generates a process using an imaginary machine (i.e., a machine that poses only technological constraints). The matrix concept is composed of three stages x:

II. Stage 1: Technology-The Theoretical Process Concept
III. Stage 2: The Transformation Stages-Constructing a Matrix
IV. Stage 3: Decision (Mathematics) Stage
V. The matrix method results in optimum selection of machine and sequence of operations. The selection and decision process is purely mathematical and is not affected by intuition or rules of thumb. For example, using old inaccurate machines for rough cuts and accurate machines for finish cuts would be the matrix recommendation for the criteria minimum cost optimization and economic quantity.

II. LITERATURE REVIEW

Classification and Coding Based System

Classification and coding based systems was the primary tool of GT in the 1960s and 1970s. According to Opitz, H., (1970) “classification and coding techniques have been used in practice but using features, based on shape and then group parts accordingly is a very labour intensive job and in order to solve this problem the idea of weighted codes is useful”

Array-Based Clustering Techniques

Chu and Tsai, (1990) has provided detailed comparison of some of the well-known array-based clustering techniques (Rank Order Clustering (ROC), Direct Clustering Analysis (DCA) and Bond Energy Analysis (BEA).Chanrasekharan and Rajagopalan, (1986) observed that “ROC is highly dependent upon the configuration of the input matrix and therefore can only be efficiently applied to well-structured Machine-Part incidence matrices”. Despite its shortcomings, ROC is considered to be the most simple and popular algorithm for cell formation. McCormick et al. (1972) suggested “BEA is a general clustering algorithm and can be applied to any nonnegative array of numbers” According to this technique the interrelationship, between an element in an array and its neighbouring four elements, is being exploited. The sum of the products of these adjoining elements creates bond energy.

Purcheck(1974)

The author was the first who have applied the approach of mathematical modelling to the cell formation problem. The research shows that first the part families are formed and then machines are grouped according to the processing requirements of each part family which indicates that the approach carries out machine-Part grouping sequentially rather than simultaneously.

Xu & Wang(1989)
The authors used fuzzy mathematics to handle the issue of uncertainty/imprecision while calculating similarity between parts. Here a dynamic part family formation procedure has been presented which assigns new parts to an already existing part family by using the principle fuzzy pattern recognition. The weakness of the approach could be its non-simultaneous approach towards machine part grouping.

Leem& Chen(1996)
The authors developed fuzzy clustering algorithm based on determining the similarity coefficient using input in the form of non-binary Machine-Part incidence matrix while taking alternative process plans into consideration. The algorithm was useful in terms considering alternative processing of parts and minimization of cost involved in intercellular movements. The weakness of the approach could be solving the cell formation problem in a sequential manner (first machine group formation followed by part family formation) rather than simultaneous.

III. MATRIX METHOD

It is not always taken into consideration in generating a process plan. Decision taken by the process planner introduces constraints. Once the process planner makes a decision, it becomes a constraint to the successive decision. For example, the machine selected imposes constraints on the accuracy, power available for the cutting operation, the maximum depth of a cut, the torque at the spindle, the available speed and feeds, the maximum cutting speed, the machining dimensions, the number of tools that can be used. A single machining operation can be adjusted to match with these constraints. Machining cost and time are functions of the machine selected and tool selected imposes constraints on tool life, depth of cut, feed rate, the maximum cutting speed. All these constraints are artificial; they affect the result of the sequence of decision made. Selecting another machine will impose different constraints. A different sequence of decision will result in a different process plan. Routing in manufacturing describes how items are processed and assemblies produced. There are two types of routing data:

1. **Technical data.** Instruct the operator, NC programmer, or setup operator how to perform the operation. Specify the tools, jigs and fixtures, cutting speed, feed rate, depth of cut, inspection, and so on. Operation means a single pass of machining or specific action in assembly.
2. **Production management data.** Specify the sequence of operation, manufacturing lead times, the time needed for each setup and the information required to determine work centre load. This data is referred to as routing.

If process planner makes a decision, it becomes a constraint to the subsequent stages. For example, the process selected imposes constraints on scheduling, by under loading or overloading a machine. Scheduler should use administrative tools to solve such situation.

Machine Selection for the matrix

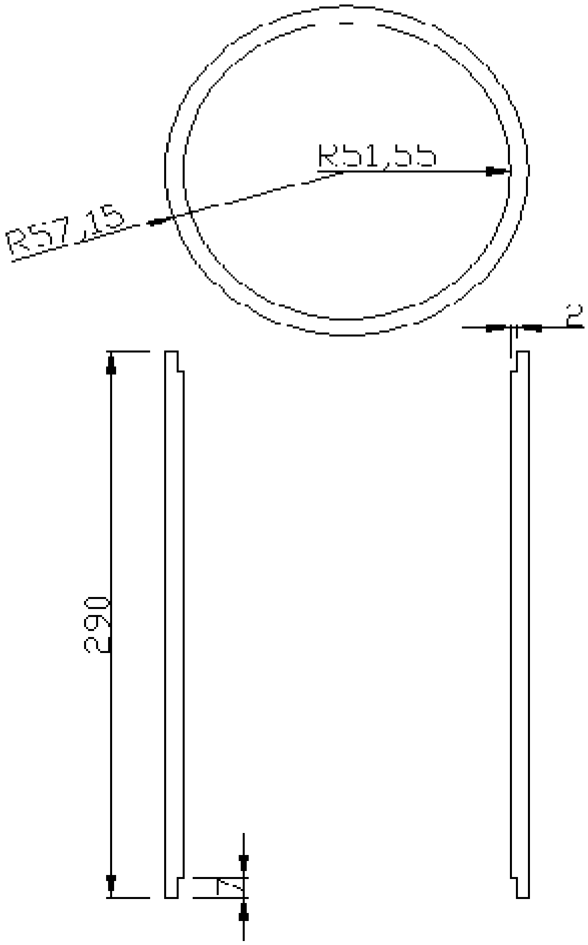
- Initially, the physical size of the machine is checked. If machine cannot accommodate a part, it is excluded from further consideration.
- If a machine cannot perform even a single operation. That machine is excluded from the matrix. Otherwise, the machine remains in the matrix. The time or cost of a specific operation that cannot be machined is set to a high value (99). This prevents selection of the machine for that operation, while leaving the possibility of selecting the machine for other operations.
- Inaccurate, old, low-cost machine may be used for rough operations; even they are not suitable for finish operations.

The matrix concept is composed of three stages :

- Stage 1: Technology-The Theoretical Process Concept
- Stage 2: The Transformation Stages-Constructing a Matrix
- Stage 3: Decision (Mathematics) Stage

IV. WORK DONE

I have studied manufacturing of idler pipe and idler shaft. Firstly we study idler pipe shown in Figure below



Machine-Operation Time Matrix for idler pipe

Operation	Priority	M1	M2	M3	M4
010	010	2.38	99	99	99
020	020	99	1.68	1.32	99
030	030	99	3.80	3.22	99
040	040	99	99	99	1.04

Machine-Operation Cost matrix

Operation	Priority	M1	M2	M3	M4	Min. Cost
010	010	**23.11**	2531.43	2627.45	2111.67	**23.11**
020	020	961.3	42.96	**35.03**	2111.67	**35.03**
030	030	961.3	97.17	**90.76**	2111.67	**90.76**
040	040	961.3	2531.43	2627.45	**22.18**	**22.18**
Total						**171.08**

Machine-Operation Total Matrix Zi,j for idler pipe

Operation	Priority	M1	M2	M3	M4
010	010	**171.26**	2687.55	2783.48	2267.79
020	020	1077.08	158.74	**148.06**	2227.45
030	030	983.57	119.44	**113.03**	2133.85
040	040	961.3	2531.43	2627.45	**22.18**

Machine-Operation Time Matrix for idler shaft

Operation	Priority	M1	M2	M3	M4
010	010	2.04	99	99	99
020	020	99	2.86	1.02	99
030	030	99	8.34	2.14	99
040	040	99	0.86	0.32	99
050	050	99	0.20	0.05	99
060	060	99	99	99	6.20

Machine-Operation Total Matrix for idler shaft

Operation	Priority	M1	M2	M3	M4
010	010	**414.92**	4732.85	4760.51	4248.74
020	020	1278.98	482.27	**395.93**	4199.48
030	030	1180.46	623.23	**351.07**	4100.96
040	040	1164.63	280.52	**256.95**	4085.13
050	050	1162.37	249.42	**242.88**	4082.81
060	060	921.69	4326.3	4354.02	**240.62**

V. RESULT AND CONCLISION

We can conclude from discussion that in case 1, by doing both operations 2 and 3 on machine 3 we can reduce 1 transfer penalty. Best sequence of operations done by machines with minimum time and minimum cost generated and time and cost saved are 3.33% and 4.47% respectively. In case 2, we can do operations 2, 3, 4, 5 on machine 3 and can reduce 3 transfer penalties. Best sequence of operations done by machines with minimum time and minimum cost generated and time and cost saved are 18.53% and 20.01% respectively.

FUTURE SCOPE

1. We have studied cases in which there are some constraints such as in case 1, operation 1 and 4 can be done on machines 1 and 4 only. In case 2, operation 1 and 6 can be done on machines 1 and 4 only. Using matrix method we can studies those cases also in which there are no constraints, all machines can do all operations.

2. In our discussed cases we have taken no random priorities. Only discussed already sequenced priorities cases. In future we can study cases in which there are random priorities in those cases operations can be moved upward and downward

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