A Study on Process Planning System for Holonic Manufacturing – Process Planning Considering both Machining Time and Machining Cost –

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1. Introduction

Manufacturing has transformed from mass production to batch production. The conventional manufacturing systems are not adaptable to small batch productions. Thus, new architectures of manufacturing systems have been proposed which can not only cope with dynamic changes in volumes and varieties of products, but also unscheduled disruptions. One of such manufacturing system is holonic manufacturing system [1].

The objective of the present research is to develop an integrated process planning and scheduling system, which is applicable to holonic manufacturing system. A systematic method is proposed to select suitable machining sequences and sequences of machining equipment as shown in Fig.1 based on the objective functions of the machining time and machining cost, by applying genetic algorithm (GA) and dynamic programming method (DP).

2. Input Information

There are i nos. of different types of machining features, MF	extsubscript{i} to be manufactured for a product and ME	extsubscript{a}(i=1,2,3,…,α, k=1,2,3,…β), feasible machining equipment for each feature. The feasible machining equipment ME	extsubscript{a} are represented by the combinations of machine tool, fixturing position and orientation and cutting tool. The constraint due to the preference relations among the machining features and the constraint of the future machining schedules for different work pieces are known.

3. Objective Function

Generally it seems that if the machining time is decreased, there is a decrease in the machining cost, but this is not so when expensive machine equipment is used to reduce the machining time. The objective function is to minimize the machining time (MT) and the machining cost (MC). In accordance to Activity Based Costing [2], the machining time and the machining cost can be shown as under:

\[ MT = \sum TA + \sum WT \]
\[ MC = \sum (TA + \sum CA_k) + \sum CO_{bu} \]

(1)

(2)

where TA is the processing time for the machining feature i with equipment k, TR is the transportation time, FT is the fixturing and refxturing time, CT is the cutting tool change time and WT is the waiting time.

Each activity has its corresponding unit activity cost CA	extsubscript{k} (=mt,ps,tr,ft,ct) for machining feature i with equipment k based on the relation between the activities and the machine tool, preparation station, AGV, fixturing and cutting tool and CO	extsubscript{bu} is the cost for buffer, as shown in the Table 1.

As the unit of machining time and machining cost is different, it is normalized to make the objective function unit less after weightages are given to both machining time and machining cost.

\[ \sum_1^\beta \sum_1^\alpha PT_k \]
\[ \sum_1^\beta \sum_1^\alpha FT_k \]
\[ \sum_1^\beta \sum_1^\alpha CT \]

(3)

4. GA and DP method

Sets of feasible machining sequences of the machining features are generated applying GA, which can satisfy the constraints of the preference relations among the machining features. The DP method is then applied to minimize the objective function that is the normalized machining time and machining cost considering the future schedule of the machining equipment. GA and DP method is repeated again and again until the most suitable machining sequences and sequences of machining equipment are obtained.

5. Conclusion

The algorithm has been constructed based on both GA and DP. It has been encoded using Visual C++. The numerical experiments for a product have been made and the results observed. Depending upon the individual factory’s requirement and priority to machining time and machining cost, suitable weightage is allocated and an integrated process planning and scheduling system is developed by finding the most suitable machining sequence and the sequence of the machining equipment.

Reference
